

March 2005

Nursing Best Practice Guideline
Shaping the future of Nursing

Assessment and Management of Foot Ulcers for People with Diabetes



RNAO

Registered Nurses' Association of Ontario
L'Association des infirmières et infirmiers
autorisés de l'Ontario

NURSING BEST PRACTICE GUIDELINES PROGRAM



Greetings from Doris Grinspun
Executive Director
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It is with great excitement that the Registered Nurses' Association of Ontario (RNAO) disseminates this nursing best practice guideline to you. Evidence-based practice supports the excellence in service that nurses are committed to deliver in our day-to-day practice.

We offer our endless thanks to the many institutions and individuals that are making RNAO's vision for Nursing Best Practice Guidelines (NBPGs) a reality. The Government of Ontario recognized RNAO's ability to lead this program and is providing multi-year funding. Tazim Virani – NBPG program director – with her fearless determination and skills, is moving the program forward faster and stronger than ever imagined. The nursing community, with its commitment and passion for excellence in nursing care, is providing the knowledge and countless hours essential to the creation and evaluation of each guideline. Employers have responded enthusiastically to the request for proposals (RFP), and are opening their organizations to pilot test the NBPGs.

Now comes the true test in this phenomenal journey: Will nurses utilize the guidelines in their day-to-day practice?

Successful uptake of these NBPGs requires a concerted effort of four groups: nurses themselves, other healthcare colleagues, nurse educators in academic and practice settings, and employers. After lodging these guidelines into their minds and hearts, knowledgeable and skillful nurses and nursing students need healthy and supportive work environments to help bring these guidelines to life.

We ask that you share this NBPG, and others, with members of the interdisciplinary team. There is much to learn from one another. Together, we can ensure that Ontarians receive the best possible care every time they come in contact with us. Let's make them the real winners of this important effort!

RNAO will continue to work hard at developing and evaluating future guidelines. We wish you the best for a successful implementation!

Doris Grinspun, RN, MSN, PhD(cand), OOnt



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How to Use this Document

This nursing best practice guideline is a comprehensive document providing resources necessary for the support of evidence-based nursing practice. The document needs to be reviewed and applied, based on the specific needs of the organization or practice setting/environment, as well as the needs and wishes of the client. Guidelines should not be applied in a “cookbook” fashion but used as a tool to assist in decision making for individualized client care, as well as ensuring that appropriate structures and supports are in place to provide the best possible care.

Nurses, other healthcare professionals and administrators who are leading and facilitating practice changes will find this document valuable for the development of policies, procedures, protocols, educational programs, assessments and documentation tools. It is recommended that the nursing best practice guidelines be used as a resource tool. Nurses providing direct client care will benefit from reviewing the recommendations, the evidence in support of the recommendations and the process that was used to develop the guidelines. However, it is highly recommended that practice settings/environments adapt these guidelines in formats that would be user-friendly for daily use. This guideline has some suggested formats for such local adaptation and tailoring.

Organizations wishing to use the guideline may decide to do so in a number of ways:

- Assess current nursing and healthcare practices using the recommendations in the guideline.
- Identify recommendations that will address identified needs or gaps in services.
- Systematically develop a plan to implement the recommendations using associated tools and resources.

RNAO is interested in hearing how you have implemented this guideline. Please contact us to share your story. Implementation resources will be made available through the RNAO website at www.rnao.org/bestpractices to assist individuals and organizations to implement best practice guidelines.

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Assessment and Management of Foot Ulcers for People with Diabetes

Disclaimer

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Summary of Recommendations

RECOMMENDATION		*LEVEL OF EVIDENCE
Practice Recommendations		
Patient Empowerment and Education	1.0 All patients with diabetic foot ulcer(s) (PWDFU) or caregivers should have an understanding of their condition and the resources available to optimize their general health, diabetes management and ulcer care.	Ia
	1.1 Education is essential as an empowerment strategy for diabetes self-management and prevention or reduction of complications.	IV
	1.2. Education is based on identified individual needs, risk factors, ulcer status, available resources and ability to heal.	IV
Holistic Assessment	2.0 Complete and document a health history, including diabetes management, allergies, medications, functional assessment and physical examination (vascular status, infection, callus, neuropathy, foot deformity/pressure, ulcer).	Ib – IV
Vascular Status	2.1 Clinically assess bilateral lower extremities for vascular supply and facilitate appropriate diagnostic testing.	IIb – IV
Infection	2.2 Assess all patients with diabetic foot ulcers for signs and symptoms of infection and facilitate appropriate diagnostic testing and treatment.	Ila
Neuropathy	2.3 Identify peripheral neuropathy by assessing for sensory, autonomic and motor (S.A.M.) changes.	II – IV
Foot Deformity and Pressure	2.4 Assess for foot pressure, deformity, gait, footwear and devices. Facilitate appropriate referrals.	Ia – IV
Foot Ulcer Assessment	3.0 Describe and document the ulcer characteristics.	IV
	3.1 Identify the location, length, width, depth and classify the ulcer(s).	Ia – IV
	3.2 Assess ulcer bed, exudate, odour and peri-ulcer skin.	IV
Goals of Care	4.0 Define goals based on clinical findings, expert opinion and patient preference.	IV
	4.1 Determine the potential of the ulcer to heal.	IV
	4.2 Develop goals mutually agreed upon by the patient and healthcare professionals.	IV
Management	5.0 Identify and optimize systemic, local and extrinsic factors that can influence wound healing.	IV
Systemic Factors	5.1 Modify systemic factors and co-factors that may interfere with or impact on healing.	IV
Local Factors	5.2 Provide local wound care considering debridement, infection control and a moist wound environment.	Ia-III
Extrinsic Factors	5.3 Provide pressure redistribution.	Ila

*See page 12 for details regarding “Interpretation of Evidence”.

RECOMMENDATION		LEVEL OF EVIDENCE
Non-healing diabetic foot wounds	5.4 Evaluate and implement treatment options for non-healable wounds.	IV
Evaluation	6.0 Evaluate the impact and effectiveness of the treatment plan.	IV
Reassess	6.1 Reassess for additional correctable factors if healing does not occur at the expected rate.	III-IV
Other therapies	6.2 Consider the use of biological agents, adjunctive therapies and/or surgery if healing has not occurred at the expected rate. Review each specific modality for recommendations.	Ia-IV
Education Recommendations		
Continuing Professional Development	7.0 Nurses and other members of the interdisciplinary team need specific knowledge and skills in order to competently assess and participate in the treatment of diabetic foot ulcers.	IV
Curriculum Support and Resources	8.0 Educational institutions are encouraged to incorporate the RNAO Nursing Best Practice Guideline <i>Assessment and Management of Foot Ulcers for People with Diabetes</i> into basic RN, RPN, MD and allied health professional curricula.	IV
Organization & Policy Recommendations		
System Support	<p>9.0 Nursing best practice guidelines can be successfully implemented only where there are adequate planning, resources, organizational and administrative support, as well as appropriate facilitation. Organizations may wish to develop a plan for implementation that includes:</p> <ul style="list-style-type: none"> ■ An assessment of organizational readiness and barriers to education. ■ Involvement of all members (whether in a direct or indirect supportive function) who will contribute to the implementation process. ■ Dedication of qualified individual(s) to provide the support needed for the development and implementation process. ■ Ongoing opportunities for discussion and education to reinforce the importance of best practices. ■ Opportunities for reflection on personal and organizational experience in implementing guidelines. <p>In this regard, RNAO (through a panel of nurses, researchers and administrators) has developed the <i>Toolkit: Implementation of Clinical Practice Guidelines</i>, based on available evidence, theoretical perspectives and consensus. The RNAO strongly recommends the use of this <i>Toolkit</i> for guiding the implementation of the best practice guideline on <i>Assessment and Management of Foot Ulcers for People with Diabetes</i>.</p>	IV
Resources	9.1 Organizations are encouraged to develop policies that acknowledge and designate human, material and fiscal resources to support the nurse and the interdisciplinary team in diabetic foot ulcer management.	IV
Team Development	9.2 Organizations are encouraged to establish and support an interdisciplinary, inter-agency team comprised of interested and knowledgeable persons to address and monitor quality improvement in the management of diabetic foot ulcers.	IV

	RECOMMENDATION	LEVEL OF EVIDENCE
Partnerships	9.3 Organizations are encouraged to work with community and other partners to develop a process to facilitate patient referral and access to local diabetes resources and health professionals with specialized knowledge in diabetic foot ulcer management.	IV
Financial Support	9.4 Organizations are encouraged to advocate for strategies and funding to assist patients in obtaining appropriate pressure redistribution devices.	IV
Advocacy	9.5 Organizations are encouraged to advocate for an increase in the availability and accessibility of diabetic foot ulcer care for all residents of Ontario.	IV

Interpretation of Evidence

Levels of Evidence

Ia Evidence obtained from meta-analysis or systematic review of randomized controlled trials.

Ib Evidence obtained from at least one randomized controlled trial.

IIa Evidence obtained from at least one well-designed controlled study without randomization.

IIb Evidence obtained from at least one other type of well-designed quasi-experimental study, without randomization.

III Evidence obtained from well-designed non-experimental descriptive studies, such as comparative studies, correlation studies and case studies.

IV Evidence obtained from expert committee reports or opinions and/or clinical experiences of respected authorities.

Responsibility for Guideline Development

The Registered Nurses' Association of Ontario (RNAO), with funding from the Government of Ontario, has embarked on a multi-year program of nursing best practice guideline development, pilot implementation, testing, evaluation and dissemination. In this fifth cycle of the program, one of the areas of emphasis is on the assessment and management of diabetic foot ulcers. This guideline was developed by a panel of nurses convened by the RNAO conducting its work independent of any bias or influence from the Government of Ontario.

Purpose & Scope

Best practice guidelines (BPG) are systematically developed statements to assist nurses and patients in decision-making about appropriate healthcare (Field & Lohr, 1990). This guideline has been developed to address the question of how to assess and manage patients with established diagnosis of diabetic foot ulcers. It will provide direction to practicing nurses (RNs and RPNs) who provide care in all healthcare settings to patients (>15 years old) with type 1 and/or type 2 diabetes who have diabetic foot ulcers.

The guideline focuses its recommendations on four areas: (1) Practice Recommendations directed at the nurse and other interdisciplinary healthcare professionals; (2) Educational Recommendations directed at the competencies required for practice; (3) Organization and Policy Recommendations directed at practice settings and the environment in order to facilitate nurses' practice and (4) Evaluation and monitoring indicators.

