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7. Diabetic Foot Ulcer Toolkit
RNAO’s

Assessment and Management of Diabetic Foot Ulcers [1]

Levels of Evidence

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Evidence obtained from at least one randomized controlled trial or meta-analysis of randomized controlled trials</td>
</tr>
<tr>
<td>B</td>
<td>Evidence from well-designed clinical studies but no randomized controlled trials</td>
</tr>
<tr>
<td>C</td>
<td>Evidence from expert committee reports or opinion and/or clinical experience or respected authorities. Indicates absence of directly applicable studies of good quality</td>
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</tbody>
</table>

RNAO’s

Strategies to Support Self-Management in Chronic Conditions: Collaboration with Clients

Levels of Evidence [2]

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>la</td>
<td>Evidence obtained from meta-analysis or systematic review of randomized controlled trial</td>
</tr>
<tr>
<td>lb</td>
<td>Evidence obtained from at least one randomized controlled trial</td>
</tr>
<tr>
<td>lla</td>
<td>Evidence obtained from at least one well-designed controlled study without randomization</td>
</tr>
<tr>
<td>llb</td>
<td>Evidence obtained from at least one other type of well-designed quasi-experimental study, without randomization</td>
</tr>
<tr>
<td>III</td>
<td>Evidence obtained from well-designed non-experimental descriptive studies, such as comparative studies, correlation studies and case studies</td>
</tr>
<tr>
<td>IV</td>
<td>Evidence obtained from expert committee reports or opinions and/or clinical experiences of respected authorities</td>
</tr>
</tbody>
</table>
1. Objectives

The objectives of the development and implementation of these resources is to help Health Care Providers to:

a. Find practical, evidence-based resources to use when caring for individuals that have or who are at risk of developing, diabetic foot ulcers

b. Perform a comprehensive patient assessment including assessing for indicators of diabetic foot ulcers that will not heal in the inpatient and outpatient care settings (Acute Care, Long Term Care and Community Care Settings)

c. Identify the correct etiology of diabetic foot ulcers

d. Recognize neuropathy and foot deformities specific to diabetic foot ulcers and apply interventions and/or referrals as appropriate

e. Complete a Lower Leg (LLA) and Diabetic Foot Assessment (DFA) including vascular-ABPIs (toe pressures) in order to appropriately classify Diabetic Foot Ulcers

f. Complete ongoing monofilament assessment for neuropathy

g. Focus wound care treatment on appropriate offloading, moisture balance, ongoing debridement and infection prevention and treatment

h. Utilize the PUSH, BWAT or LUMT tool for accurate wound measurement

i. Determine if the wound is “Healable, Maintenance or Non-Healable”

j. Recognize signs & symptoms of infection and identify treatment interventions

k. Assess Infection (PEDIS – IWGDF)

l. Assess for osteomyelitis by identifying bone exposure, probing to bone or stalled wound

m. Perform accurate wound assessment including progress towards healing

n. Increase the use and implementation of evidence-based diabetic foot ulcer treatment plans including pain management using pharmacological and non-pharmacological interventions

o. Identify and implement appropriate best practice wound care

p. Improve the coordination and communication between care providers/care institutions regarding the transfer/discharge plan for patients with diabetic foot ulcer

q. Encourage self-management in treatment and education plans

2. Background

In 2014, the World Health Organization reported that globally the prevalence of diabetes was estimated to be 9% or 347 million people among adults aged 18+ years, creating a global epidemic [3] compelling healthcare organizations around the world to identify and acknowledge their own challenges regarding the prevention and management of complications
resulting from diabetes. Since 2014, healthcare organizational globally have been creating, modifying and researching methods and frameworks to identify and resolve these challenges.

Current trends in diet, population growth, aging, urbanization, a reduction in physical activity and consequent increase of obesity and other societal changes [4] across the developed world has substantially increased the prevalence of diabetes. The increase in diabetes has been reported across socioeconomic status, age and geography and growing statistics of diabetes across Ontario Canada is no exception. The Canadian Diabetes Association (2014) reported that 1.4 million Ontarians (9.8%) were diabetic at a cost of $5.8 billion dollars in 2014 with estimations into the year 2024 increasing the prevalence to 2.2 million (13.1%) at a cost $7.6 billion across Ontario [5].

For healthcare organizations with a high population of diabetic patients, prevention and management of complications associated with diabetes is at the forefront – and for good reason. The effects and consequences of a high population of diabetic patients across health care organizations are well documented. People with diabetes are “over three times more likely to be hospitalized with cardiovascular disease, 12 times more likely to be hospitalized with end-stage renal disease and over 20 times more likely to be hospitalized for a non-traumatic lower limb amputation compared to the general population,” [6]. The costs of amputations have been found to be 10 to 40 times greater than the cost of effective initiatives to prevent amputation [7]. The Canadian Institute for Health Information reports alarming statistics regarding foot ulceration, a common complication for patients on service at CCAC’s: “foot ulceration affects an estimated 15 - 25% of people with diabetes at some time in their lives. One third of amputations in 2011-2012 were performed on people reporting a diabetic foot wound,” in addition statistics across acute care organizations have confirmed that the number one complication for admission in acute care hospitals in Canada is the diabetic foot ulcer [7].

In addition to the high percentage of diabetic patients in health care organizations; interventions in the prevention and management of complications associated with the disease must include other areas of concern. In its 2014 report, the Canadian Diabetes Association estimated that the number of Canadians living with diabetes emphasized that diabetes is the leading cause of “blindness, end stage renal disease, foot ulceration and non-traumatic amputation in Canadian adults;” [5]. Capes and Sherifali (2010) state that of the Canadians living with diabetes, an estimated “325,000 (approximately 16%) will develop a foot ulcer.”

Given the high percentage of patients living with diabetes in Ontario, healthcare organizations need to ensure an enhanced focused care model for patients with diabetes; promotion of healthy behaviours in the prevention of diabetic complications, reduce health risk for complications associated in the diabetic patient, and a decrease in fiscal resources used to provide care for diabetic complications [8] [9].

The following document summarizes research, best practice guidelines, literature, expert interprofessional opinions and ongoing changes to the care received by patients with diabetes across the sectors of care. This work was completed by a collaborative group of interdisciplinary wound care professionals from Acute Care, Complex Continuing Care/Rehabilitation, Long-Term Care (public and private), Primary Care, Specialized Ambulatory Clinics and Home Care (including Service Provider Organizations). This document focuses on the prevention and management of diabetic foot ulcers and should be utilized by clinicians and policy makers in the endeavor to create enhanced care for these patients.

**Best Practices for Assessment, Prevention, and Treatment of Diabetic Foot Ulcers**

The Registered Nurses’ Association of Ontario (RNAO) embarked on a multi-year program of nursing best practice guideline development, pilot implementation, testing, evaluation and dissemination. In 2005, during the fifth cycle of the program, one of the areas of importance was on the assessment and management of diabetic foot ulcers. This guideline was developed by a panel of interdisciplinary team members convened by the RNAO [1].
In 2006, The Canadian Association of Wound Care (CAWC) developed best practice recommendations for the prevention and treatment of diabetic foot ulcers for clinical practice [10].

Every 5 years, since 1992, the Clinical & Scientific Section (C&SS) of the Canadian Diabetes Association has published comprehensive, evidence-based recommendations for healthcare professionals to consider in the prevention and management of diabetes in Canada [11]. They have served as a helpful resource and aid for anyone caring for people with diabetes and are recognized, not only in Canada but also internationally, as high-quality, evidence-based clinical practice guidelines. In 2013, the Canadian Diabetes Association (CDA) created a Clinical Practice Guidelines Expert Committee to review existing literature and best practices. The committee created updated Clinical Practice Guidelines for patients with a Diabetic Foot Ulcer [12].

All clinicians are expected to use best practices to assess, prevent, and treat diabetic ulcers to improve patient outcomes. The framework used in this guideline was applied from the Registered Nurses Association of Ontario (RNAO) "Clinical Best Practice Guidelines of Assessment and Management of Diabetic Foot Ulcers (2005)" and its supplement (2013) [1]. The RNAO Clinical Best Practice Guidelines "Strategies to Support Self-Management in Chronic Conditions: Collaboration with Clients" (2010) [2] was also used for self-management section. A complete list of references used can be found in the appendices.


2013 brought together another international-interdisciplinary expert group to review and submit best practice guidelines for wound management in the diabetic foot ulcer. This group formed in recognition of literature gaps in not only assessment, debridement, infection management but an appropriate dressing selection to optimize healing in patients with diabetic foot ulcers [17]. These guidelines have been published and referenced in the document.
Wound Bed Preparation Paradigm

The wound bed preparation (WBP) [18] paradigm is used to assess, diagnosis, and treat wounds while considering patient concerns. It links evidence-based literature, expert opinion, and clinical experiences of respected wound care specialists. The framework is beneficial because the components are interrelated and can be re-evaluated if the wound deviates from the care plan. Furthermore, the interprofessional team is able to collaborate together through shared discussion to classify a healable, maintenance, and non-healable wound.

Figure 1 Adapted from:
3. **Address Patient-Centered Concerns** [2] [1] [19] [20] (see Toolkit Item #6 for worksheet) (Level B,C: RNAO’s Assessment and Management of Diabetic Foot Ulcers) (Level Ia, Ib, III: RNAO’s Strategies to Support Self-Management in Chronic Conditions: Collaboration with Clients)

a. **Assess Psychosocial Needs /Pain and Quality of Life (QOL)**

- Communicate with patients, their caregivers and significant others to identify patient-centered goals to determine realistic expectations for healing or non-healing outcomes.
- Although pain is not usually a concern in diabetic foot ulcers, assess pain and in collaboration with patient and caregivers, create a pain relief plan. When pain does occur it may indicate ischemia, infection or Charcot.
- Individuals with diabetes need to be informed about the risks and complications, understand the loss of protective sensation (LOPS), and be taught the problem-solving skills necessary to respond to health-related problems. 
- Assess quality of life (QOL) (see Toolkit Item #10a and #10b for assessment forms) and screen for mental health concerns (i.e. depression see Toolkit Item #11 for assessment form)
- Encourage and provide ongoing support for smoking cessation if applicable (see Toolkit Item #7a for Smoking, Chronic Wound Healing, and Implications for Evidence-Based Practice – McDaniel and Browning, Toolkit Item #7b for Checklist to readiness to quit smoking, see Toolkit Item #7c for Applying 5 A’s to smoking cessation, see Toolkit Item #7d for WHY test, see Toolkit Item #7e for smoking cessation medication comparison chart and see Toolkit Item #7f for Strategies to avoid relapse). [20]

b. **Socioeconomic Determinates of Health** (see Toolkit Item #5 for Canadian Nurses Association *Social Determinants of Health and Nursing: A Summary of Issues*)

- Provide education to patients, caregivers and significant others for care and the management of diabetes
- Educate patients, their caregivers and significant others regarding the possible need for long term compression garments. Assess need for assistance in utilizing garments.
- Assess for the presence or absence of social support system for treatment and preventions of diabetic foot ulcers.
- Pressure offloading devices are often expensive and the healthcare professional may need to consult with appropriate agencies to facilitate access to such treatments for their patients.