It is acknowledged that individual competencies of nurses vary between nurses and across categories of nursing professionals (RNs and RPNs) and are based on knowledge, skills, attitudes and judgement enhanced over time by experience and education. It is expected that individual nurses will perform only those aspects of care for which they have received appropriate education and experience. Both RNs and RPNs should seek consultation in instances where the patient's care needs surpass the individual nurse's ability to act independently.

Caring for patients with diabetic foot ulcers is an interdisciplinary endeavour. Effective care depends on a coordinated interdisciplinary approach incorporating ongoing communication between health professionals and patients. It is however acknowledged that personal preferences and unique needs as well as the personal and environmental resources of each individual patient must always be kept in mind.

Guideline Development Process

In January of 2004, a panel of nurses with expertise in practice, education and research related to diabetic foot ulcers was established by the RNAO. At the onset, the panel discussed and came to consensus on the scope of the best practice guideline.

A search of the literature for systematic reviews, clinical practice guidelines, relevant articles and websites was conducted. See Appendix A for a detailed outline of the search strategy employed.

The panel identified a total of eight clinical practice guidelines related to diabetic foot ulcers. These guidelines were reviewed according to a set of initial inclusion criteria, which resulted in elimination of one guideline. The inclusion criteria were:

- Guideline was in English, international in scope.
- Guideline was dated no earlier than 1997.
- Guideline was strictly about the topic area.
- Guideline was evidence-based (e.g., contained references, description of evidence, sources of evidence).
- Guideline was available and accessible for retrieval.

Seven guidelines were critically appraised with the intent of identifying existing guidelines that were current, developed with rigour, evidence-based and which addressed the scope identified by the panel for the best practice guideline. A quality appraisal was conducted on these seven clinical practice guidelines using the *Appraisal of Guidelines for Research and Evaluation Instrument* (AGREE Collaboration, 2001). This process yielded a decision to work primarily with the following seven guidelines.

- Australian Centre for Diabetes Strategies (2001). National evidence based guidelines for the management of type 2 diabetes mellitus – Draft for public consultation – 6 April 2001 for the identification & management of diabetic foot disease. Australian Centre for Diabetes Strategies [Electronic version].

Available: http://www.diabetes.net.au/PDF/evidence_based_healthcare/FootProblems.pdf

- CREST – Clinical Resource Efficiency and Support Team (1998). Guidelines for the management of the diabetic foot: Recommendations for practice. Clinical Resource Efficiency and Support Team [Electronic version]. Available: http://www.crestni.org.uk/publications/diabetic_foot.pdf

- Frykberg, R. G., Armstrong, D. G., Giurini, J., Edwards, A., Kravette, M., Kravitz, S. et al. (2000). Diabetic foot disorders: A clinical practice guideline. American College of Foot and Ankle Surgeons [Electronic version]. Available: <http://www.acfas.org/diabeticcpg.html>

- Hutchinson, A., McIntosh, A., Feder, R.G., Home, P. D., Mason, J., O’Keefee, C. et al. (2000). Clinical guidelines and evidence review for type 2 diabetes: Prevention and management of foot problems. Royal College of General Practitioners [Electronic version]. Available: <http://www.rcgp.org.uk/rcgp/clinspec/guidelines/diabetes/contents.asp>
- Inlow, S., Orsted, H., & Sibbald, R. G. (2000). Best practices for the prevention, diagnosis and treatment of diabetic foot ulcers. *Ostomy/Wound Management*, 46(11), 55-68.
- Ministry of Health Malaysia (2003). Clinical practice guidelines: Management of diabetic foot. Ministry of Health Malaysia [Electronic version]. Available: <http://www.acadmed.org.my/cpg/Draft%20CPG%20%20management%20of%20diabetic%20foot.pdf>
- Royal Melbourne Hospital (2002). Evidence based guidelines for the inpatient management of acute diabetes related foot complications. Melbourne Health [Electronic version]. Available: http://www.mh.org.au/ClinicalEpidemiology/new_files/Foot%20guideline%20supporting.pdf

The panel members divided into subgroups to undergo specific activities using the short-listed guidelines, other literature and additional resources for the purpose of drafting recommendations for nursing interventions. This process yielded a draft set of recommendations.

An advisory panel was recruited to review and provide feedback on the draft recommendations. The advisory panel represented physicians, other healthcare disciplines as well as professional associations. An acknowledgement of the advisory panel is provided at the front of this document. Feedback on the recommendations was obtained from healthcare consumers through a focus group. The panel members as a whole reviewed the recommendations and the feedback from the advisory panel and consumers, discussed gaps and available evidence, and came to a consensus on a draft guideline.

This draft was submitted to a set of external stakeholders for review and feedback of the content. It was also critiqued using the AGREE instrument (AGREE Collaboration, 2001). An acknowledgement of these reviewers is provided at the front of this document. Stakeholders represented healthcare consumers, various healthcare disciplines as well as professional associations. External stakeholders were provided with specific questions for comments, as well as the opportunity to give overall feedback and general impressions. The results were compiled and reviewed by the development panel. Discussion and consensus resulted in revision to the draft document prior to publication.

Definition of Terms

An additional Glossary of Terms related to clinical aspects of the document is located in Appendix B.

Clinical Practice Guidelines or Best Practice Guidelines: Systematically developed statements (based on best available evidence) to assist practitioner and patient decisions about appropriate healthcare for specific clinical (practice) circumstances (Field & Lohr, 1990).

Consensus: A process for making policy decisions, not a scientific method for creating new knowledge. At its best, consensus development merely makes the best use of available information, be that of scientific data or the collective wisdom of the participants (Black et al., 1999).

Education Recommendations: Statements of educational requirements and educational approaches/strategies for the introduction, implementation and sustainability of the best practice guideline.

Evidence: “An observation, fact or organized body of information offered to support or justify inferences or beliefs in the demonstration of some proposition or matter at issue” (Madjar & Walton, 2001, p.28).

Meta-Analysis: The use of statistical methods to summarize the results of independent studies, thus providing more precise estimates of the effects of healthcare than those derived from the individual studies included in a review (Alderson, Green & Higgins, 2004).

Organization & Policy Recommendations: Statements of conditions required for a practice setting that enable the successful implementation of the best practice guideline. The conditions for success are largely the responsibility of the organization, although they may have implications for policy at a broader government or societal level.

Practice Recommendations: Statements of best practice directed at the practice of healthcare professionals that are evidence-based.

Randomized Controlled Trial: For the purposes of this guideline, a study in which subjects are assigned to conditions on the basis of chance, and where at least one of the conditions is a control or comparison condition.

Stakeholder: A stakeholder is an individual, group, or organization with a vested interest in the decisions and actions of organizations that may attempt to influence decisions and actions (Baker et al., 1999). Stakeholders include all individuals or groups who will be directly or indirectly affected by the change or solution to the problem. Stakeholders can be of various types, and can be divided into opponents, supporters, and neutrals (Ontario Public Health Association, 1996).

Systematic Review: Application of a rigorous scientific approach to the preparation of a review article (National Health and Medical Research Council, 1998). Systematic reviews establish where the effects of healthcare are consistent and research results can be applied across populations, settings, and differences in treatment (e.g., dose); and where effects may vary significantly. The use of explicit, systematic methods in reviews limits bias (systematic errors) and reduces chance effects, thus providing more reliable results upon which to draw conclusions and make decisions (Alderson et al., 2004).

Background Context

Diabetes mellitus is serious, complex, life-long condition affecting 4.2% of the world's population and 1.5 million Canadians (Boulton, Meneses, & Ennis, 1999; Canadian Diabetes Association (CDA), 1998). Diabetes seriously burdens individuals, their families and society. It is estimated that the cost of diabetes and its chronic complications range from 4.6 to 13.7 billion U.S. dollars annually (Dawson, Gomes, Gerstein, Blanchard & Kahler, 2002; Gordois, Scuffham, Shearer, Oglesby & Tobian, 2003). The aboriginal (First Nations, Metis and Inuit) population in Canada demonstrates a prevalence of type 2 diabetes that is at least three times the national average (Health Canada, 2000; 2002; Indian and Inuit Health Committee & Canadian Pediatric Society, 1994). This increased incidence is reflected in high rates across all age groups. It is important to note that Aboriginal ancestry has been identified as an independent risk factor for diabetes and despite this fact, little is known of this particular group (Health Canada, 2000; 2002; Young, 2003; Young, Szathmary, Evers & Wheatley, 1990).

There are two major classifications of diabetes; Type 1 and Type 2. Type 1 diabetes, which affects 10-15% of all people with diabetes, is primarily the result of the inability to produce insulin due to beta cell destruction in the pancreas. While Type I diabetes accounts for fewer individuals with diabetes, it results in a disproportionately higher frequency of diabetes related complications. Type 2 diabetes, affecting over 80% of those diagnosed with diabetes, results from a combination of insufficient insulin production and/or resistance of the cells of the body to the actions of insulin (RNAO, 2004).

Control of blood glucose levels is paramount to minimizing complications related to diabetes (Diabetes Control and Complication Trial (DCCT) Research Group, 1993; United Kingdom Prospective Diabetes Study (UKPDS) Group 33, 1998). This is achieved through lowering serum glucose using oral hypoglycemic agents, and/or subcutaneous injections of insulin, dietary restriction and regular exercise. Other factors contributing to delayed onset of complications include control of hypertension, hyperlipidemia and hyperinsulinemia. Unfortunately, these treatments may not completely control the progression of diabetes-related changes including neuropathy (CDA, 1998).

Assessment and Management of Foot Ulcers for People with Diabetes

Regardless of the type of diabetes classification, over time, failure to achieve optimal glycemic control can cause damage to the body's small and large blood vessels and nerves. Damage to these vessels and nerves can affect all organs in the body; however, the eyes, heart, kidneys, and skin are most commonly affected in patients with diabetes.