Health is a resource for everyday life and is influenced by the determinants of health: income, social status, support networks, education, employment and working conditions, health services, healthy child development, physical environment, gender, culture, genetics, and personal health practices. Unemployment, lack of sick benefits, job insecurity, low income, and homelessness can deter healing and cause more stress. For example, money is needed to purchase adequate food that is vital for wound healing. Patient may need a referral for a social worker to assist with finances.
The following questions could assist in assessing your patient’s financial concerns:

1. Do you have benefits from any other sources to cover cost of insulin/supplies, compression stockings, medical drugs, parking fees, food allowance. Check for availability for financial compensation (e.g. private insurance, veterans medical benefits, Ontario Disability Support Program –ODSP/Ontario Works, Non-Insured Health Benefits -NIHB and Southern Ontario Aboriginal Diabetes Initiative – SOADI for First Nations people and Inuit)
2. Are you the sole bread-winner in your family?
3. How often have you used the food bank or soup kitchen this month?
4. Do you have sick-time benefits or unemployment insurance?
5. Would you like a referral to Meals on Wheels or information on food bank/soup kitchen?

Social Supports

There is evidence to suggest that strong supportive networks improve health and healing [21]. Patients who have limited social support are more at risk for depression, greater risk for complications, decreased well-being, poor mental health and physical health. Furthermore, patients who are disabled, migrants from other countries, ethnic minorities and refugees are vulnerable to racism, discrimination and hostility that may harm their health. Patients who have stigmatizing conditions such as mental health, addictions (street drug use, methadone patients and cigarette smokers), and diseases such as HIV/AIDS suffer from higher rates of poverty and limited supports.

The following questions could assist in assessing your patient’s support system:

1. Do you have someone to help you? Friend, family, neighbor, church member?
2. Does patient seem depressed or suicidal?
3. Do you have transportation to receive medical follow-up and to obtain groceries?
4. Do you have someone to help you with your personal care such as showering?
5. Do you have someone to get your groceries, housekeeping and other necessities?
6. Are you afraid of your partner or family member?
7. Would you like a referral to a social worker or case worker?

C Chronic Disease Self-management

- Assess level of patient’s self-management skills

Chronic Disease Self-management

Self-management promotes and strengthens the confidence (self-efficacy) of the patient to be able to care for their chronic disease [2]. The focus of self-management is to allow the patient to self-identify concerns and to address these concerns collaboratively with nurses and health professionals. Fostering and promoting independence is strongly encouraged but the patient and caregiver will need to be assessed by health professional for cognitive and physical ability.
The Self-management Initiative, through the Ontario Ministry of Health and Long-Term Care (MOHLTC), is an integrated, comprehensive strategy aimed at preventing and improving management of chronic conditions in Ontario. The goal of this cost-free program is to provide education and skills training workshops to both health care providers and patients with chronic conditions. For more information, please call 1-866-337-3318 or www.wwselfmanagement.ca.

1. Self-Management Initiative Link for Patients with Chronic Conditions

2. Self-Management Initiative Link for Health Care Providers
The 5 A’s of Behavioural Change

Assess
Beliefs, Behavior and Knowledge

Arrange
Specify plan for follow-up (e.g. visits, phone calls, mailed reminders)

Advise
Provide specific information about health risks and benefits of change

Personal Action Plan
List specific goals in behavioral terms
List barriers and strategies to address them
Specify follow-up plan
Share plan with practice team and patient’s social support

Assist
Identify personal barriers, strategies, problem-solving techniques and social/environmental support

Agree
Collaboratively set goals based on patient’s interest and confidence in their ability to change the behaviour

These activities are not necessarily linear with each step following the other sequentially. The goal of the 5 A’s, in the context of self-management support, is to develop a personalized, collaborative action plan that includes specific behavioural goals and a specific plan for overcoming barriers and reaching those goals. The 5 A’s are elements that are interrelated and are designed to be used in combination to achieve the best results especially when working with patients in complex health and life situations.

Figure 2: RNAO Clinical Best Practice Guideline: Strategies to Support Self-Management in Chronic Conditions: Collaboration with Clients [2]
1. ASSESS
Beliefs, Behavior and Knowledge

- Establish rapport with patients and families
- Screen for depression on initial assessment, at regular intervals and advocate for follow-up treatment of depression
- Establish a written agenda for appointments in collaboration with the patient and family, which may include:
  a) Reviewing clinical data
  b) Discussing patient’s experiences with self-management
  c) Medication administration
  d) Barriers/stressors
  e) Creating action plans
  f) Patient education including assessing learning style
- Consistently assess patient’s readiness for change to help determine strategies to assist patient’s readiness for change to help determine strategies to assist patient with specific behaviours
- Identify patient specific goals

2. ADVISE
Provide specific information about health risks and benefits of change

- Combine effective behavioural, psychosocial strategies and self-management education processes as part of delivering self-management support
- Utilize the “ask-tell-ask” (also known as Elicit-Provide-Elicit) communication technique to ensure the patient receives the information required or requested
- Use the communication technique “Closing the Loop” (also known as “teach back”) to assess a patient’s understanding of information
- Assist patients in using information from self-monitoring techniques (e.g., glucose monitoring, home blood pressure monitoring) to manage their condition
- Encourage patients to use monitoring methods (e.g., diaries, logs, personal health records) to monitor and track their health condition
- Identify community resources for self-management (e.g., support groups)

3. AGREE
Collaboratively set goals based on patient’s interest and confidence in their ability to change the behaviour

- Collaborate with patients to:
  a) Establish goals
  b) Develop action plans that enable achievement of SMART goals (see below)
  c) Establish target dates for success of goals and reassessment
  d) Monitor progress towards goals

4. ASSIST
Identify personal barriers, strategies, problem-solving techniques and social/environmental support

- Use motivational interviewing with patients to allow them to fully participate in identifying their desired behavioural changes
• Teach and assist patients to use problem-solving techniques
• Be aware of community self-management programs in a variety of settings, and link patients to these programs through the provision of accurate information and relevant resources

5. ARRANGE
Specify plan for follow-up (e.g., visits, phone calls, mailed reminders)

• Arrange regular and sustained follow-up for patients based on the patient’s preference and availability (e.g., telephone, email, regular appointments). Nurses and patients discuss and agree on the data/information that will be reviewed at each appointment and share with other interdisciplinary team members involved
• Use a variety of innovative, creative and flexible modalities with patients when providing self-management support such as:
  a) Electronic support systems
  b) Printed materials
  c) Telephone contact
  d) Face-to-face interaction
  e) New and emerging modalities
• Tailor the delivery of self-management support strategies to the patients’ culture, social and economic context across settings
• Facilitate a collaborative practice team approach for effective self-management support
• Share with caregiver/family members/circle of care
Figure 3: College of Nurses Ontario SMART Goals [22]

**Specific**
A specific goal is detailed, focused and clearly stated. Everyone reading the goal. Everyone should know exactly what you want to learn.

**Measurable**
A measurable goal is quantifiable, meaning you can see the results.

**Attainable**
An attainable goal can be achieved based on your skill, resources and area of practice.

**Relevant**
A relevant goal applies to your current role and is clearly linked to your key role & responsibilities.

**Time-limited**
A time-limited goal has specific timelines and a deadline. This will help motivate you to move toward your goal and to evaluate your progress.

College of Nurses SMART Goals Link
## Stages of Change Model

Table 1: RNAO Clinical Best Practice Guideline: Strategies to Support Self-Management in Chronic Conditions: Collaboration with Clients [2]

<table>
<thead>
<tr>
<th>Stage in Transtheoretical Model of Change</th>
<th>Patient Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-contemplation</td>
<td>Not thinking about change; may be resigned Feeling of no control Denial: does not believe it applies to self Believes consequences are not serious</td>
</tr>
<tr>
<td>Contemplation</td>
<td>Weighing benefits and costs of behavior, proposed change</td>
</tr>
<tr>
<td>Preparation</td>
<td>Experimenting with small changes</td>
</tr>
<tr>
<td>Action</td>
<td>Taking a definitive action to change</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Maintaining new behavior over time</td>
</tr>
<tr>
<td>Relapse</td>
<td>Experiencing normal part of process of change Usually feels demoralized</td>
</tr>
</tbody>
</table>
There are 3 self-management strategies that health professionals can use to promote self-management in patients with Diabetic Foot Ulcers [2]

1. **Motivational Interviewing** (assess patient-centered concerns)
   (see Toolkit Item #6 for worksheet)

   The following questions could assist in assessing your patient’s concerns:
   - What is your most important problem or concern? (It may not be related to the disease)
   - Do you have a history of depression? Are you depressed now?
   - What has worked in the past and what did not work?
   - Why do you want to change and how hard are you willing to work?
   - Are you willing to make the changes in your lifestyle to improve your health?
   - What might prevent you from working hard on this (e.g., barriers that are present)

   Choose the one area that you would like to work on:
   - Improve physical activity
   - Perform wound care
   - Practice leg exercises
   - Purchasing, wearing and caring for my compression stockings if applicable
   - Donning and doffing compression stockings using aids if applicable
   - Nutrition
   - Leg elevations
   - Skin care of my legs
   - Control weight
   - Stop smoking
   - Prevention of new ulcers
   - Managing co-morbidities
   - Alternative therapy modalities
   - Work modifications
   - Meet new people

   How willing are you to set goals and make changes in lifestyle on a scale of 1-10?

   What is it that you find most difficult about living with venous disease and how can I help you?

2. **Goal Setting**

   - Provide specific health information and health risks requested from patient and family. Here is a sample of topics to discuss: Monofilament Testing, Infection, wound treatment, managing loss of sensation, nutrition, smoking cessation, offloading, prevention for life, blood sugar control and diet, debridement, amputation.
   - Collaboratively develop a Personal Action Plan (see below)
   - Set SMART Goals (specific, measureable, achievable, relevant and timely)
Try to make goals small enough to achieve success or patient may not try again if she/he fails

Personal Action Plan

1. List specific goals in behavioral terms

2. List barriers and strategies to address them

3. Specify Follow-up Plan

4. Share plan with practice team and client's social support

3. Problem Solving

- Assist with problem solving to help identify barriers and enlist family/social support
- Ascertain financial barriers
- Arrange for follow-up visits to review goals and discuss challenges
- Encourage healthy coping such as yoga, music, counselling, friends, and family support

[College of Nurses SMART Goals Link] [RNAO BPG Self-Management Link]
4. Identify and Treat the Cause

(Level C: RNAO’s Assessment and Management of Diabetic Foot Ulcers [1])

4.1 Assessment

Should be undertaken by healthcare professional(s) trained and experienced in diabetic foot ulcer management

a. Identify Risk Factors and Etiology of Diabetic Foot Ulcers (DFUs) [23]

Not all patients with diabetes are at-risk for ulceration. Key risk factors include presence of peripheral neuropathy, foot deformity, peripheral vascular disease, or a history of foot ulceration or amputation of (a part of) the foot or leg [13] [24] [25] [26] [27] [28]. In general, patients without any of these risk factors do not appear to be at-risk for ulceration. For the current best practice, we define the at-risk patient in line with the definition from the International Working Group on the Diabetic Foot (IWGDF) [13] as ‘a patient with diabetes who does not have an active foot ulcer, but who has peripheral neuropathy, with or without the presence of foot deformity or peripheral artery disease, or a history of foot ulcer(s) or amputation of (a part of) the foot or leg.’

<table>
<thead>
<tr>
<th>Table 2: International Working Group Diabetic Foot Definitions [13]</th>
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</thead>
<tbody>
<tr>
<td><strong>Peripheral Neuropathy</strong></td>
</tr>
<tr>
<td><strong>Loss of Protective Sensation</strong></td>
</tr>
<tr>
<td><strong>Foot Deformity</strong></td>
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<tr>
<td><strong>Peripheral Artery Disease</strong></td>
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<tr>
<td><strong>Therapeutic Footwear</strong></td>
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</table>

Risk factors that are predictive and/or precursors of DFU include direct and indirect causes. For example, deformities of the foot are a direct cause of DFU. Foot deformities develop from a multitude of reasons including joint contractures, clawing of toes, spurs, bunions, bunionettes, extrusions of bones (as in Charcot neuroarthropathy), malunited fractures, and arthritides. Clawed toes, repetitive shear stresses, and trauma are other conditions that can be direct causes of DFU [29] [30] [31] [32] [33] [34] [35]

Indirect causes of DFU lead to wounds through secondary processes. For example, patients with diabetes with sensory neuropathy may disregard callus formation over deformities because no pain is associated with pressure being placed on the callus. Without attention to removing the deformity and/or debulking the callus, an ulcer frequently develops with continuing loading (i.e., weight bearing) over the sites [23] [13] [27] [36] [37].
Table 3: Direct and Indirect Causes of Risk Factors [23]

<table>
<thead>
<tr>
<th>Cause</th>
<th>Examples</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indirect: leads to DFU through secondary mechanisms. Usually onset of the DFU does not occur immediately; often there is repetitive exposure to the cause of it is a chronic, establish condition</strong></td>
<td>Neuropathy</td>
<td>Delays diagnosis and leads to muscle imbalances and eventually deformities. Contributed to dryness of skin. Neuropathy, post-traumatic and congenital causes.</td>
</tr>
<tr>
<td></td>
<td>Deformity</td>
<td></td>
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<tr>
<td></td>
<td>Peripheral Artery Disease</td>
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<tr>
<td></td>
<td>Venous Statis Disease</td>
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<tr>
<td></td>
<td>Glycosylation of tissues</td>
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<td></td>
<td>Collagen Vascular Diseases</td>
<td></td>
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<td></td>
<td>Angilitis</td>
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<tr>
<td><strong>Direct: leads to DFU through an immediate effect of the cause</strong></td>
<td>Deformity</td>
<td>Join contractures, clawing of toes, spurs, bunions, bunionettes, etc.</td>
</tr>
<tr>
<td></td>
<td>Trauma</td>
<td>Immediate injury or sometimes delayed sloughs.</td>
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<tr>
<td></td>
<td>Charcot Neuroathropathy</td>
<td>Bone collapse leads to deformities</td>
</tr>
<tr>
<td></td>
<td>Malunited fractures</td>
<td>Deformities increase contact pressure stresses.</td>
</tr>
<tr>
<td></td>
<td>Osteoporosis</td>
<td>Subliminal stress – pathological fractures – deformities – ulcers</td>
</tr>
<tr>
<td></td>
<td>Congenital Anomalie</td>
<td>May result in deformities.</td>
</tr>
</tbody>
</table>

Enzymatic glycosylation of soft tissues reduces the elasticity of tissues as well as soft tissue padding and is another indirect cause of DFU [38] [14] [13] [39]. With loss of elasticity and padding, wounds are likely to occur with repetitive minimal stresses or constant pressure. However, they would not ordinarily occur if the tissues were normal. Most DFU occur because of a combination of indirect and direct causes. Direct causes make the sites more vulnerable to wound formation, and the indirect causes delay management and/or attenuate the healing/wound prevention processes [23] [14] [26] [40] [17].

The more risk factors that are present, the more likely DFU will occur. Within 1 year of wound healing following DFU, up to 60% of patients with a previous DFU history will develop a recurrent wound [41] [39] [42]. Reasons for this include failure to implement preventive measures as well as the wound site being more vulnerable to re-injury due to; less resiliency and elasticity of scar tissue, abnormal mechanics from tissue loss with amputations and debridement, or combinations of these. Hence, this healed ulcer group presents a dichotomy; it has the highest risk for developing new or recurrent ulcerations and conversely is the easiest group to recognize the risk factors [24] [43] [44].
Risk factors include:

**Physiological**

- Sub-optimal glycemic control/monitoring
- Advanced diabetes
  1. Neuropathy
     - Autonomic (e.g. bladder, BP, temp, digestion, sexual function)
     - Sensory (lack of protective sensation)
     - Motor (e.g. Drop foot)
  2. Retinopathy
  3. Nephropathy
- Osteoporosis
- Hypertension
- Heart disease
- Hyperlipidemia
- Collagen vascular diseases (eg. Ankylosing spondylitis, Dermatomyositis, Polyarteritis nodosa, Psoriatic arthritis, Rheumatoid arthritis, Scleroderma, Systemic lupus erythematosus)
- Gout
- Use of immunosuppressant medications
- Advanced age
- History of deep vein thrombosis
- History of foot infections or osteomyelitis
- Decreased cognitive ability
- Alcohol/drug abuse
- Peripheral artery disease
- Venous stasis disease (Insufficiency)
- Glycosylation of tissues
- Congenital abnormalities
- Vasculitis (Angilitis)
- Previous ulceration

**Physical Limitations**

- Obesity
- Deformity (Charcot foot, hammer toes, bunions, claw toes, non-union fractures, fixed ankle joint)
- Presence of toe infections (fungal or bacterial), callous and/or corns
- Limited joint mobility
- Visual disturbances
- Amputation
- Trauma

**Socioeconomic/Lifestyle**

- Smoking
- Unsafe home environment
- Inadequate foot wear
- Inadequate hygiene
- Lack of awareness for self-care
- Financial insecurity
- Decreased level of activity
- Nutritional deficits
PATHOGENESIS OF ULCERATION

The reason for the susceptibility and increase incidence of foot ulcers in the diabetic patient is because of the interaction of several pathogenic factors. Research supports this reason establishing that “diabetic foot ulcers result from the simultaneous action of multiple contributing causes,” [26], [45], [46] [47] while the main principal causes are noted to be peripheral neuropathy and ischemia from peripheral vascular disease, [33] [39] [48] [26] [10] [49]. The four pathogenic factors that trigger the formation of an ulcer in the diabetic patient includes abnormal foot biomechanics, peripheral arterial disease, neuropathy and poor wound healing [50] [26] [32] [51] [13] [25] [45] [23] [17].

SUCCESSFUL DIAGNOSIS AND MANAGEMENT OF PATIENTS WITH DIABETIC FOOT ULCERS INVOLVES A HOLISTIC-MULTIDISCIPLINARY APPROACH THAT INCLUDES:

1. Optimal diabetes control
2. Effective local wound care
3. Infection control
4. Pressure relieving strategies
5. Restoring pulsatile blood flow

[17] [31] [34] [12] [78] [57] [40] [6] [11] [1]
General Inspection

A careful inspection of the feet in a well-lit room should always be carried out after the patient has removed shoes and socks. Because inappropriate footwear and foot deformities are common contributory factors in the development of foot ulceration [1] [13], the shoes should be inspected and the question “Are these shoes appropriate for these feet?” should be asked. Examples of inappropriate shoes include those that are excessively worn or are too small. See page # for more information on offloading.

Skin Assessment

The dermatological assessment should initially include a global inspection, including interdigital, for the presence of ulceration or areas of abnormal erythema. The presence of callus (particularly with hemorrhage), nail dystrophy, or paronychia (infection next to nail) should be recorded [54], with any of these findings prompting referral to a specialist or specialty clinic. Focal or global skin temperature differences between one foot and the other may be predictive of either vascular disease, infection or ulceration and could also prompt referral for specialty foot care [55] [56] [57] [35].

Musculoskeletal Assessment

The musculoskeletal assessment should include evaluation for any gross deformity [16]. Rigid deformities are defined as any contractures that cannot easily be manually reduced and are most frequently found in the digits. Common forefoot deformities that are known to increase plantar pressures and are associated with skin breakdown include metatarsal phalangeal joint hyperextension with interphalangeal flexion (claw toe) or distal phalangeal extension (hammer toe) [58] [59] [5] [17].

Neurological Assessment

Peripheral neuropathy is the most common component cause in the pathway to diabetic foot ulceration [60] [31] [44] [61]. The clinical exam recommended, however, is designed to identify loss of protective sensation (LOPS) rather than early neuropathy. The diagnosis and management of the latter were covered in a 2004 ADA technical review [32]. The clinical examination to identify LOPS is simple and requires no expensive equipment.

Factors that may affect healing potential:

Local
- Presence of necrosis, foreign body and/or infection
- Disruption of microvascular supply
- Cytotoxic (toxic to cells) agents
- Repetitive pressure-local trauma
- Exposed bone
- Size

Host
- Co-morbidities (i.e. inflammatory conditions, nutritional insufficiencies, peripheral vascular, renal, obesity or coronary artery disease)
- Glycemic control
- Systemic cytotoxic drugs
- Smoking
- Cognitive impairment
• Alcohol and substance abuse
• Ill-fitting foot wear
• Adherence to plan of care by patient and caregivers
• Cultural and personal belief systems
• Psychological well-being

**Environment**
• Access to care and or offloading
• Family support
• Healthcare sector
• Geographic surroundings
• Socioeconomic status

**Predictors of delayed healing:**
• Fixed ankle joint
• Wound base has more than 50% yellow fibrin
• Wound has been present longer than 6 months
• Wound is larger than 5cm² (L x W≥5cm²)
• Patient had previous hip or knee surgery

The PUSH tool has been validated to utilize for measurement and predictors of healing for DFU [1] [52] [53].