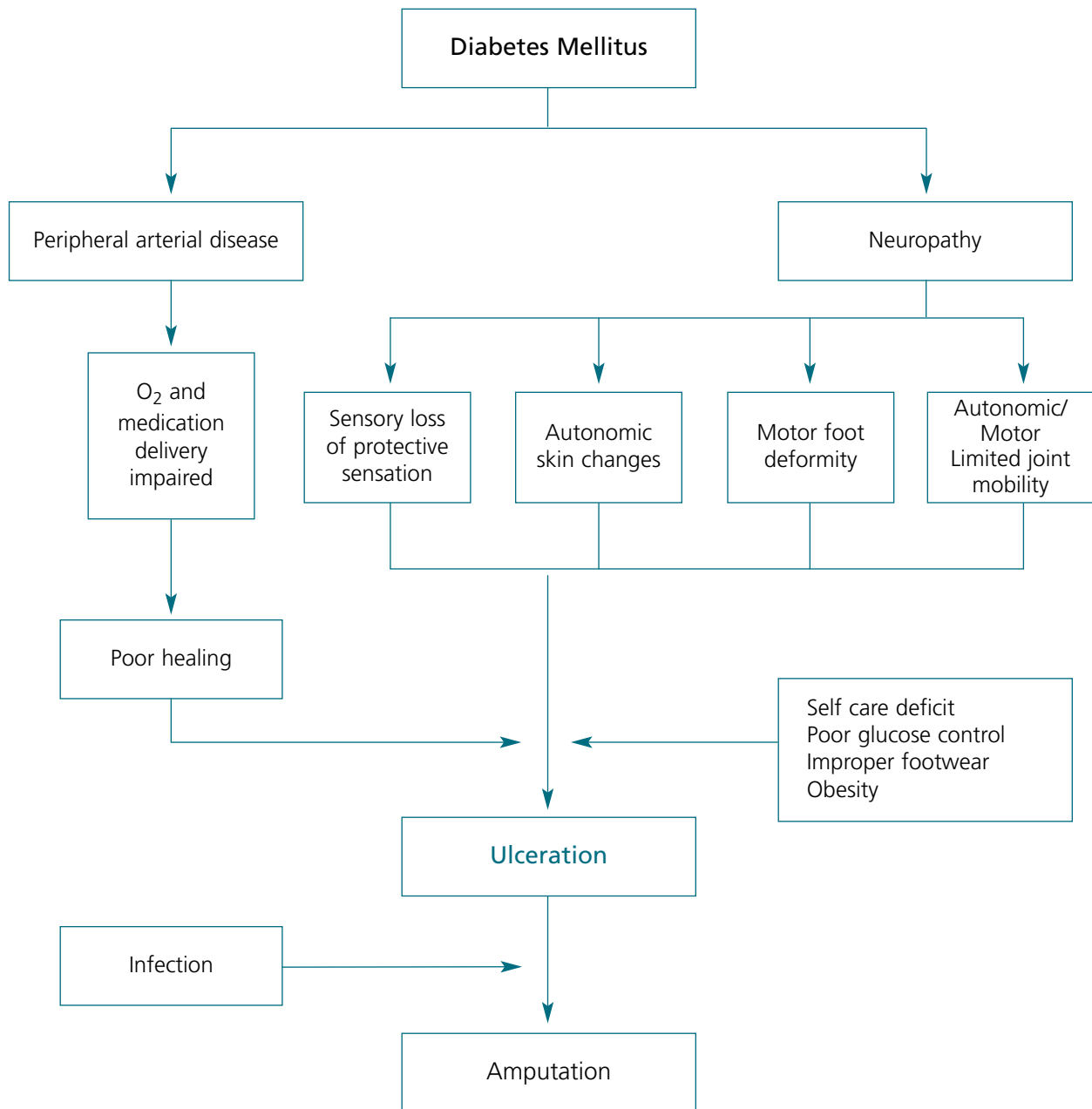
These changes along with those previously mentioned lead to a cascade of events resulting in changes to the foot itself. According to Boulton, Kirsner, & Vileikyte (2004), the “triad of neuropathy, deformity and trauma is present in almost two thirds of patients with foot ulcers” (p. 49). The structural changes discussed along with vascular insufficiency, infection and pressure predispose the person with diabetes (PWD) to develop a foot ulceration (See Figure 1: Pathway to Diabetic Foot Ulcers).

In industrialized countries, diabetes is the leading cause of non-traumatic, lower extremity amputations (American Diabetes Association (ADA), 1999; Foundation for Accountability, 1996). Approximately 15% of all persons with diabetes (PWD) will develop a foot ulcer at some time during the course of their disease (ADA, 1999). Eighty-five percent of lower extremity amputations are preceded by foot ulcers (Reiber, Boyko & Smith, 1995). Of these, 14% to 24% will proceed to major amputation (Ramsey, Newton, Blough, McCulloch, Sandhu, Reiber et al., 1999). Neuropathy is most commonly associated with the development of diabetic foot ulcers, but the presence or co-existence of peripheral vascular disease and infection can also lead to skin breakdown. It is widely known that diabetic foot ulceration is a significant end-stage complication of diabetes (Boulton et al., 1999). Moreover, the risk of amputation increases 10-fold in patients with diabetes and concurrent end-stage renal disease (ESRD)(Eggers, Gohdes & Pugh, 1999).

It should be emphasized that the most common offending agent or cause of traumatic foot ulceration is footwear (Birke, Patout Jr. & Foto, 2000; Tyrrell, 2002). The use of ill-fitting shoes are instrumental in the development of blisters, callus and corns which can lead to ulceration in patients with diabetes. In particular, peripheral neuropathy in people with diabetes leads to a cascade of events resulting in changes to the foot itself. These changes, along with those previously mentioned, predispose the patient with diabetes to the development of ulceration.

Given the data on the burden of illness and the significant long-term impact on health of people with diabetes, care of persons with diabetic foot ulcers demands a systematic, team approach from healthcare professionals (Dargis, Pantlejeva, Jonushaite, Vileikyte & Boulton, 1999; Sumpio, 2000). The development panel recognizes the complexity of the treatment of individuals with diabetic foot ulcers, and acknowledges the stressful conditions in which nurses work, in particular, the demands on the time of nurses in various practice settings. To this end, the recommendations serve as a guide for nurses to identify and assess patients in high risk groups who would benefit from specialized wound care. A specialized interdisciplinary team should work closely with patients and their families to address the complex lifestyle, self-care and multiple treatment demands of patients who have a diabetic foot ulcer. It is acknowledged that this level of care is not yet accessible to or accessed by all people with diabetes. Moreover, fewer patients with foot ulcerations receive optimal wound management (Boulton et al., 2004). Nurses can facilitate and positively influence wound healing outcomes by promoting, collaborating and participating in interdisciplinary care teams who follow best practice guidelines similar to those presented in this document.

Figure 1: Pathway to Diabetic Foot Ulcers



Adapted with permission of Dr. M. E. Levin.

Levin, M. E. (2001). Pathogenesis and general management of foot lesions in the diabetic patient. In J. H. Bowker & M. A. Pfeifer (Eds.), *Levin and O'Neals The Diabetic Foot*. (6th ed.) (pp.222). St. Louis, MO: Mosby, Inc.

Guiding Principles in the Care of Patients with Diabetic Foot Ulcers

1. Diabetic foot ulcers are complex wounds, best treated with a team approach.
2. Nurses and their interdisciplinary colleagues require knowledge and collaboration to provide care.
3. Successful management of foot ulcers can significantly improve quality of life for patients with diabetes, their family and caregivers.
4. Patients are empowered through education and involvement in the planning and implementation of their care.
5. The V. I. P. principle (Vascular supply, Infection, and Pressure redistribution) guides the assessment and management of diabetic foot ulcers.
6. Nurses and their interdisciplinary colleagues demonstrate integration of the best evidence for practice and expertise in local wound care.
7. Patients with diabetes who are aware of their risk category and management strategies can reduce ulcer re-occurrence. Nurses and their interdisciplinary colleagues have a role in educating their patients about reducing ulcer recurrence and further foot complications. Hence, it is highly recommended by the development panel to implement this guideline in conjunction with the RNAO (2004) Best Practice Guideline entitled *Reducing Foot Complications for People with Diabetes*. This guideline is available to download at www.rnao.org/bestpractices.
8. Ulcer healing of patients with diabetes, improvement of quality of life and reduction in amputation rate requires the successful implementation of a comprehensive foot ulcer program.
9. The development and implementation of a successful diabetic foot ulcer program involves collaboration with practice leaders, educators and administrators.
10. Diabetic foot ulcer program outcomes should be evaluated and benchmarked for continuous quality improvement.

Practice Recommendations

Patient Empowerment and Education:

Recommendation 1.0:

All patients with diabetic foot ulcer(s) (PWDFU) or caregivers should have an understanding of their condition and the resources available to optimize their general health, diabetes management and ulcer care. (*Level of Evidence = 1a*)

Discussion of Evidence:

In order to address the many individual variables involved in learning, the process of educating patients with diabetes has become participative rather than didactic (Whittemore, 2000). Evidence supports educational intervention for improvement in foot care knowledge and behaviour in the short term for people with diabetes (Hutchinson et al., 2000; Valk, Kriegsman, & Assendelft, 2002). There is additional evidence to support that people with diabetes who are at a higher risk for foot ulceration significantly benefit from education and regular reinforcement of that education (ADA, 2001; CDA, 1998; 2003; Mason, O'Keefe, Hutchinson, McIntosh, Young & Booth, 1999a; The University of York – NHS Centre for Reviews and Dissemination, 1999; New Zealand Guidelines Group (NZGG), 2000). A three-fold increased amputation risk was demonstrated by Reiber, Pecoraro & Koepsell (1992) for those people with diabetes who had not received formal diabetes education, suggesting significant prevention is possible with appropriate teaching strategies.

Expert opinion supports the need for reinforcement of basic foot care education in patients with diabetes and established foot ulcers. Nurses, as the single largest group of health professionals working in a range of settings, are well positioned to monitor risk status for re-occurrence, identify new or deteriorating ulcers and provide and/or reinforce basic foot care education. They may act as the primary diabetes foot care educator, or as a link between patients and their primary care providers or within specialized diabetes care teams (RNAO, 2004).

Recommendation 1.1:

Education is essential as an empowerment strategy for diabetes self-management and prevention or reduction of complications. (*Level of Evidence = IV*)

Discussion of Evidence:

Diabetes education should be interactive, solution-focused and based on the experiences of the learner. It should be staged and tailored to meet individual needs and abilities. The education of patients should be in keeping with the principles of adult learning using a client-centred approach (Glasgow, 1999). The nurse should be sensitive to socioeconomic, cultural, psycho-social and other individual domains when planning all interventions.

Randomized controlled trials evaluating education for people with diabetes are of poor quality and have significant methodological issues (Valk, Kriegsman & Assendelft, 2004). The existing evidence, however, does indicate that foot care knowledge and patient behaviour is positively influenced, albeit for a short time period, and education may be of particular benefit to those patients at high risk (Valk et al., 2004). Group education and sustained long-term follow-up have both been shown to enhance knowledge and produce positive outcomes (CDA, 2003).