**The symptoms of peripheral neuropathy include the following:**

• Hypesthesia (diminished capacity for physical sensation of the skin)
• Hyperesthesia (excessive sensitivity of the skin)
• Allodynia (pain due to a stimulus which does not normally provoke pain. Thus, *allodynia* involves a change in **quality** of sensation, whether touch or heat or cold, for example)
• Paresthesia (tingling, pins and needles)
• Dysesthesia (unpleasant, abnormal sense of touch usually burning or tingling)
• Radicular pain (pain that follows the root of the nerve)
• Anhydrosis (inability to sweat normally)
Most people harboring atherosclerotic disease of the lower extremities are asymptomatic; others develop ischemic symptoms. A complete vascular assessment should be done on all patients with diabetic foot ulcers \cite{48} \cite{15} \cite{1}.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Neuropathic</th>
<th>Ischaemic</th>
<th>Neuro-ischaemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensation</td>
<td>Sensory loss</td>
<td>Painful</td>
<td>Degree of sensory loss</td>
</tr>
<tr>
<td>Callus/necrosis</td>
<td>Callus present and often thick</td>
<td>Necrosis common</td>
<td>Minimal callus</td>
</tr>
<tr>
<td>Wound bed</td>
<td>Pink and granulating, surrounded by callus</td>
<td>Pale and sloughy with poor granulation</td>
<td>Poor granulation</td>
</tr>
<tr>
<td>Foot temperature and pulses</td>
<td>Warm with bounding pulses</td>
<td>Cool with absent pulses</td>
<td>Cool with absent pulses</td>
</tr>
<tr>
<td>Other</td>
<td>Dry skin and fissuring</td>
<td>Delayed healing</td>
<td>High risk of infection</td>
</tr>
<tr>
<td>Typical location</td>
<td>Weight-bearing areas of the foot, such as metatarsal heads, the heel and over the dorsum of clawed toes</td>
<td>Tips of toes, nail edges and between the toes and lateral borders of the foot</td>
<td>Margins of the foot and toes</td>
</tr>
<tr>
<td>Prevalence (based on \cite{35})</td>
<td>35%</td>
<td>15%</td>
<td>50%</td>
</tr>
</tbody>
</table>
## Table 5: Characteristics of Diabetic Foot Ulcer

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensory Neuropathy</strong></td>
<td>1</td>
</tr>
<tr>
<td>- Impairment of nerve function (lack of sensation or pain)</td>
<td></td>
</tr>
<tr>
<td>- Incidence of neuropathy related to duration and glycemic control</td>
<td></td>
</tr>
<tr>
<td>- One of the more common areas for ulceration in the diabetic with peripheral neuropathy is over the plantar surface of the metatarsal heads.</td>
<td></td>
</tr>
<tr>
<td><strong>Motor Neuropathy</strong></td>
<td>2</td>
</tr>
<tr>
<td>- Wasting of intrinsic muscles of the foot</td>
<td></td>
</tr>
<tr>
<td>- Muscle imbalance</td>
<td></td>
</tr>
<tr>
<td>- Structural foot deformity; digital instability claw toes and subluxated metatarsophalangeal joints</td>
<td></td>
</tr>
<tr>
<td>- Limited joint mobility</td>
<td></td>
</tr>
<tr>
<td><strong>Autonomic Neuropathy</strong></td>
<td>3</td>
</tr>
<tr>
<td>- Loss of autonomic system function</td>
<td></td>
</tr>
<tr>
<td>- Absence of sweat and oil production leads to dry scaly skin and development of cracks and fissures</td>
<td></td>
</tr>
<tr>
<td><strong>Rigid Deformity</strong></td>
<td>4</td>
</tr>
<tr>
<td>- Altered Gait Patterns</td>
<td></td>
</tr>
<tr>
<td>- High compression and frictional forces occur around deformity</td>
<td></td>
</tr>
<tr>
<td>- Bunions, Hammertoes</td>
<td></td>
</tr>
<tr>
<td>- Prominent Metatarsal</td>
<td></td>
</tr>
<tr>
<td><strong>Limited Joint Mobility (Claw Toe)</strong></td>
<td>5</td>
</tr>
<tr>
<td>- Claw toe is often the result of nerve damage</td>
<td></td>
</tr>
<tr>
<td>- The toes &quot;claw,&quot; digging down into the soles of your shoes and creating painful calluses.</td>
<td></td>
</tr>
</tbody>
</table>
Charcot's Foot

- Progression of neuropathy with involvement of the sensory, autonomic and motor components of the distal nervous system, coupled with the effects of repetitive minor trauma and local osteoporosis, results in the typical Charcot's foot.
- Neuroosteoarthropathy or Charcots Foot/Joint:
  - Early stages: hot, swollen, red foot with bounding pulses and prominent veins. Presentation of joint may be mistaken for cellulitis
  - Over time bones of the ankle fragment, arch collapses and result is a “rocker bottom” configuration of the foot
  - Foot is then arched and not able to handle pressure resulting in tissue breakdown and ulceration of the arch

3. http://www.medetec.co.uk/
4.2 Obtain a Comprehensive Patient History and Perform a Physical Assessment

(Level C: RNAO’s Assessment and Management of Diabetic Foot Ulcers [1])

Information obtained should be documented in a structured format (assessment form) for a patient presenting with either their first or recurrent diabetic foot ulcer and should be ongoing thereafter.

Patients with advanced diabetes may have peripheral arterial disease (see guidelines for PAD).

a. Complete a comprehensive patient history including:

- Medical history including history of diabetes
- History of episodes of chest pain, hemoptysis or pulmonary embolus
- History of heart disease, stroke or transient ischemic attack (TIA)
- Comorbidities (peripheral vascular disease, intermittent claudication, rheumatoid arthritis or ischemic rest pain)
- Pain
- Smoking history
- History of ulcer and past treatments
- Current and past medications
- Nutritional status
- Allergies
- Psychosocial status including quality of life
- Functional, cognitive, emotional status and ability for self-care
- Lifestyle (activity level, interests, employment, dependents, support system)

b. Complete a comprehensive physical examination including:

- Blood Pressure, height, weight, pulses in foot and ankle
- Review bloodwork that should include the following:

<table>
<thead>
<tr>
<th>Body Weight (kg):</th>
<th>Height (cm):</th>
<th>BMI:</th>
<th>Recent Weight Loss: [Y] / [N]</th>
<th>Weight Loss (kg):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Protein-Calorie Malnutrition
- Pre-albumin if available (low scores indicate risk for malnutrition)
- Serum albumin level (<30g/l will delay healing; <20g/l will be non-healable)
- C-reactive Protein (CRP)

Check for anemia
- CBC (including RBC, Hct, Hgb, MCV, Platelets etc.)
  - If anemic, proceed to checking →
  - Serum Iron
  - Total Iron Binding
  - Ferritin
  - Transferrin
  - B12
  - Red blood cell folate level

Kidney function
- BUN
- Creatinine
- Potassium
- Albumin/Urine creatinine ratio
c. Perform a bilateral lower leg assessment including:
   (Level A: RNAO’s Assessment and Management of Diabetic Foot Ulcers [1])

1. ABPI/TPBI completed within last 3 mths and results documented
2. If unable to obtain ABPI/TPBI, referral to medical imaging for vascular studies is recommended
3. Repeat ABPI/TPBI assessment every 3 months if healing is not progressing
4. 60 Second diabetic foot screen assessment including monofilament test
5. Texas Diabetic Foot Risk Classification score
   http://www.nhsgrampian.org/guidelines/diabetes/topics/Figu1UnivOfTexaClasSystForDiabFo.html
   OR
   International Working Group Diabetic Foot Risk Classification score
   http://swrwoundcareprogram.ca/Uploads/ContentDocuments/IWDGF%20Risk%20Classification%20an
   d%20Associated%20Interventions.pdf
6. Bilateral lower leg assessment that includes:
   • Leg measurements (foot, ankle, calf, thigh)
   • Nail changes (thicker, dry, crumbly, presence of fungal infection)
   • Assess interdigital spaces
   • Presence of callous or corns
   • Presence of varicosities (varicose veins)
   • Ankle flare
   • Drainage on socks

NEUROLOGICAL Bilateral lower leg assessment that includes:

Autonomic Assessment

• Assess pulses (popliteal – behind knee, dorsalis pedis – top of foot, posterior tibial – medial ankle)
• Measurement of edema (ankle, calf and thigh)
• Assess capillary refill (normal less than 3 seconds)
• Colour (dependent and on elevation)
• Assess dermatological changes due to impaired blood flow & poor sweat gland function (dry, cracked skin, fissures, maceration and hyperhidrosis – excessive sweating)
• Presence of hair on lower leg, feet and toes

Motor Assessment

• Range of motion (ROM) of knee, ankle and foot
• Proprioception (patient awareness of joint position) of hallux (great toe)
• Foot deformities (bony and soft tissue changes Charcot)
• Gait assessment with appropriate off-loading footwear
• Examination of footwear (foreign objects, wear pattern, pressure points, presence of wound drainage)
• Activities of daily living
• Safety of transfers
Sensory Assessment

- Monofilament testing (Monofilament size 5.07 = 10gram)
- Soft touch (cotton ball)
- Temperature difference using an infrared thermometer to compare both legs (2 degree Celsius difference indicates possible infection present)
- Presence of pain

7. Determine cause of the wound

Suggested reading:

Diabetes, Healthy Feet and Your Patients. How healthy are YOUR patients’ feet? Brochure

Five simple clinical tests (10 –G monofilament, pinprick sensation, ankle reflexes, tuning fork test and vibration perception threshold testing) each with evidence from well-conducted prospective clinical cohort studies, are considered useful in the diagnosis of LOPS in the diabetic foot [44] [31] [60] [39] [61]. The task force agrees that any of the five tests listed could be used by clinicians to identify LOPS, although ideally two of these should be regularly performed during the screening exam—normally the 10-g monofilament and one other test. One or more abnormal tests would suggest LOPS, while at least two normal tests (and no abnormal test) would rule out LOPS. The last test listed, vibration assessment using a biothesiometer or similar instrument, is widely used in the U.S.; however, identification of the patient with LOPS can easily be carried out without this or other expensive equipment.

Monofilaments (size 5.07 = 10gram)

Many prospective studies have confirmed that loss of pressure sensation using the 10-g monofilament is highly predictive of subsequent ulceration [44] [62] [63]. Screening for sensory loss with the 10-g monofilament is in widespread use across the world, and its efficacy in this regard has been confirmed in a number of trials, including the recent Seattle Diabetic Foot Study [39] [62] [64] [65].

Nylon monofilaments are constructed to buckle when a 10-g force is applied; loss of the ability to detect this pressure at one or more anatomic sites on the plantar surface of the foot has been associated with loss of large-fiber nerve function. It is recommended that ten sites (1st, 3rd, and 5th metatarsal heads and plantar surface of distal hallux) be tested on each foot.

The technique for testing pressure perception with the 10-g monofilament is illustrated below; patients should close their eyes while being tested. Caution is necessary when selecting the brand of monofilament to use, as many commercially available monofilaments have been shown to be inaccurate.

The sensation of pressure using the buckling 10-g monofilament should first be demonstrated to the patient on a proximal site (e.g., upper arm). The sites of the foot may then be examined by asking the patient to respond “yes” or “no” when asked whether the monofilament is being applied to the particular site; the patient should recognize the perception of pressure as well as identify the correct site. Areas of callus should always be avoided when testing for pressure perception [49].
d. Assess the Wound and Peri-wound

Wound and Peri-wound Assessment is best performed using a validated and reliable wound assessment tool.

See Toolkit item #10a for Bates-Jensen Wound Assessment Tool
Toolkit item #11 for PUSH Assessment Tool
Toolkit item #12 for LUMT Tool

A comprehensive wound assessment should include observation and documentation of the following:

1. Location
2. Odour
3. Infection (PEDIS – IWGDF, NERDS -- STONEES)
4. Sinus Tracts (including undermining and tunneling): Measurement can be obtained by gently inserting small probe into sinus tract, marking probe with end of finger and measuring length from end of probe to finger end
5. Exudate: Comment on amount, type and colour of exudate present
6. Pain: Increase in pain level (new pain is a red flag in patients with altered sensation)
7. Wound bed appearance: colour and type of tissue present (fibrin, granulation or epithelial tissue) and presence of eschar or slough (estimate amounts)
8. Condition of peri-wound (surrounding skin) and wound edges (comment on callous if present)
e. Wound Measurement
(Level B: RNAO’s Assessment and Management of Diabetic Foot Ulcers [1])

1. Measure and document the surface areas of ulcers at regular intervals to monitor progress using the PUSH, BWAT or LUMT tool.
2. Measure depth of wound
3. Measure size of wound: Area of wound measured by multiplying length (longest measurement) and width (shortest measurement) of wound
4. Identify how measurements are taken to allow for consistency of measurement

50% reduction in wound surface area at 4 weeks of best practice treatment is a good predictor of wound healing 90% by 8 weeks and wound closure by 12 weeks.

f. Vascular Assessment

Peripheral Artery Disease (PAD) Assessment and Recommendations (The IWGDF Guidance on the diagnosis, prognosis and management of peripheral artery disease in patients with foot ulcers in diabetes [15])

- Identifying PAD among patients with foot ulceration is important because its presence is associated with worse outcomes, such as a slower (or lack of) healing of foot ulcers, lower extremity amputations, subsequent cardiovascular events and premature mortality [51] [66]
- Diagnosing PAD is challenging in patients with diabetes, as they frequently lack typical symptoms, such as claudication or rest pain, even in the presence of severe tissue loss [51] [67] [68]
- Arterial calcification, foot infection, edema and peripheral neuropathy, each of which is often present with diabetic foot ulceration, may adversely affect the performance of diagnostic tests for PAD [15]
- Peripheral arterial disease (PAD) is a component cause in approximately one-third of foot ulcers and is often a significant risk factor associated with recurrent wounds [61] [16] [17]. Therefore, the assessment of PAD is important in defining overall lower-extremity risk status.
- Vascular examination should include palpation of the posterior tibial and dorsalis pedis pulses [55] [16], which should be characterized as either “present” or “absent” [15]
- An Ankle Brachial Pressure Index (ABPI/TBPI) measurement should be performed by a trained practitioner to rule out the presence of peripheral arterial disease. These measurements offer valuable information as a screening tool for lower extremity peripheral arterial disease. “All clinicians involved in the management of patients with lower limb ulcers should have direct access to an 8 MHz hand held doppler device. This should not be considered a special investigation limited to vascular laboratory”

The International Working Group has created the IWGDF Guidance on the diagnosis, prognosis and management of peripheral artery disease in patients with foot ulcers in diabetes [15]. The Guideline outlines assessment procedures, recommendations, treatment and rationales.
Acute arterial occlusion is a life and limb threatening situation which requires immediate emergency intervention

Signs and symptoms that may become severe may be associated with the following:

- Pale or blue skin
- Skin cold to the touch
- Sudden decrease in mobility
- No pulse where one was present prior to this
- Sudden and severe pain

ABPI 0.5 to 0.8  TBPI 0.64 to 0.7
Suggest Transcutaneous Oxygen Pressure(TcPo₂), Laser Doppler Flowmetry, Doppler Arterial Waveforms or Segmental Doppler Pressure studies

ABPI <0.5  TBPI <0.64
Urgent vascular surgical consult needed

Link to IWGDF Guidance on the diagnosis, prognosis and management of peripheral artery disease in patients with foot ulcers in diabetes

Link to Waterloo Wellington Integrated Wound Care Program Website Arterial Ulcers
### Ankle Brachial Pressure Index (ABPI)/Toe Brachial Pressure Index (TBPI) Interpretations

**ABPI**

- **> 0.9-1.2** ....Normal (1.2 or > could indicate calcification, seen in diabetes, patients that smoke, hypertension, rheumatoid arthritis, systemic vasculitis or advanced age)

- **0.80-0.9** ......Mild ischemia (inflow disease may be present)

- **0.50-0.79** ....Moderate ischemia (Would benefit from vascular surgeon consult to expedite wound healing)

- **0.35-0.49** ....Moderately severe ischemia (Urgent vascular surgery consult recommended)

- **0.20-0.34** ....Severe ischemia (Urgent vascular surgery consult recommended)

- **<0.20** ........Likely critical ischemia, but absolute pressure and clinical picture must be considered (Urgent vascular surgery consult recommended)

**TBPI:**

- **> 0.7** ........Normal > 0.7

- **0.64 - 0.7**.....Borderline

- **< 0.64**........ Abnormal indicating arterial disease (Urgent vascular surgery consult recommended)

### Foot Assessment

RNAO recommends a 3 month complete reassessment if no evidence of healing and a 6 month reassessment for resolving and healing (but not yet healed) wounds. If ulceration does not heal or show improvement after 3 months of compression and patient has an Ankle Brachial Pressure Index (ABPI) of > 0.8 to 1.3, a referral to a vascular surgeon to review potential surgical interventions is recommended.

<table>
<thead>
<tr>
<th>Foot Assessment</th>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABPI:</td>
<td>TBPI:</td>
<td>ABPI:</td>
</tr>
</tbody>
</table>
Further Investigation Required (Table 7)
(Level C: RNAO’s Assessment and Management of Diabetic Foot Ulcers [1])

<table>
<thead>
<tr>
<th>Physical Assessment of the Lower Extremities</th>
<th>Diagnostic Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ Intermittent claudication(^G) (calf pain)</td>
<td>■ Ankle brachial pressure index (ABPI)(^G)</td>
</tr>
<tr>
<td>■ Peripheral pulses</td>
<td>■ Toe pressures (^G) and toe brachial index</td>
</tr>
<tr>
<td>■ Colour (G) on limb elevation, rubor (G) on limb dependency, mottling</td>
<td>■ Arterial duplex scan</td>
</tr>
<tr>
<td>■ Cool temperature</td>
<td>■ Transcutaneous oxygen</td>
</tr>
<tr>
<td>■ Ischemic pain (pain causing frequent waking at night, or needing to dangle limb for pain relief)</td>
<td>■ Angiography (including CT angiogram and MR angiogram)</td>
</tr>
<tr>
<td>■ Dry gangrene</td>
<td></td>
</tr>
<tr>
<td>■ Hair loss, dystrophic nails</td>
<td></td>
</tr>
<tr>
<td>(damaged or misshaped nail plates)</td>
<td></td>
</tr>
<tr>
<td>■ Shiny, taut, thin, dry skin</td>
<td></td>
</tr>
</tbody>
</table>

An Ankle Brachial Pressure Index (ABPI) >1.2 and <0.8 warrants referral for further medical assessment. People with abnormally low or abnormally high ABPI should be further investigated for peripheral arterial disease. For example, an ABPI >1.3 is considered indicative of non-compressible vessels that are found in individuals with diabetes, chronic renal failure and who are older than 70 years of age.
h. Nutritional Assessment
(Level B: RNAO’s Assessment and Management of Diabetic Foot Ulcer [1])

The following assessments and blood work should be considered when investigating nutritional status of a person with a wound:

<table>
<thead>
<tr>
<th>Body Weight (kg):</th>
<th>Height (cm):</th>
<th>Recent Weight Loss/Gain: □ Y / □ N Over _________ (time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI:</td>
<td></td>
<td>Intentional Change in Weight: □ Y / □ N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weight Loss/Gain (kg): __________________________</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protein-Calorie Malnutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Pre-albumin if available (low scores indicate risk for malnutrition)</td>
</tr>
<tr>
<td>□ Serum albumin level (&lt;30g/l will delay healing; &lt;20g/l will be non-healable)</td>
</tr>
<tr>
<td>□ C-reactive Protein (CRP) (indicator of increased nutritional need)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Check for anemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ CBC (including RBC, Hct, Hgb, MCV, Platelets etc.)</td>
</tr>
<tr>
<td>□ Serum Iron</td>
</tr>
<tr>
<td>□ Total Iron Binding</td>
</tr>
<tr>
<td>□ Ferritin</td>
</tr>
<tr>
<td>□ Transferrin</td>
</tr>
<tr>
<td>□ B12</td>
</tr>
<tr>
<td>□ Red blood cell folate level</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kidney function (To check hydration)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ BUN</td>
</tr>
<tr>
<td>□ Creatinine</td>
</tr>
<tr>
<td>□ Potassium</td>
</tr>
<tr>
<td>□ Albumin/Urine creatinine ratio</td>
</tr>
</tbody>
</table>

In addition to inquiring about recent weight loss, signs of dehydration, and assessing the Braden Scale Nutritional sub-scale, which helps to capture protein intake, there are several signs of micronutrient deficiencies that are easy to detect when you know what to look for.

**Signs of micronutrient deficiencies:**

- Reddish tongue with a smooth surface (Vitamin B deficiency)
- Magenta flank-steak appearing tongue with cracks at corners of the mouth (called angular stomatitis) (Vitamin B2 deficiency)
- Dementia, diarrhea, dermatitis (pellagra)—crepe paper skin with wrinkles in the skin and flat surfaces between the wrinkles—also associated with bullous pemphigoid and granuloma annulare (Vitamin B3 deficiency)
- Prominent “snowflake” exfoliation of the epidermis of the lower legs (Essential Fatty Acid deficiency)
- Skin and capillary fragility with purpura, skin tears, increase risk of pressure ulcers, severe collagen deficiency so that the skin is like plastic wrap, and extensor tendons and venous plexus is easily seen through the transparent epidermis (Chronic Scurvy/Vitamin C deficiency)
- Reddish, scaly, itchy skin lesions (Vitamin A, E, and K deficiency)
- Seborrheic-like rash that is red, flaky seen along the lateral eyebrows, nasal labial folds and chin (Zinc deficiency)
- Prolonged tenting of the skin in the presence of adequate fluid intake
If the presence of any of these signs of micronutrient deficiencies is noted, a referral should be made to a Registered Dietitian who can work with the primary care provider for screening of dietary deficiencies and treatment.