Recommendation 1.2:

Education is based on identified individual needs, risk factors, ulcer status, available resources and ability to heal. (Level of Evidence = IV)

Discussion of Evidence:

As visible care providers across the continuum, nurses are in a unique position to promote the maintenance of healthy feet, identify problems at any stage, positively influence self-care practices, and refer higher risk individuals for expert care (RNAO, 2004).

There is evidence that diabetes self-care behaviours influence blood glucose control. Improved glycemic control facilitates healing of foot ulcers and delays and/or prevents diabetes related complications that further contribute to peripheral neuropathies and reduced lower extremity circulation (DCCT Research Group, 1993; RNAO, 2004; UKPDS Group 33, 1998).

The needs assessment should be the driving force for individual program planning and management. These assessments need to be tailored to determine appropriate allocation of personnel and resources to ensure the education and healthcare needs of the individual are met (ADA, 1999). Personal attitudes and cultural beliefs, level of literacy, age and physical condition will all influence the individual's ability to carry out the recommended regimen (American Association of Diabetes Educators, 1999; Canadian Diabetes Association – Diabetes Educator Section, 2000).

Although education seems to have short term positive impact on foot care knowledge and patient behaviour, it is uncertain whether it can prevent foot ulceration and amputation. In a systematic review examining patient education regarding diabetic foot ulceration, Valk et al. (2002), conclude that further research is required to recognize the impact of patient education on ulcer incidence and whether education has different effects for individuals with different levels of risk of ulcer development.

As discussed in the best practice guideline *Reducing Foot Complications for People with Diabetes* (RNAO, 2004), the following elements should be included in basic foot care programs:

- Awareness of personal risk factors;
- Value of annual inspection of feet by a healthcare professional;
- Daily self inspection of feet;
- Proper nail and skin care;
- Injury prevention; and
- When to seek help or specialized referral

(ADA, 2001; Apelqvist, Bakker, van Houtum, Nabuurs-Franssen & Schaper, 2000; CDA, 1998; Diabetes Education Study Group of the European Association for the Study of Diabetes, 2001; Institute for Clinical Systems Improvement, 2000; NZGG, 2000; Pinzur, Slovenkai & Trepman, 1999).

See Appendix C for the University of Texas Foot Classification System – Categories 0-3: Risk Factors for Ulceration.

See Appendix D for the University of Texas Foot Classification System – Categories 4-6: Risk Factors for Amputation

See Appendix E for the University of Texas Health Science Center San Antonio Diabetic Wound Classification System.

See Appendix F for patient handout on diabetic foot care.

Holistic Assessment:

Recommendation 2.0:

Complete and document a health history, including diabetes management, allergies, medications, functional assessment and physical examination (vascular status, infection, callus, neuropathy, foot deformity/pressure, ulcer). (*Level of Evidence = Ib – IV*)

The holistic assessment of patients with diabetes and foot ulceration should include:

- History of presenting illness (*Level of Evidence = IV*)
 - Initiating event (trauma, shoe wear, etc.)
 - Duration of ulceration
 - Treatments prescribed
 - Outcome of the treatments
- Past medical history (*Level of Evidence = III*)
- Medications (*Level of Evidence = IV*)
- Current diabetes management (*Level of Evidence = Ib*)
- Allergies (*Level of Evidence = IV*)
- Family history (*Level of Evidence = III*)
- Activities of Daily Living (ADL)/Instrumental Activities of Daily Living (IADL) or functional assessments (*Level of Evidence = III*)
- Quality of life (*Level of Evidence = III*)

Discussion of Evidence:

A comprehensive assessment is required for all patients who present with diabetic foot ulceration. This assessment must include the etiology, factors that influence healing and the patient's biopsychosocial status.

History of Presenting Illness (*Level of Evidence = IV*)

- Initiating event
- Duration of ulceration
- Treatments prescribed
- Outcome of the treatments

The evaluation of the patient with a diabetic foot ulcer requires a detailed history and physical examination, appropriate diagnostic tests, and identification of risk factors for ulceration. People with diabetic foot ulcers should be identified as high risk for amputation (Australian Centre for Diabetes Strategies, 2001; Falanga & Sabolinski, 2000).

Assessment and Management of Foot Ulcers for People with Diabetes

Past Medical/Surgical History (*Level of Evidence = III*)

A careful history is required to determine general health, diabetes control and complications. This should include:

- All other medical conditions (co-morbidities) and complications associated with diabetes
- Any surgeries and/or previous amputation related to diabetes
- History of previous ulcers related to diabetes

Co-morbidities and complications associated with Diabetes:

Renal impairment

Eggers et al. (1999), identified that patients with diabetes mellitus and end stage renal disease (ESRD), accounted for 50% of amputations within this patient population. Those with ESRD only, without diabetes mellitus had one-fifth the rate of amputations. Those with ESRD from other causes but had diabetes mellitus as a risk factor accounted for approximately 25% of the amputations. In the ESRD post amputation population, the survival rate at two years was 33%.

Hypertension

Results of the Hypertension Optimal Treatment and United Kingdom Prospective Diabetes Study (UKPDS) trials report clinically important reductions in microvascular and macrovascular complications and diabetes related death (CDA, 2003). Individuals with co-existing hypertension have a five-fold increased risk of developing peripheral vascular disease (PVD) and therefore are at increased risk for amputation, compared to normotensive individuals with diabetes (Royal Melbourne Hospital, 2002). Adler, Stratton, Neil, Yudkin, Matthews, Cull et al. (2000) demonstrated that macro and microvascular (retinopathy, nephropathy) complications are linked to elevated blood pressure.

Retinopathy

Reiber, Vileikyte, Boyko, Del Aguila, Smith, Lavery et al. (1999) reviewed seven studies indicating that retinopathy is an independent predictor of amputation, possibly due to microvascular disease.

Hospital admissions and previous surgeries

A history of previous amputation is a strong predictor of future amputations. Up to 34% of patients develop another ulcer within one year after healing while the 5 year rate of re-ulceration has been shown to be 70% (Frykberg et al., 2000).

Medications (*Level of Evidence = IV*)

Medication records will provide the health practitioner with information regarding diabetes management, as well as potential drug interactions, and those that may impair wound healing.

Current Diabetes Management (*Level of Evidence = Ib*)

Glycemic Control

The complications from diabetes are strongly related to high blood glucose levels. Improved glycemic control reduces complications. The United Kingdom Prospective Diabetes Study (UKPDS) showed that intensive control of blood glucose resulted in a substantial reduction of the risk of complications of type 2 diabetes. Each 1% reduction in A1C produced significant decreases in complications. A1C values in the normal range (<6%) comprised the lowest risk (Stratton, Adler, Neil, Matthews, Manley, Cull et al., 2000). The DCCT Research Group (1993) concluded that intensive therapy to maintain blood glucose levels close to the

normal range effectively delayed the onset and slowed the progression of diabetic retinopathy, nephropathy and neuropathy in patients with insulin dependent diabetes (IDDM), now identified as type 1.

A Japanese study examining glycemic control and microvascular complications concluded that intensive glycemic control can delay onset and progression of diabetic retinopathy, nephropathy and neuropathy in Japanese patients with NIDDM (type 2 diabetes)(Ohkubo, Kishikawa, Araki, Miyata, Isami, Motoyoshi et al., 1995). The Wisconsin Epidemiologic Study of diabetes retinopathy showed a consistent exponential relationship between worsening glycemic control and complications (Moss, Klein & Klein, 1996). The CDA Clinical Practice Guidelines (2003) recommends the following targets for glycemic control for most patients with type 1 and type 2 diabetes:

- $A_1C \leq 7.0\%$ to reduce the risk of microvascular and macrovascular complications.
- Fasting plasma glucose of 4.0 to 7.0 mmol/L and 2-hour postprandial plasma glucose targets of 5.0 to 10.0 mmol/L.

The CDA (2003) advises that treatment goals and strategies must be individualized according to risk factors such as complications and co-morbidities.

Allergies (Level of Evidence = IV)

Any allergies should be recorded in the medical history. Particular notes should be made of medications.

Family History (Level of Evidence = III)

Persons who have close relatives with certain diseases (e.g., heart disease, diabetes, and osteoporosis) are more likely to develop those diseases themselves (Bennett, 1999). Family health history is an important risk factor that reflects inherited genetic susceptibility, shared environment and common behaviours (Centres for Disease Control and Prevention, 2004).

Activities of Daily Living (ADL) (Level of Evidence = III)

It is important to determine how the patient is able to function within the environment that they are living in and how this impacts the patient's quality of life. Ribu & Wahl (2004) conducted a qualitative study with seven patients having type 1 or type 2 diabetes and foot ulcers to determine the patients' perspective of living with lower extremity ulcers and diabetes. The result indicates that patients experienced changes in their feet, pain and insomnia, fatigue and limited mobility, social isolation and loneliness, a restricted life, loss of control and fear for the future. When treating a patient's foot ulcer, clinicians need to consider patients' subjective feelings toward the various aspects of their life situations and the impact of their situation on their quality of life.

Vascular Status:

Recommendation 2.1:

Clinically assess bilateral lower extremities for vascular supply and facilitate appropriate diagnostic testing. (*Level of Evidence = IIb – IV*)

The assessment of vascular supply can be achieved through history, physical examination and diagnostic tests.

History and Physical Examination of the Lower Extremities	Diagnostic Tests*
<ul style="list-style-type: none"> ■ Peripheral pulses ■ Intermittent claudication ■ Colour (pallor on limb elevation, rubor on limb dependency, mottling) ■ Temperature ■ Capillary refill ■ Edema ■ Pain ■ Dry gangrene 	<ul style="list-style-type: none"> ■ Ankle brachial pressure index (ABPI) ■ Arterial duplex scan ■ Toe and ankle pressures ■ Transcutaneous oxygen

RNAO Guideline Development Panel, 2005

*Accessibility of these diagnostic tests may be limited to centres with specialty in vascular surgery and wound care.

Discussion of Evidence:

The affected foot must have adequate blood flow to support healing (Birke et al., 2000; Reiber et al., 1999). The literature supports the notion that peripheral arterial disease (PAD), also known as peripheral vascular disease (PVD), is not the cause of skin breakdown alone, but can prolong wound healing and increase the risk of subsequent amputation (Apelqvist, 1998; Birke et al., 2000; Crane & Branch, 1998; Sinacore & Mueller, 2000). In persons with diabetes seen at a younger age, PAD is often bilateral. Moreover, risk of PAD increases with the duration of the disease (Calhoun, Overgaard, Stevens, Dowling & Mader, 2002). Furthermore the risk of PAD increases by ten-fold in those with diabetes and concurrent renal failure (Apelqvist, 1998; Eggers et al., 1999).

The presence of peripheral pedal pulses represents a minimum systolic pressure of 80 mmHg (Lavery & Gazewood, 2000). The National Evidence Based Guidelines for the Management of Type 2 Diabetes Mellitus (Australian Centre for Diabetes Strategies, 2001) states that the absence of peripheral pulses has prognostic significance for future amputation in people with or without foot ulceration. With the distal nature of the disease process, persons with diabetes may have ischemia in the presence of dorsalis pedis pulses (Boulton et al., 1999).

One of the first classical symptoms of vascular insufficiency is claudication (calf pain). However, in patients with diabetes, this classic symptom can be masked by the presence of neuropathy (Calhoun et al., 2002). A cohort study by Eneroth, Apelqvist & Stenstrom (1997), found that claudication was an insignificant predictor or symptom of vascular disease. A positive history of lower limb intermittent claudication combined with non-palpable pedal pulses bilaterally increases the probability of vascular insufficiency in diabetes (Boyko, Ahroni, Davignon, Stensel, Prigeon & Smith, 1997).

Capillary refill is defined as abnormal if it takes longer than 5 seconds for the tissue to return to its normal colour after applying pressure and releasing it.

The colour of the foot should be assessed for rubor on dependency, pallor on elevation, mottling and dry gangrene, all of which are signs of ischemia (Bowker & Pfeifer, 2001). A vascular surgery referral is recommended for patients with signs of arterial insufficiency in order that a comprehensive vascular assessment can be completed.

See Appendix G for further details about diagnostics to determine vascular supply.

Infection:

Recommendation 2.2:

Assess all patients with diabetic foot ulcers for signs and symptoms of infection and facilitate appropriate diagnostic testing and treatment. (*Level of Evidence = IIa*)

Discussion of Evidence:

Persons with diabetic foot ulcers may not be able to mount an inflammatory response due to impaired immunodefense, decreased peripheral circulation and metabolic control (Armstrong, Lavery, Sariaya & Ashry, 1996; Eneroth et al., 1997). In addition, increased co-morbidities associated with aging places the person with diabetes at a higher risk for infection.

Identifying infection in a chronic wound can be a challenge since the clinical assessment for infection in chronic wounds differs from acute wounds. Gardner, Frantz & Doebbling (2001) validated the work by Cutting & Harding (1994) and provided a checklist to aid the clinician in identifying the clinical signs of infection in chronic wounds. Gardner et al. (2001), in a cross-sectional design study, identified the following signs and symptoms:

- Increased pain (100% specificity)
- Wound breakdown (100% specificity)
- Friable granulation tissue (76% specificity)
- Foul odour (88% specificity)


Deep infection will often cause erythema and warmth extending 2 cm or more beyond the wound margin. This increased inflammatory response is painful and will cause the wound to increase in size or lead to satellite areas of tissue breakdown which cause adjacent ulceration. Deep infections, especially in ulcers of long duration can often lead to osteomyelitis. Probing to bone is a simple, non-invasive technique for rapid identification of osteomyelitis and should be included in the initial assessment of all patients with infected pedal ulcers (Grayson, Balaugh, Levin & Karchmer, 1995). When combined with clinical evaluation and radiographic interpretation, probing to bone is a cost-effective and specific assessment tool (Caputo, Cavanagh, Ulbrecht, Gibbons & Karchmer, 1994).

With infection, the wound may change in odour, colour, tissue quality and exudates. A healthy wound has a faint but not unpleasant odour, infections usually result in a distinctive and slightly unpleasant smell (Cutting & Harding, 1994).

Assessment and Management of Foot Ulcers for People with Diabetes

Based on the utilization of the signs and symptoms listed below, the timely diagnosis and treatment of infection is vital to the healing of diabetic foot ulcers. Deep foot infections are serious, potentially limb threatening and have been identified as the immediate cause of 25-51% of amputations in persons with diabetes (Tennvall, Apelqvist & Eneroth, 2000).

Table 1: Clinical signs and symptoms of impaired bacterial balance in persons with a diabetic foot ulcer

 SIGNS OF DEEP WOUND AND SYSTEMIC SIGNS OF INFECTION ARE POTENTIALLY LIMB AND/OR LIFE THREATENING. THESE CLINICAL SIGNS AND SYMPTOMS REQUIRE URGENT MEDICAL ATTENTION.		
Non limb threatening infection	Limb threatening infection	
Superficial infection <ul style="list-style-type: none"> ■ Non-healing ■ Bright red granulation tissue ■ Friable and exuberant granulation ■ New areas of breakdown or necrosis ■ Increased exudate ■ Bridging of soft tissue and the epithelium ■ Foul odour 	Deep wound infection <ul style="list-style-type: none"> ■ Pain (in a previously insensate foot) ■ Swelling, induration ■ Erythema (> 2 cm) ■ Wound breakdown ■ Increased size or satellite areas ■ Undermining or tunnelling ■ Probing to bone ■ Flu-like symptoms ■ Anorexia ■ Erratic glucose control 	Systemic infection In addition to deep wound infection: <ul style="list-style-type: none"> ■ Fever ■ Rigours ■ Chills ■ Hypotension ■ Multi-organ failure

RNAO Guideline Development Panel, 2005

Infection occurs when bacteria in a wound overcomes the natural defences of the host's immune system. The likelihood of a wound becoming infected is related to microbial load and the type of micro-organism. However, equally important factors are the characteristics of the wound (type, site, size and depth), the level of blood perfusion and the ability of the host to resist infection:

$$\text{Infection} = \frac{\text{Number of organisms} \times \text{Virulence of organisms}}{\text{Host resistance}}$$

This equation represents a balance between increasing number of organisms and virulence that can eventually overcome the host's ability to contain infection (Dow, Browne & Sibbald, 1999; Peacock & Van Winkle, 1976).

While emphasis is frequently placed on bacterial burden, the host resistance (the patient with diabetes) is often the critical factor in determining whether infection will develop. Persons with diabetes have compromised immunity which leads to a reduced resistance to infection.

Most chronic wounds contain more than three species of micro-organisms, which increases the risk of infection as they may develop synergies with one another. In wounds that are infected with a number of species it is not possible to distinguish which is the causative organism (Table 2).

Changes in microbial flora over time

The microbial flora in a chronic wound changes over time in a predictable fashion as seen in Table 2.

Table 2: Microbial flora in a chronic wound over time

Time	Type of micro-organism	Clinical and laboratory findings
First few days	Cutaneous flora	
1 to 4 weeks	Cutaneous flora accompanied by Gram-positive aerobic cocci, often beta-haemolytic <i>Streptococci</i> , <i>S. aureus</i> .	Purulent discharge Gram-positive Single species
4 weeks onwards	Cutaneous flora accompanied by Gram-negative facultative anaerobic bacteria, particularly coliforms followed by anaerobic bacteria and <i>Pseudomonas</i>	Tissue necrosis Undermining Deep involvement Poly-microbial mixture of aerobic and anaerobic pathogens

Used with permission. Dow, G., Browne, A. & Sibbald, R. G. (1999). Infection in chronic wounds: Controversies in diagnosis and treatment. *Ostomy/Wound Management*, 45(8), 23-27, 29-40.

Diagnostic tests and imaging are other procedures that are used to determine infection.

For diagnostic tests and imaging to determine infection, see Appendix H.

For description of swabbing technique, see Appendix I.



Neuropathy:

Recommendation 2.3:

Identify peripheral neuropathy by assessing for sensory, autonomic and motor (S.A.M.) changes.

(Level of Evidence = II – IV)

Discussion of Evidence:

Lavery, Armstrong, Vela, Quebedeau & Fleishchli (1998) noted that patients with only peripheral neuropathy and no other risk factors were 1.7 times more likely to develop ulceration. Patients with both neuropathy and foot deformity were 12.1 times more likely to have an ulcer. Patients with neuropathy, deformity and a history of amputation were 36.4 times likely to develop a foot ulcer.

There are three components to peripheral neuropathy. Listed below are the effects of each form of neuropathy that the patient with diabetes may present with that will increase the risk of ulcer development:

Component	Pathophysiology	Assessment	Outcome
Sensory	<ul style="list-style-type: none"> ■ Myelin sheath is disrupted by hyperglycemia ■ Disruption leads to segmental demyelination process accompanied by a slowing of motor nerve conduction and an impairment of sensory perception (Zangaro & Hull, 1999) 	<ul style="list-style-type: none"> ■ 4 site testing including the great toe, first, third and fifth metatarsal heads, using a 10-gram (5.07) monofilament* is recommended as an appropriate screening process to determine the presence of protective sensation in the persons with diabetes (ADA, 2001; Campbell, Graham, Kidd, Molly, O'Rourke & Coagiuri, 2000; Frykberg et al., 2000; Hunt, 2001; Hutchinson et al., 2000; Institute for Clinical Systems Improvement, 2000; Lavery & Gazewood, 2000; McCabe, Stevenson & Dolan, 1998; NZGG, 2000; RNAO, 2004; Smieja, Hunt, Edelman, Etchells, Cornuz & Simel, 1999; Zangaro & Hull, 1999). ■ Gait analysis 	<ul style="list-style-type: none"> ■ Loss of protective sensation ■ Sensory ataxia ■ Falls (15-fold increase compared to those without diabetes)
Autonomic	<p>Sympathetic Denervation</p> <ul style="list-style-type: none"> ■ Loss of vasomotor control ■ Peripheral blood flow ■ Arteriovenous shunting ■ Bone blood flow hyperemia ■ Glycosylation of collagen 	<ul style="list-style-type: none"> ■ Dry scaly skin caused by lack of hydration ■ Inspect between the toes especially between the fourth and fifth toes for fissures ■ Maceration ■ Loss of hair growth and thickened toenails 	<ul style="list-style-type: none"> ■ Anhidrosis ■ Callus ■ Fissure cracks ■ Onychomycosis (fungal nails) ■ Peripheral edema ■ Waxy skin = altered joint mobility
Motor	<ul style="list-style-type: none"> ■ Non-enzymatic glycosylation ■ Atrophy of intrinsic muscles of the foot (toe plantar flexors) ■ Subluxation of metatarso-phalangeal joints 	<ul style="list-style-type: none"> ■ Increased peak pressure ■ Range of motion ■ Absent deep tendon reflexes ■ Diminished vibratory sense 	<ul style="list-style-type: none"> ■ Claw toes ■ Hammer toes ■ Charcot arthropathy ■ Muscle weakness ■ Ankle equinus ■ Pes cavus ■ Pes planus ■ Contracture of Achilles Tendon

*(Apelqvist,1998; Boyko, Ahroni, Stensel, Forsberg, Davignon & Smith, 1999; Bureau of Primary Health Care, 2005; Frykberg, Lavery, Pham, Harvey, Harkless & Veves, 1998; Lavery, Armstrong, Wunderlich, Tredwell & Boulton; 2003; Shaw & Boulton, 1997).