**Targets for Glycemic Control for Most People with Type 1 and Type 2 Diabetes**

- Fasting plasma glucose of 4.0 to 7.0 mmol/L (8.0 for the elderly to prevent chance of hypoglycemia)
- A1C ≤ 7.0% to reduce the risk of microvascular and macrovascular complications
- 2-hour postprandial (after meal) plasma glucose targets of 5.0 to 10.0 mmol/L (5.0 to 8.0 mmol/L if A1C targets not being met)

As recommended by the Canadian Diabetes Association (CDA) Clinical Practice Guidelines (CDA CPG Expert Committee, 2008)

The Nestle Mini-Nutritional Assessment (MNA) (Toolkit item #11) is a screening and assessment tool that identifies individuals age 65 and above who are malnourished or at risk of malnutrition, allowing for earlier intervention to provide adequate nutritional support. It has not been validated for use with younger individuals. The screening tool consists of 6 questions.

- Complete the screen by filling in the boxes with the appropriate numbers.
- Total the numbers for the screening score.

The screening score (max 14 points):

- 12-14 points = normal nutritional status
- 8-11 points = at risk of malnutrition
- 0-7 points = malnourished

Link to Mini-Nutritional Assessment Form
i. **Assess for Infection**

The validated mnemonics “NERDS” and “STONEES” classify the signs and symptoms of localized infection (NERDS) and spreading infection (STONEES). Increased localized pain is a significant predictor of deep compartment infection.

**Presence of Superficial Bacteria**

- **N**: Non-healing wound
- **E**: Exudate increased
- **R**: Red friable (fragile tissue that bleeds easily)
- **D**: Debris (presence of necrotic tissue (eschar/slough) in wound)
- **S**: Smell

**Presence of Spreading Bacteria (< 3 low bacteria count, >3 high bacteria count)**

- **S**: Size increasing
- **T**: Temperature increased (> 3 degrees F difference)
- **O**: Os (probes to bone or bone is increased)
- **N**: New areas of breakdown
- **E**: Exudate present
- **E**: Erythema and/or Edema
- **S**: Smell

j. **Relief of Pressure and Protection of Ulcer**

(***Level A: RNAO’s Assessment and Management of Diabetic Foot Ulcers [1])**

The International Working Group Diabetic Foot Ulcers outlines the importance of offloading to enhance wound healing:

- This is a cornerstone in treating an ulcer associated with increased biomechanical stress
- The preferred treatment for a neuropathic plantar ulcer is a non-removable knee-high offloading device, either total contact cast (TCC) or removable walker rendered irremovable
- When a non-removable TCC or walker is contra-indicated or not tolerated, use a removable device
- When these devices are contra-indicated, use footwear that best offloads the ulcer

**Offloading is for LIFE!**
- In non-plantar ulcers, consider offloading with shoe-modifications, temporary footwear, toe-spacers or orthoses
- If other forms of biomechanical relief are not available, consider felted foam, in combination with appropriate footwear
- Instruct the patient to limit standing and walking, and to use crutches or wheelchair if necessary

### Total Contact Cast or Prefabricated Removable Walking Casts (rendered irremovable) is GOLD STANDARD of Care

#### Contraindications for Total Contact Casting (TCC)
- Patients with documented lower-extremity arterial disease
- Patients with an active wound infection or a sinus tract with deep extension into the foot which requires daily wound access for topical wound management
- Patients with unstable gait
- Patients with cast claustrophobia or previously known non-adherence to treatment plan
- Patients with fluctuating leg edema or active skin disease
- Inadequately trained clinical staff
- Restless leg syndrome or conditions which cause leg tremors

#### Check for red marks, blisters, skin abrasions, etc. caused by offloading device. If found, send patient to treating practitioner immediately.

### Ongoing Offloading Care (per Waterloo Wellington Pathway for Diabetic Foot Ulcer document)

- Ensure appropriate footwear/offloading referrals have been arranged to a qualified offloading specialist (if patient does not have)
- Review weartime of offloading device as per treating practitioner’s directions
- Review adherence to using appropriate footwear and/or offloading device(s)
- Assess barriers to appropriate offloading
- Initial and ongoing callous reduction is part of offloading
- Assess for secondary complications of offloading and refer concerns to dispensing practitioner
  1. Look for redmarks, blisters, skin abrasions
  2. Ask about knee, hip or back issues (including contralateral limb) due to height difference of offloading device
  3. Check for unsafe gait (are they stable, using appropriate aids, etc)
- Check gait aids such as walker, cane, crutches
- Review long term goals of offloading (i.e. transition from cast to shoes, foot orthoses, etc.)
- Teach patient to assess for secondary complications
- Discuss winter footwear with appropriate offloading specialist
- Check for availability for financial compensation (e.g. private insurance, veterans medical benefits, Ontario Disability Support Program – ODSP, Assisted Devices, Non-Insured Health Benefits - NIHB and Southern Ontario Aboriginal Diabetes Initiative – SOADI for First Nations people and Inuit)
k. **Determine if the wound is “Healable, Maintenance or Non-Healable”**

**Healable Wounds:** Have sufficient vascular supply, underlying cause can be corrected, offloaded & health can be optimized  
**Goal:** Principles of wound bed preparation and moist wound healing: treat the cause, debridement, bacterial balance, exudate control, protect peri-wound skin

**Maintenance Wounds:** have healing potential, but various patient factors are compromising wound healing at this time  
**Goal:** Principles of wound bed preparation and moist wound healing: treat the cause, debridement, bacterial balance, exudate control and protect peri-wound skin. Avoid higher cost advanced wound treatments until factors compromising wound healing are resolved. Focus on quality of life issues, exudate and odour management

**Non-healable/Palliative wounds:** has no ability to heal due to untreatable causes such as terminal disease or end-of-life  
**Goal:** Avoid higher cost advanced wound treatment and focus on exudate and odour management, quality of life issues. [1]
Provide Local Wound Care

a. Intervention Algorithm
b. Signs and Symptoms of Wound Infection  
(Level A, B and C: RNAO’s Assessment and Management of Diabetic Foot Ulcers [1])

Diabetic Foot Ulcers, like most chronic wounds, can become infected with superficial or spreading bacteria. However, the risk for infection in the diabetic foot is especially problematic. Reasons for heightened risk of infection in the Diabetic Foot include [14]:

- Immune compromised host
- Poor glycemic control
- Poor granulation and prolonged wound healing
- More than 50% of foot infections in diabetics lack elevated WBC and erythrocyte sedimentation rate or fever
- High colonization with staph/fungal

<table>
<thead>
<tr>
<th>Signs and Symptoms Specific to Diabetic Foot Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Usual signs and symptoms of infection may be more subtle in patients with diabetes</td>
</tr>
<tr>
<td><strong>Local Infection:</strong> NERDS (non-healing, exudate, red friable tissue, debris, smell)</td>
</tr>
<tr>
<td><strong>Deep Infection:</strong> STONEES (size increasing, temperature increase, os – probes to bone, new areas of breakdown, exudate, erythema, edema, smell)</td>
</tr>
<tr>
<td>• Elevated blood sugars from patient’s baseline</td>
</tr>
<tr>
<td>• Increase in pain level (new pain is a red flag in patients with altered sensation)</td>
</tr>
<tr>
<td>• Generalized malaise/fever</td>
</tr>
<tr>
<td>• Wound probes to bone (likely osteomyelitis)</td>
</tr>
</tbody>
</table>

The average cost of healing a single ulcer is $8,000, that of an infected ulcer is $17,000, and that of a major amputation is $45,000 [70]. Limb-threatening diabetic foot infections are usually polymicrobial. Commonly encountered pathogens include methicillin-resistant *staphylococcus aureus*, β-hemolytic streptococci, enterobacteriaceae, *pseudomonas aeruginosa*, and enterococci. Anaerobes, such as *bacteroides, peptococcus*, and *peptostreptococcus*, are rarely the sole pathogens but are seen in mixed infections with aerobes. Antibiotics selected to treat severe or limb-threatening infections should include coverage of gram-positive and gram-negative organisms and provide both aerobic and anaerobic coverage [70].

Proper debridement is necessary to decrease the risk of infection and reduce peri-wound pressure, which can impede normal wound contraction and healing [18] [31] [1] [16] [49] [34] [27] [18].

The International Working Group has created the IWGDF Guidance on the diagnosis, and management of infection in patients with foot ulcers in diabetes [16]. The Guideline outlines assessment procedures, recommendations, treatment and rationales.

Classification/Diagnosis

1. Diabetic foot infection must be diagnosed clinically, based on the presence of local or systemic signs or symptoms of inflammation (Strong; Low).
2. Assess the severity of any diabetic foot infection using the Infectious Diseases Society of America/International Working Group on the Diabetic Foot classification scheme (Strong; Moderate)

Link to IWGDF Guidance on the diagnosis and management of infection in the Diabetic Foot Ulcer Patient [16]
Table 8: Classification Systems of Infection and Ischemia - DFU

<table>
<thead>
<tr>
<th>Classification system</th>
<th>Key Points</th>
<th>Pros/Cons</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wagner</td>
<td>Assesses ulcer depth along with presence of gangrene and loss of perfusion using six grades (0-5)</td>
<td>Well established(^{58}) Does not fully address infection and ischemia</td>
<td>Wagner 1981(^{59})</td>
</tr>
<tr>
<td>University of Texas (Armstrong)</td>
<td>Assesses ulcer depth, presence of infection and presence of signs of lower-extremity ischemia using a matrix of four grades combined with four stages</td>
<td>Well established(^{58}) Describes the presence of infection and ischemia better than Wagner and may help in predicting the outcome of the DFU</td>
<td>Lavery et al 1996(^{60}) Armstrong et al 1998(^{62})</td>
</tr>
<tr>
<td>PEDIS</td>
<td>Assesses Perfusion, Extent (size), Depth (tissue loss), Infection and Sensation (neuropathy) using four grades (1-4)</td>
<td>Developed by IWWGF User-friendly (clear definitions, few categories) for practitioners with a lower level of experience with diabetic foot management</td>
<td>Lipsky et al 2012(^{46})</td>
</tr>
<tr>
<td>SINBAD</td>
<td>Assesses Site, Ischemia, Neuropathy, Bacterial infection and Depth Uses a scoring system to help predict outcomes and enable comparisons between different settings and countries</td>
<td>Simplified version of the S(AD)SAD classification system(^{61}) Includes ulcer site as data suggests this might be an important determinant of outcome(^{62})</td>
<td>Ince et al 2008(^{63})</td>
</tr>
</tbody>
</table>
### Table 9: Texas Diabetic Wound Classification System

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Areas of pressure which are sometimes called pre-ulcerative lesion</td>
<td>Superficial ulcer not including tendon, capsule or bone</td>
<td>Deep ulcer including tendon, capsule but not bone</td>
<td>Deep ulcer including bone and articulation</td>
</tr>
<tr>
<td>B</td>
<td>Infection</td>
<td>Infection</td>
<td>Infection</td>
<td>Infection</td>
</tr>
<tr>
<td>C</td>
<td>Ischemia</td>
<td>Ischemia</td>
<td>Ischemia</td>
<td>Ischemia</td>
</tr>
<tr>
<td>D</td>
<td>Infection &amp; Ischemia</td>
<td>Infection &amp; Ischemia</td>
<td>Infection &amp; Ischemia</td>
<td>Infection &amp; Ischemia</td>
</tr>
</tbody>
</table>

### Table 10: Limb-Threatening Infection in Patients with a Diabetic Foot Ulcer [70, 71]

#### SUPERFICIAL INFECTION
- Non-healing
- Bright red granulation tissue
- Friable and exuberant granulation
- New areas of breakdown or necrosis
- Increased exudates
- Bridging of soft tissue and the epithelium
- Foul odour

#### DEEP WOUND INFECTION
- Pain
- Swelling, induration
- Erythema (> 2 cm)
- Wound breakdown
- Increased size or satellite areas
- Undermining or tunneling
- Probing to bone
- Anorexia
- Flu-like symptoms
- Erratic glucose control

#### SYSTEMIC INFECTION
In addition to deep wound infection:
- Fever
- Rigour
- Chills
- Hypotension
- Multi-organ failure
Management of Infection

- Swabs for C&S not usually helpful if wound is dry; if wet then should be done using LEVINE semi-quantitative method
- In addition to recognizing the signs and symptoms of infection in diabetic foot ulcers, it may be helpful to obtain a culture and sensitivity (C&S) using a validated method of sampling to quantify bacteria in wounds
- Tissue biopsies are considered the gold standard but unfortunately are not practicable in many settings.
- A linear relationship between quantitative tissue biopsy and swab for C&S taken using the Levine method of sampling (see below) has been validated and is recommended for assessing any open wound
- Swabs for C&S are important in determining the type of bacteria and the appropriate antibiotics, but are not necessary to confirm the presence or absence of infection.
- C&S results may not reflect the presence or absence of biofilm.

Levine Method for obtaining C&S laboratory swab [18]

1. Cleanse wound thoroughly
2. Place swab on granulation tissue
3. Apply enough pressure to extract fluid
4. Turn swab 360 degrees on fluid (avoid slough or debris)
5. Place swab in transport medium

IWGDF Guidance on the diagnosis and management of foot infections in persons with diabetes [16]

Diabetic foot infection must be diagnosed clinically, based on the presence of local and systemic signs and symptoms of inflammation (Strong; moderate). Assess the severity of any diabetic foot infection using the Infectious Diseases Society of America/International Working Group on the Diabetic Foot classification scheme. [16]

The full PEDIS system (which includes classification of other wound descriptors, such as arterial disease, neuropathy and wound size) of the IWGDF was originally developed for research purposes, but it can serve as a clinical classification as well [16]. Classification of DFIs using the full PEDIS system or the infection part of the IWGDF/IDSA DFI scheme has been shown in several prospective studies to predict the need for hospitalization or lower extremity amputation [16].
a. While virtually all clinically infected diabetic foot wounds require antimicrobial therapy do not treat clinically uninfected wounds with antimicrobial therapy (Strong; Low)

b. Select specific antibiotic agents for treatment based on the likely or proven causative pathogens, their antibiotic susceptibilities, the clinical severity of the infection, evidence of efficacy of the agent for DFI and costs (Strong; Moderate)

c. A course of antibiotic therapy of 1-2 weeks is usually adequate for most mild and moderate infections (Strong; High)

d. Administer parenteral therapy initially for most severe infections and some moderate infections, with a switch to oral therapy when the infection is responding (Strong; Low)

e. Do not select a specific type of dressing for a diabetic foot infection with the aim of preventing an infection or improving its outcome (Strong; High)

f. For diabetic foot osteomyelitis we recommend 6 weeks of antibiotic therapy for patients who do not undergo resection of infected bone and no more than a week of antibiotic treatment if all infected bone is resected (Strong; Moderate)

g. We suggest not using any adjunctive treatments for diabetic foot infection. (Weak; Low)

h. When treating a diabetic foot infection, assess for use of traditional remedies, previous antibiotic use, and consider local bacterial pathogens and their susceptibility profile. (Strong; Low)

i. We recommend sending a specimen for culture that is from deep tissue, obtained by biopsy or curettage after the wound has been cleansed and debrided. We suggest avoiding swab specimens, especially of inadequately debrided wounds, as they provide less accurate results [72] [73]

j. We recommend that clinicians select an empiric antibiotic regimen on the basis of the severity of the infection and the likely etiologic agent(s) (strong, low).

k. For mild to moderate infections in patients who have not recently received antibiotic treatment, we suggest that therapy just targeting aerobic GPC is sufficient (weak, low).

l. For most severe infections, we recommend starting broad-spectrum empiric antibiotic therapy, pending culture results and antibiotic susceptibility data (strong, low).

m. Empiric therapy directed at Pseudomonas aeruginosa is usually unnecessary except for patients with risk factors for true infection with this organism (strong, low).

n. Consider providing empiric therapy directed against methicillin-resistant Staphylococcus aureus (MRSA) in a patient with a prior history of MRSA infection; when the local prevalence of MRSA colonization or infection is high; or if the infection is clinically severe (weak, low). [73]
### Table 11. Infectious Diseases Society of America and International Working Group on the Diabetic Foot Classifications of Diabetic Foot Infection

<table>
<thead>
<tr>
<th>Clinical Manifestation of Infection</th>
<th>PEDIS Grade</th>
<th>IDSA Infection Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>No symptoms or signs of infection</td>
<td>1</td>
<td>Uninfected</td>
</tr>
<tr>
<td>Infection present, as defined by the presence of at least 2 of the following items:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Local swelling or induration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Erythema</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Local tenderness or pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Local warmth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Purulent discharge (thick, opaque to white or sanguineous secretion)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local infection involving only the skin and the subcutaneous tissue (without involvement of deeper tissues and without systemic signs as described below). If erythema, must be &gt;0.5 cm to ≤2 cm around the ulcer. Exclude other causes of an inflammatory response of the skin (e.g. trauma, gout, acute Charcot neuro-osteoarthropathy, fracture, thrombosis, venous stasis).</td>
<td>2</td>
<td>Mild</td>
</tr>
<tr>
<td>Local infection (as described above) with erythema &gt; 2 cm, or involving structures deeper than skin and subcutaneous tissues (e.g. abscess, osteomyelitis, septic arthritis, fasciitis), and No systemic inflammatory response signs (as described below)</td>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td>Local infection (as described above) with the signs of SIRS, as manifested by ≥2 of the following:</td>
<td>4</td>
<td>Severe a</td>
</tr>
<tr>
<td>• Temperature &gt;38°C or &lt;36°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Heart rate &gt;90 beats/min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Respiratory rate &gt;20 breaths/min or PaCO₂&lt;32 mm Hg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• White blood cell count &gt;12 000 or &lt;4000 cells/μL or ≥10% immature (band) forms</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: IDSA, Infectious Diseases Society of America; PaCO₂, partial pressure of arterial carbon dioxide; PEDIS, perfusion, extent/size, depth/tissue loss, infection, and sensation; SIRS, systemic inflammatory response syndrome.

Ischemia may increase the severity of any infection, and the presence of critical ischemia often makes the infection severe. Systemic infection may sometimes manifest with other clinical findings, such as hypotension, confusion, vomiting, or evidence of metabolic disturbances, such as acidosis, severe hyperglycemia, and new-onset azotemia [29, 43, 44]
e. **Signs and symptoms of Osteomyelitis**

- Based on bone culture results
- Empiric therapy always cover S. aureus mixed infections are common
- Parenteral for penetration initially and prolonged oral for 6 weeks
- Oral good bioavailability fluoroquinolones and clindamycin may be adequate for most
- If necrotic bone is removed then shorter course

<table>
<thead>
<tr>
<th></th>
<th>Mild infection</th>
<th>Serious Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Present</strong></td>
<td>Slow progression</td>
<td>Acute or rapid</td>
</tr>
<tr>
<td><strong>Ulceration</strong></td>
<td>Involves skin only epidermis/dermis</td>
<td>Penetrates to fascia, muscle, bone</td>
</tr>
<tr>
<td><strong>Cellulitis</strong></td>
<td>Min &lt;2 cm</td>
<td>Extensive distant</td>
</tr>
<tr>
<td><strong>Local signs</strong></td>
<td>Slight inflammation</td>
<td>Severe crepitus</td>
</tr>
<tr>
<td><strong>Systemic signs</strong></td>
<td>None or min</td>
<td>Fever, chills, confusion, leukocytosis</td>
</tr>
<tr>
<td><strong>Metabolic control</strong></td>
<td>Mild abnormal</td>
<td>Severe hyperglycemia, acidosis</td>
</tr>
<tr>
<td><strong>Foot vascularity</strong></td>
<td>Minimal impaired</td>
<td>Absent pulses reduced ABI</td>
</tr>
<tr>
<td><strong>Complicating features</strong></td>
<td>None or minimal</td>
<td>Gangrene, eschar, abscesses, foreign body</td>
</tr>
</tbody>
</table>

Table 12: Signs and Symptoms of Osteomyelitis [16]
f. **Antiseptics Guidelines**

**Recommendations for the use of antiseptics and antiseptic dressings**

An international consensus panel studied use of silver in healable wounds. This panel recommended that silver be used for a two week period if infections is suspected and then be reassessed. It is the opinion of Dr. David Keast, a leading wound care specialist that these recommendations can be extended to the use of all antiseptics and antiseptic dressings (eg. iodine and PHMB).

**Choices for after initial two weeks using antiseptics or antiseptic dressings**

<table>
<thead>
<tr>
<th>Healable wounds</th>
<th>Bacterial burden has been reduced and the wound is progressing to healing</th>
<th>Discontinue use of antiseptics and antiseptic dressings</th>
<th>Continue to use and monitor</th>
<th>Suggest: Low adherent knitted viscose fabric impregnated with a polyethylene glycol (PEG) base containing 10% Povidone Iodine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial burden has been reduced the wound is progressing but there are patient risk factors that put them at risk of re-infection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacterial burden is controlled but the location of the wound is such that it is at risk of recontamination e.g. perianal, or exit sites for g-tubes etc</td>
<td>Continue to use as an antimicrobial barrier.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No effect</td>
<td>Discontinue and change strategy such as systemic antibiotics or a change of the topical antiseptic or better debridement. As always factors such as adequate plantar pressure redistribution in neuropathic foot ulcers or compression therapy for venous disease must be in place.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slough/Eschar</th>
<th>No slough or obvious biofilm present</th>
<th></th>
<th>Suggest: Iodine gel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slough is present</td>
<td>Topical antiseptic to remove biofilm needed</td>
<td></td>
<td>Suggest: Periodic debridement provided arterial blood supply is adequate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maintenance or Non-healable Wounds</th>
<th>Eschar to be kept dry</th>
<th>No real limit to use</th>
<th>Use as long as required</th>
<th>Suggest: Povidone Iodine is best as an antiseptic with drying properties. Use it as long as required to keep dry</th>
</tr>
</thead>
</table>

*Table 13: As per Dr. Stephan Landis and Dr. David Keast (Leading Wound Care Specialists) Aug. 2015*
g. **Antibiotics Guidelines**

Antibiotics should be prescribed using local protocols and, in complex cases, the advice of a clinical microbiologist or infectious diseases specialist. Avoid prescribing antibiotics for uninfected ulcerations. IDSA46 offers evidence-based suggestions, which can be adapted to local needs.