See Appendix J for description and use of monofilament.

Foot Deformity and Pressure:

Recommendation 2.4:

Assess for foot pressure, deformity, gait, footwear and devices. Facilitate appropriate referrals.

(Level of Evidence = Ia – IV)

Discussion of Evidence:

Studies have demonstrated that while trauma to a neuropathic foot may be related to a single event, ulcers frequently occur as a result of repeated minor trauma such as from footwear or elevated pressure on the bottom of the foot. Foot deformities such as prominent metatarsal heads, clawing of the toes and limited joint mobility alters the gait or mechanics of walking resulting in abnormal forces on the foot, poor shock absorption, and shearing and stress to soft tissues (RNAO, 2004; Shaw & Boulton, 1997). People with diabetes should be assessed regularly to detect foot deformities and should have interventions to reduce foot pressure and ulcer risk (Australian Centre for Diabetes Strategies, 2001; Royal Melbourne Hospital, 2002).

Assess for Pressure


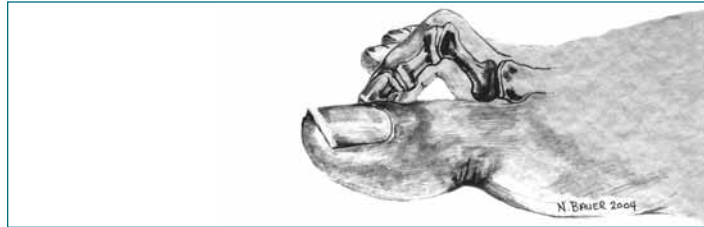
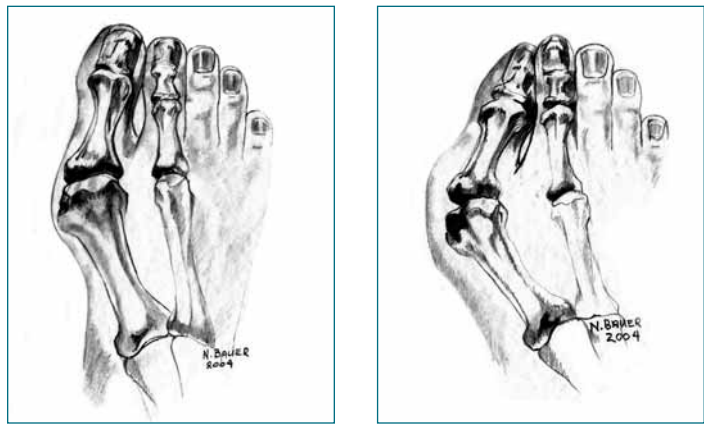
Elevated foot pressure is an important risk factor for foot complications (Lavery et al., 2003). The plantar surface of the forefoot is found to be the most common location for the development of an ulcer (ADA, 1999). Forefoot and rear foot pressure ratios are increased in the severe diabetic neuropathic foot indicating an imbalance in pressure distribution. Equinus deformity with severe peripheral neuropathy may be an important factor in ulcer etiology (Caselli, Pham, Giurini, Armstrong & Veves, 2002). Reduced plantar soft tissue thickness at the metatarsal heads is associated with increased foot pressure and may predict development of diabetic foot ulcer (Abouaasha, van Schie, Griffiths, Young & Boulton, 2001).

Pressure over bony prominences can lead to callus formation and in the absence of protective sensation may predispose the area to breakdown (Australian Centre for Diabetes Strategies, 2001; Boyko et al., 1999; Frykberg et al., 1998; Hutchinson et al., 2000). Callus may act as a foreign body elevating plantar pressures and there is significant reduction in pressure when the callus is removed (Boulton et al., 1999; Murray, Young, Hollis & Boulton, 1996; Pataky, Golay, Faravel, Da Silva, Makoundou, Peter-Riesch et al., 2002; Young, Cavanagh, Thomas, Johnson, Murray & Boulton, 1992).

Identify Structural Deformities

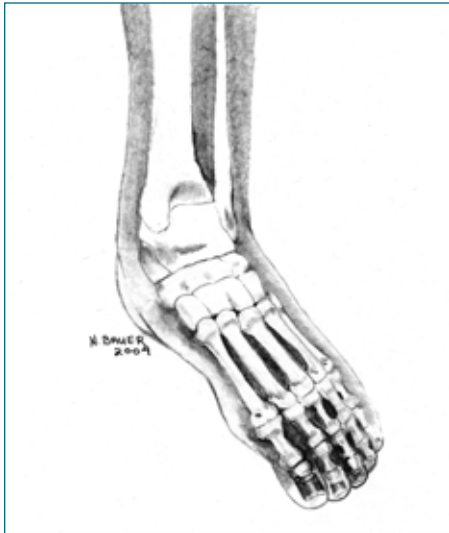
The physical examination of a person with diabetes should include assessment and intervention for foot deformity (Australian Centre for Diabetes Strategies, 2001; Royal Melbourne Hospital, 2002). There is significant evidence that with increased number of deformities, there is an increased risk and magnitude of plantar pressure (Lavery et al., 2003).

Deformities may include, but are not limited to, hammer toe, claw toe, hallux deformity, pes planus, pes cavus and Charcot arthropathy.

Deformity	Description and Evidence
	<p>With atrophy of the intrinsic muscles of the foot, especially the toe plantar-flexors, the flexor/extensor balance at the metatarso-phalangeal joints is altered. This causes clawing at the toe and possible subluxation of the metatarso-phalangeal joints. As a result, the submetatarsal fat pads are displaced and there is reduced pressure absorbing subcutaneous tissue at the metatarsal heads. In addition, glycosylation of collagen from hyperglycemia results in thickened, waxy skin which affects joint mobility. All these factors contribute to foot deformity and ulcer risk (Bennett, Stocks & Whittam, 1996; Shaw & Boulton, 1997).</p>
<p>*Hammer Toe – bent middle joint</p> 	
<p>*Claw Toe – joint at base of toe is bent up and middle joint is bent down</p>	
	
<p>*Halgus Valgus or Small Bunion (Mild/Moderate) – joint at the base of big toe is pushed to the side</p>	<p>*Hallus Valgus or Large Bunion (Severe) – big toe may move under second toe</p>

Deformity

Description and Evidence



Pes Planus

Pes planus produces flattening of the foot. Pes planus feet have increased lateral talometatarsal angle and increased second metatarsal length (Ledoux, Shofer, Ahroni, Smith, Sangeorzan & Boyko, 2003). There are many reasons for this condition, the first of which is heredity. Many have this condition and never have any problems of any kind.

However, others will have this condition created through years in soft, unsupportive shoes on hard surfaces, injury, pregnancy, or other factors. This often leads to other problems.



The arch in the foot is caused by a broad band of fibrous connective tissue, called the longitudinal ligament. A ligament is nothing more than connective tissue that connects bone to bone. The longitudinal ligament connects the metatarsal phalangeal joints to the os calcis or heel bone. Like a string on a bow, they hold the two ends together and create an arch. This arch is a shock absorption structure and it also helps to maintain all the tarsals in proper erect anatomic position. As this arch decreases, impact from the concrete becomes worse.

When the arch ligament stretches or tears, the arch falls. If it falls far enough, the tarsals may begin to shift to the inside or create pronation or a valgus (greater than 90 degree erect) position at the ankle. This can cause problems in the origin area, (the metatarsals) or in the heel. It also may cause pressure on the medial (inner) knee and perhaps the hip and back. It is like pulling the string on a marionette too tight, the result is a kinked mass on one side. The human body is much the same, put too much tension on major muscle groups and the joints kink and yell back.



Pes Cavus

In pes cavus, the arch is abnormally high on weight bearing. The heel is often tilted inwards at the ankle (but not always). In many, the toes will appear clawed. When not standing the front half of the foot (forefoot) will appear to be dropped below the level of the rear foot. Ledoux et al. (2003) identified biomechanical differences among pes planus and pes cavus feet in persons with diabetes. They found pes cavus feet had more prominent metatarsal heads, bony prominences, hammer/claw toes, increased hallux dorsiflexion and decreased hallux plantarflexion.

Deformity	Description and Evidence
  <p data-bbox="191 1066 477 1102">*Charcot Arthropathy</p>	<p data-bbox="699 317 1403 1136">Charcot joint is a form of neuroarthropathy that occurs most often in the foot. Nerve damage from diabetes causes decreased sensation, muscle and ligament atrophy and subsequent joint instability. Walking on this insensitive and weakened joint can cause even more damage to the foot structure. In the acute stage there is inflammation and bone reabsorption which destroys the bone. In later stages, the arch falls and the foot may develop a rocker bottom appearance. Weight distribution of the sole is altered causing deformities leading to pressure points that enhances ulcer development. Signs to assess for are: hot on the onset, pain, discomfort, erythema, swelling, rigid deformities, limited joint mobility, callus formation (ADA, 2001; Bowker & Pfeifer, 2001). One in 680 people with diabetes develop Charcot joint with an incidence of 9-12% individuals with documented diabetic peripheral neuropathy (Royal Melbourne Hospital, 2002). It is important that the Charcot foot is recognized early so that appropriate treatment of the foot can be provided to prevent further injury and promote a stable foot (Lavery et al., 1998). For patient information on Charcot arthropathy, visit www.rnao.org/bestpractices.</p>
<p data-bbox="191 1335 477 1371">Limited Joint Mobility</p>	<p data-bbox="699 1188 1403 1587">Progressive stiffening of collagen-containing tissues leads to thickening of the skin, loss of joint mobility, and potential fixed flexor deformity. Up to 30% of patients with diabetes may have limited joint mobility. Reduction in mobility of the ankle joint may cause increased plantar pressure when walking and be a major risk factor in the pathogenesis of diabetic foot ulcers (Fernando, Masson, Veves & Boulton, 1991; Zimny, Schatz & Pfohl, 2004). Achilles tendon contracture is a common cause of limited joint mobility causing increased pressure on the forefoot during ambulation (Armstrong, Lavery & Bushman, 1998; Mueller, Sinacore, Hastings, Strube & Johnson, 2004).</p>

Above illustrations provided by Nancy A. Bauer, BA, Bus Admin, RN, ET.