<table>
<thead>
<tr>
<th>Table 14- Guidelines of Antibiotics for the Infected Diabetic Foot Ulcer from IDSA GUIDELINES [73]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection Severity</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Mild (usually treated with oral agent[s])</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Methicillin-resistant S. aureus (MRSA)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Moderate (may be treated with oral or initial parenteral agent[s]) or severe (usually treated with parenteral agent[s])</td>
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<td></td>
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</tbody>
</table>
Agents in bold face type are those that have been most commonly used as comparators in clinical trials (see Table 7). The only agents currently specifically FDA approved for diabetic foot infections are shown in italics.

Narrow-spectrum agents (eg, vancomycin, linezolid, daptomycin) should be combined with other agents (eg, a fluoroquinolone) if a polymicrobial infection (especially moderate or severe) is suspected.

Use an agent active against MRSA for patients who have a severe infection, evidence of infection or colonization with this organism elsewhere, or epidemiological risk factors for MRSA infection.

Select definitive regimens after considering the results of culture and susceptibility tests from wound specimens, as well as the clinical response to the empiric regimen.

Similar agents of the same drug class can probably be substituted for suggested agents.

Some of these regimens do not have FDA approval for complicated skin and skin structure infections.

Abbreviations: CPK, creatine phosphokinase; ESBL, extended-spectrum β-lactamase; FDA, US Food and Drug Administration; IV, intravenous; MIC, minimum inhibitory concentration; MRSA, methicillin-resistant Staphylococcus aureus; MSSA, methicillin-sensitive Staphylococcus aureus; PO, oral; QID, 4 times a day; TID, 3 times a day.

Agents approved for treating skin and skin structure infections on the basis of studies that excluded patients with diabetic foot infections (eg, ceftaroline, telavancin) are not included. *Agents shown to be effective in clinical trials including patients with diabetic foot infections. Daptomycin or linezolid may be substituted for vancomycin.

<table>
<thead>
<tr>
<th>Agent/Microorganism</th>
<th>Notes/Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ertapenem</strong></td>
<td>Once-daily dosing. Relatively broad spectrum including anaerobes, but not active against P. aeruginosa</td>
</tr>
<tr>
<td><strong>Tigecycline</strong></td>
<td>Active against MRSA. Spectrum may be excessively broad. High rates of nausea and vomiting and increased mortality warning. Non-equivalent to eratapenem + vancomycin in 1 randomized clinical trial</td>
</tr>
<tr>
<td><strong>Levofloxacin</strong></td>
<td>Limited evidence supporting clindamycin for severe S. aureus infections; PO &amp; IV formulations for both drugs</td>
</tr>
<tr>
<td><strong>Imipenem-cilastatin</strong></td>
<td>Very broad-spectrum (but not against MRSA); use only when this is required. Consider when ESBL-producing pathogens suspected</td>
</tr>
<tr>
<td><strong>MRSA</strong></td>
<td><strong>Linezolid</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Daptomycin</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Vancomycin</strong></td>
</tr>
<tr>
<td><strong>Pseudomonas aeruginosa</strong></td>
<td><strong>Piperacillin-tazobactam</strong></td>
</tr>
</tbody>
</table>
h. Determining Goals for Local Treatment for Diabetic Foot Ulcers
(Level A, B and C: RNAO’s Assessment and Management of Diabetic Foot Ulcers)

**Healable Wounds:** Have sufficient vascular supply, underlying cause can be corrected, offloaded & health can be optimized

**Goal:** Principles of wound bed preparation and moist wound healing: treat the cause, debridement, bacterial balance, exudate control, protect peri-wound skin

**Maintenance Wounds:** have healing potential, but various patient factors are compromising wound healing at this time

**Goal:** Principles of wound bed preparation and moist wound healing: treat the cause, debridement, bacterial balance, exudate control and protect peri-wound skin. Avoid higher cost advanced wound treatments until factors compromising wound healing are resolved. Focus on quality of life issues, exudate and odour management

**Non-healable/Palliative wounds:** has no ability to heal due to untreatable causes such as terminal disease or end-of-life

**Goal:** Avoid higher cost advanced wound treatment and focus on exudate and odour management, quality of life issues. [1].

If healing potential is not established, aggressive debridement and moist interactive healing is not recommended. [6] [1] [81] [27] [57]

i. **Utilize Product Picker from Canadian Association of Wound Care (CAWC)**

Product Picker for Classification of Dressing Products
Each organization may use the PDF Fillable CAWC Product Picker to list the products available within their organization (see Toolkit Item #14)

[j. **South West Regional Wound Care Program’s Dressing and Wound Cleansing Table:**

Healable and Non-Healable/Maintenance Wounds

South West Regional Dressing and Cleansing Enabler Healable Wounds
South West Regional Dressing and Cleansing Enabler Non-Healable/Maintenance Wounds

Canadian Association for Enterostomal Therapy’s ‘Evidence-Based Recommendations for Conservative Sharp Wound Debridement’]
NOTE: Normal saline and sterile water do NOT contain preservatives and must be discarded 48 hours after opening

k. Patient Education on Foot Care and Daily Assessment [1]

Ongoing Foot care is a vital element to promote wound healing and prevent recurrence of Diabetic Foot Ulcers

The following information is provided to clients as recommended practices:

- Foot care -- Podiatrist or chiropodist
- Foot wear -- protective shoes and pressure reduction
- Daily foot assessment
- Monofilament testing for neuropathy
- Glycemic control
- Prophylactic surgery

Foot soaks are NOT recommended for patients with a Diabetic Foot Ulcer. There is currently no proven benefit to soaking diabetic feet, and in fact there is the potential for maceration of tissues and increased risk of infection. Use of hot water may not be recognized by the patient due to the presence of neuropathy leading to thermal tissue damage and soaking in antiseptic chemicals such as hydrogen peroxide maybe damaging to healthy granulation tissue [48] [27] [74] [57] [10] [13] [1].

I. Adjunctive Therapies

Consider Multi-disciplinary referrals for adjunctive therapy.

Adjunctive therapy refers to additional treatment used together with the primary treatment to achieve the outcome of the primary treatment.

There are many types of adjunctive therapies for wound management. The ones contained in this resource include only those that have been verified by rigorous research standards and are included in the RNAO/CAWC best practice guidelines.

**Electrical Stimulation Therapy (EST)**

*(Level B: RNAO’s Assessment and Management of Diabetic Foot Ulcer [1]*)

- Refers to the application of a low level electrical current to the base of a wound or peri-wound using conductive electrodes to induce cellular activity to facilitate wound healing.

**Therapeutic Ultrasound (TU)**

*(Level A: RNAO’s Assessment and Management of Diabetic Foot Ulcer)*

- Refers to the therapeutic application of ultrasound waves to the base of a wound or peri-wound to induce cellular activity to facilitate wound healing.
6. Provide Organizational Support

a. Multi-disciplinary Team Intervention Referral Criteria Checklist

<table>
<thead>
<tr>
<th>Primary Care Physician</th>
<th>Physiotherapist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Nursing</td>
<td>Physiatrist</td>
</tr>
<tr>
<td>Advanced Wound Specialist</td>
<td>Registered Kinesthesiologist</td>
</tr>
<tr>
<td>Nurse Practitioner</td>
<td>Chiropractor</td>
</tr>
<tr>
<td>Infectious Disease Specialist</td>
<td>Diabetic Education Program</td>
</tr>
<tr>
<td>Vascular Surgeon</td>
<td>Patient self-referral link</td>
</tr>
<tr>
<td>Orthopedic Surgeon</td>
<td><a href="http://www.waterloowellingtondiabetes.ca/">http://www.waterloowellingtondiabetes.ca/</a></td>
</tr>
<tr>
<td>Dermatologist</td>
<td>Medical professional referral link</td>
</tr>
<tr>
<td>Plastic Surgeon</td>
<td><a href="http://www.waterloowellingtondiabetes.ca/">http://www.waterloowellingtondiabetes.ca/</a></td>
</tr>
<tr>
<td>Internist/Endocrinologist</td>
<td>Professional-Site-Referral-Page.htm</td>
</tr>
<tr>
<td>Nephrologist</td>
<td>Certified Pedrothist</td>
</tr>
<tr>
<td>Cardiologist</td>
<td>Certified Orthotist</td>
</tr>
<tr>
<td>Ophthalmologist/Optometrist</td>
<td>Certified Prosthetist</td>
</tr>
<tr>
<td>Mental Health Specialist</td>
<td>Podiatrist</td>
</tr>
<tr>
<td>Psychologist/Psychiatrist</td>
<td>Footcare Nurse</td>
</tr>
<tr>
<td>Social worker</td>
<td>Lymphatic Massage Therapist</td>
</tr>
<tr>
<td>Registered Dietitian</td>
<td>Compression Stocking Fitter</td>
</tr>
</tbody>
</table>
| Pharmacist              | Other
| Occupational Therapist  | Other

b. Patient, Caregiver and Healthcare Provider Teaching and Learning Resources

- RNAO Learning Package: Assessment and Management of Diabetic Foot Ulcers (see Toolkit Item #18)
- Diabetes Passport (Ministry of Ontario)
- Regional Resources

- Certified Pedorothist
- Certified Orthotist
- Certified Prosthetist
- Podiatrist
- Footcare Nurse
- Lymphatic Massage Therapist
- Compression Stocking Fitter
- Other

RNAO Diabetic Foot Risk Assessment
Waterloo/Wellington Diabetes Directory
CAWC Diabetic

C. Discharge or Transfer Planning and Communications

Regardless of the method of providing the information (e.g. Care Connect, photocopy or Discharge Summary), it is agreed that the following information is critical in providing seamless care when individuals who have diabetic foot ulcers are being discharged or transferred to a different care setting:

- Current blood work results
- Vascular study results
- Current and past treatment regimes
- Any surgical interventions?
Appropriate documents that need to be shared

- Identify need to reassess ABPI/TPBI in 6 months
- Lower leg assessment results
- Recent vascular study results (eg. ABPI, TPBI, Transcutaneous Oxygen Pressure(TcPo₂), Laser Doppler Flowmetry, Doppler Arterial Waveforms or Segmental Doppler Pressure studies)
- Relevant consultation notes
- Diagnostic results
- Post and current treatment and education plan
- List of appropriate contact information for ongoing needs

If wound closed or eschar is stable (in arterial disease) send discharge summary outlining outstanding issues and teaching completed to:

- Referral source
- Most responsible physician (MRP)/nurse practitioner
d. Waterloo Wellington Integrated Wound Care Program Evidence-Based Wound Care Diabetic Foot Ulcer Clinical Pathway

PLACEHOLDER FOR FORMATTED PATHWAY
REFERENCES


[84] Butalia, S., Palda, V. A., Sargeant, R. J., Detsky, A. S., & Mourad, O. , "Does this patient with diabetes have osteomyelitis of the