* Reference:

Diabetes Nursing Interest Group & Registered Nurses' Association of Ontario (2004). Diabetes foot: Risk assessment education program. Images of the diabetic foot. Registered Nurses' Association of Ontario [Electronic version]. Available: www.rnao.org/bestpractices/PDF/BPG_Foot_Diabetes_Workshop_slides.pdf

Gait Abnormality

Gait is the manner or style of walking. The neurodegenerative process is accelerated in diabetes and this results in a decline in motor control and a pathology-related decline in postural stability/foot posture, and abnormal weight bearing (Mason O'Keefe, McIntosh, Hutchinson, Booth & Young, 1999b; Meier, Desrosiers, Bourassa & Blaszczyk, 2001). Alterations in gait, balance and mobility are caused by sensory ataxia, poor vision, debilitation and/or neuropathy in the patient with diabetes (Sinacore & Mueller, 2000). Assessment of gait is important because patients with diabetes and neuropathy have a 15 times greater risk of experiencing a fall compared to those without neuropathy (Sinacore & Mueller, 2000).

Some gait patterns that may be observed in a patient with diabetes are: ataxic (unsteady, uncoordinated, employing a wide base of support), steppage (lift the foot higher to accommodate for foot drop and/or poor ankle-joint mobility) and antalgic (a limp, usually signifying discomfort).

Footwear and Devices

Examination and use of existing footwear and devices should be assessed for areas of pressure and adherence with wearing. Appropriate education should be provided. See Appendix K for suggestions in assessing and selecting shoes and socks.

Shoes

It is imperative that patients with diabetes see a foot or healthcare specialist regularly for the assessment of their feet as well as their shoes and other devices associated with ambulation as a preventative measure to reduce the occurrence and re-occurrence of ulcers (ADA, 2001; Campbell et al., 2000; Frykberg et al., 2000; Hunt, 2001; Hutchinson et al., 2000; Institute for Clinical Systems Improvement, 2000; Lavery & Gazewood, 2000; McCabe et al., 1998; NZGG, 2000; Smieja et al., 1999; Zangaro & Hull, 1999).

Foot ulceration has been associated with constant or repetitive pressure from tight shoes over bony prominences on the dorsum of the lesser toes, at the medial aspect of the first metatarsal head, or the lateral aspect of the fifth metatarsal (Lavery et al., 1998). In a large prospective study, Abbott, Carrington, Ashe, Bath, Every, Griffiths et al. (2002) found that the main cause (55%) of ulceration was pressure from footwear.

In a systematic review of interventions to prevent diabetic foot ulcers, two randomized controlled trials on patient footwear were reviewed. One study found that type of shoe may be independently important, and that providing patients with normal well-fitting shoes that distribute abnormal pressures may also reduce ulcer risk (Mason et al., 1999a). The second study reported that evidence does not support widespread dispensing of therapeutic shoes and inserts for patients with diabetes and foot deformities. Patient education may be a more important intervention. However, for those patients unable to be closely monitored or who have severe deformities, specialized footwear may be beneficial (Reiber, Smith, Wallace, Sullivan, Hayes, Vath et al. 2002). Maciejewski, Reiber, Smith, Wallace, Hayes & Boyko (2004) reported results consistent with the second study.

Assessment and Management of Foot Ulcers for People with Diabetes

Orthotics

Orthotics are custom-made shoe inserts which serve to correct or relieve misalignment and or pressure areas of the foot. A systematic review was conducted to assess the effectiveness of pressure relieving interventions in prevention and treatment of diabetic foot ulcers. Spencer (2004) reviewed four randomized controlled trials of pressure relieving interventions and concluded that in-shoe orthotics are of benefit.

Diagnostic Tests

Accessibility of these tests may be limited to specialty centres.

X-ray

X-rays are useful primarily as imaging tools to identify possible osteomyelitis, foreign bodies, tissue gas, or bony abnormalities (Royal Melbourne Hospital, 2002).

Pressure Map

Pressure mapping measures foot pressures in standing and walking positions. Lavery et al. (1998) identified high plantar pressure (65 N/cm^2) as a significant factor associated with the presence of foot ulceration. Pham, Armstrong, Harvey, Harkless, Giurini & Veves (2000) using an F-Scan mat system, found that foot pressures $\geq 6 \text{ kg/cm}$ put patients at risk for foot ulcerations.

Foot Ulcer Assessment:

Recommendation 3.0:

Describe and document the ulcer characteristics. (*Level of Evidence = IV*)

Discussion of Evidence:

Good record keeping using common language and objective descriptors such as wound measurements and ulcer grading can increase clarity and may improve outcomes. Careful monitoring of wound healing is as important as initial assessment and treatment in influencing outcome (Krasner, 1998). At present, there is a lack of clearly established standards for assessing and documenting wound progress.

Recommendation 3.1:

Identify the location, length, width, depth and classify the ulcer(s). (*Level of Evidence = Ia – IV*)

Discussion of Evidence:

Identification of Ulcer on the Lower Extremity (*Level of Evidence = IIa*)

Location of a foot ulcer is determined by the site of trauma. In three large prospective studies, 53% of ulcers involved the toes and 22% involved the first metatarsal area (Apelqvist et al., 2000; Armstrong, Lavery & Harkless, 1998a; Reiber et al., 1999).

Measuring the Length and Width (*Level of Evidence = Ia*)

A systematic review evaluated treatments for diabetic foot ulcers by calculating length and width (Margolis, Kantor & Berlin, 1999). As length and width decreased, the wound was classified as healing. It is important when measuring a wound that the measurements are done using a consistent method such as tracings (Krasner & Sibbald, 2001). This will greatly increase reliability in determining progress towards closure. Clinical studies have shown that a reduction in ulcer area (approximately 20 to 40%) after 2 to 4 weeks of treatment is a good predictor of healing (Margolis et al., 1999; Tallman, Muscare, Carson, Eaglstein & Falanga, 1997; van Rijswijk & Polansky, 1994).

Measuring the Depth (*Level of Evidence = IV*)

Wound depth is most commonly measured and quantified by gently inserting a sterile swab stick or probe into the wound. Find the deepest point and put a gloved forefinger on the swab stick at the skin level. Place next to a measuring guide. The presence or absence of undermining, a space between the surrounding skin and wound bed, and tunneling can also be determined in this manner. If tunneling or undermining is present, use the “clock” system to document location (e.g., area of the wound closest to the head is the 12 o’clock position).

Standardizing the procedure for measurement is crucial in order to evaluate whether the wound is moving in the direction of the goal of care. The University of Texas Health Science Center San Antonio Diabetic Wound Classification System (see Appendix E) is an example of a grading system to stage the depth of the wound.

Recommendation 3.2:

Assess ulcer bed, exudate, odour and peri-ulcer skin. (*Level of Evidence = IV*)

Discussion of Evidence:

The aim of wound bed assessment is to identify and plan the management of factors that will promote an optimal healing environment (Vowden & Vowden, 2002). The condition of the periwound area provides important information about the status of the wound and can influence choice of treatment. Surrounding skin assessment includes evaluating colour, callus formation, induration, moisture and edema. Redness can be indicative of unrelieved pressure or prolonged inflammation (Boulton, 1991). When the surrounding skin has been exposed to moisture for a prolonged period of time, signs of maceration (pale, white or grey tissue) may be observed. Callus formation is indicative of ongoing pressure to the affected area.

Debridement of callus is generally performed to facilitate accurate assessment of the wound. Induration (an abnormal firmness of the tissue) and edema are assessed by gently pressing the skin within 4 cm of the wound.

Assessment and Management of Foot Ulcers for People with Diabetes

Wound exudate characteristics, e.g., type and amount of drainage, provide important information about the status of the wound. Rating the amount of drainage is useful only if a description of each rating is provided.

Wound is dry = no exudate

Moist wound = scant or small

Wet/saturated = heavy

In addition to amount, the type of exudate should be described.

Serous = clear yellow fluid without blood, pus or debris

Serosanguinous = thin, watery, pale red to pink fluid

Sanguinous = bloody, bright red

Purulent = thick, cloudy, mustard yellow or tan

All wounds, especially those treated with moisture retentive dressings, can emit an odour. Necrotic wounds tend to have more offensive odour than clean wounds, while wounds infected with anaerobes tend to produce a distinct acrid or putrid odour. A descriptive odour assessment can provide important information, as a change in odour may be indicative of an alteration in bacterial balance.

Goals of Care:

Recommendation 4.0:

Define goals based on clinical findings, expert opinion and patient preference. *(Level of Evidence = IV)*

Recommendation 4.1:

Determine the potential of the ulcer to heal. *(Level of Evidence = IV)*

Recommendation 4.2:

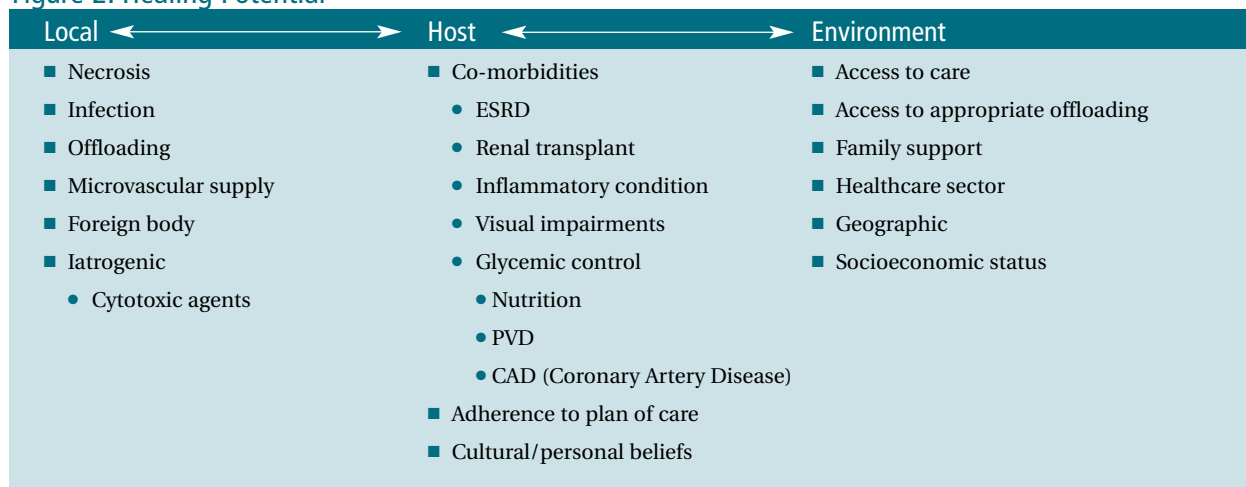
Develop goals mutually agreed upon by the patient and healthcare professionals.

(Level of Evidence = IV)

Discussion of Evidence:

The perceived value of treating foot ulcers varies from the point of view of the patients and healthcare professionals. The role of the nurse in the management of patients with a diabetic foot ulcer is to advocate, collaborate and facilitate the process of goal directed care. The healing potential of a wound must be taken into consideration. See Figure 2 for factors affecting healing potential.

Figure 2: Healing Potential



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The primary goal in the treatment of diabetic foot ulcers is to obtain wound closure as expeditiously as possible. The resolution of foot ulcers and decreasing the rate of re-occurrence can lower the probability of lower extremity amputation in patients with diabetes.

According to the American Diabetes Association (1999) Consensus Development Conference of Diabetic Foot Wound Care, foot wounds in patients with diabetes should be treated for several reasons – improve function and quality of life; control infection; maintain health status; prevent amputation; and reduce costs.

Healing of foot wounds improves the appearance of the foot and may allow the patient to return to ambulation in appropriate footwear. Improving function and return to well-being are important goals of therapy (ADA, 1999). With impaired mobility, foot wounds often lead to general deconditioning and psychosocial dysfunction.

Frequent re-evaluation with response-directed treatment is essential. Once the ulcer is closed, the management of PWDFU should include strategies to decrease the probability of re-occurrence. Patient involvement is an essential component of diabetic foot ulcer care, particularly when the encouragement of adherence, with chronic or complex treatment regimens, is imperative. The care of the patient should be based on a patient or client centred care approach (See the RNAO guideline [2002a] on *Client Centred Care*). Patient-focused care involves a collaborative care planning and interdisciplinary team approach to assessing, planning, implementing, monitoring and evaluating the care with the patient (Carter, 1995). Diabetic foot ulcer management in a patient-focused model of care is a holistic approach that offers an integrated care pathway, identifying the nursing, medical and paramedical activities that must be synchronized to ensure the patient receives the appropriate treatment from experts of each discipline (Carter, 1995). Carter (1995) also states that fragmentation of care may lead to conflicting advice for the patient, and the potential for wastage of time and effort which may lead to protracted wound healing. In a consumer focus group session led by the development panel, patients who were interviewed consistently expressed dissatisfaction with limited healthcare expertise and access to specialized services, fragmented care and long wait times.

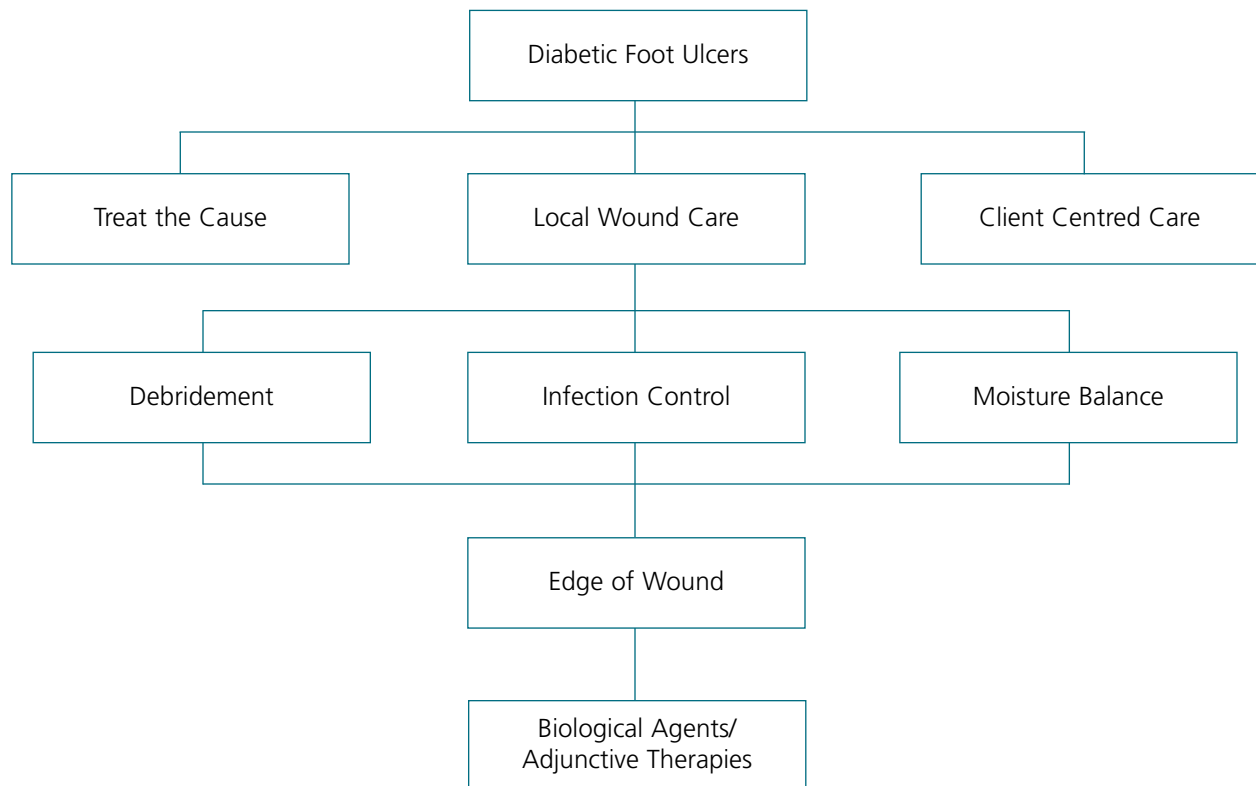
Management:

This section will discuss the management of diabetic foot ulcers based on a holistic assessment as discussed in the previous section. The **Principles of Management should include:**

- Vascular management of ischemia and existing co-morbidities
- Infection control and removal of necrotic tissue
- Plantar pressure offloading – intrinsic and extrinsic

The following model assists the clinician in providing a practice framework for treatment of persons with diabetic foot ulcers (PWDFU).

Figure 3: Framework for Practice



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Recommendation 5.0:

Identify and optimize systemic, local and extrinsic factors that can influence wound healing.

(Level of Evidence = IV)

Discussion of Evidence:

Patients with diabetes often have a combination of complicating factors. These factors may be categorized as systemic, local and extrinsic (see Appendix L). Morris, Jones & Harding (2001) indicate that there is no strong evidence to support that correcting all these factors will necessarily improve wound healing. However, addressing factors that can be controlled or optimized may increase the potential for healing and quality of life.

Systemic Factors:

Recommendation 5.1:

Modify systemic factors and co-factors that may interfere with or impact on healing.

(Level of Evidence = IV)

Discussion of the Evidence:

Healing diabetic foot ulcers is a complex process. One cannot expect healing to occur just by simply dressing the wound. Early identification of the co-factors for impaired healing allows the clinician to initiate appropriate referrals and develop a comprehensive interdisciplinary plan of care. By utilizing a systematic approach in the management of each patient with a diabetic foot ulcer, the wound care clinician increases the probability of achieving wound closure. According to McGuckin, Goldman, Bolton, & Salcido (2003) and Seaman (2000), the team directing the patient care must perform a thorough history and physical examination and order relevant investigative studies.

Local Factors:

Recommendation 5.2:

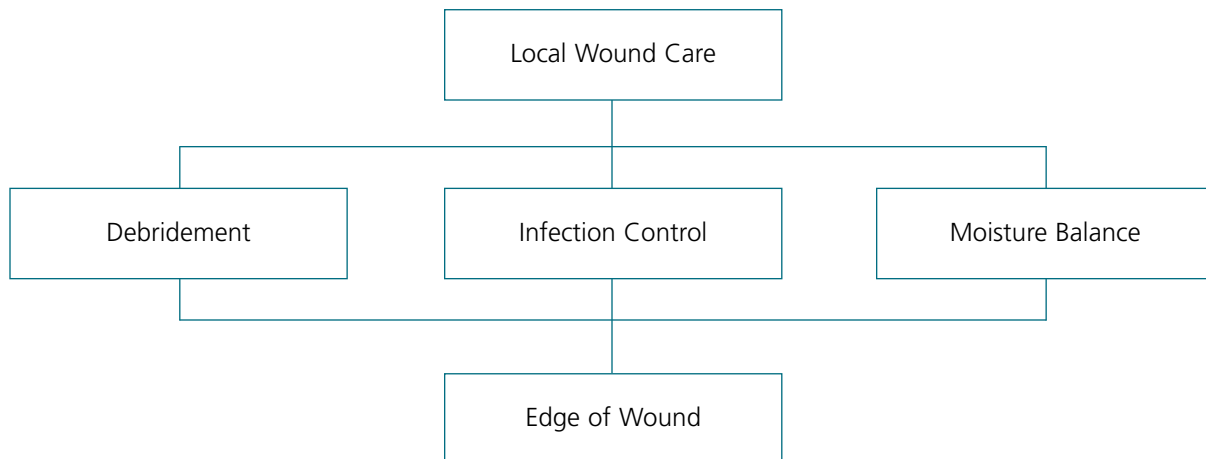
Provide local wound care considering debridement, infection control and a moist wound environment. *(Level of Evidence = Ia – III)*

Discussion of Evidence:

If healing potential is not established, aggressive debridement and moist interactive healing is not recommended. Wounds that have the greatest potential for healing at an optimal rate require care that includes:

- Debridement
- Infection control
- Moisture balance

Figure 4: Local Wound Care Model



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Debridement

Although debridement methods vary, common methods of debridement for diabetic foot ulcers include:

- Mechanical irrigation with saline solution
- Use of autolytic agents (e.g., hydrogels)
- Sharp, using a scalpel or scissors (method of choice in an infected wound)
- Surgical (occurs in the operating room with anesthesia and surgical instruments)

The frequency of debridement is scheduled at the discretion of the clinician (Inlow et al., 2000).

Callus Reduction

Debridement of callus can significantly reduce pressure at the callus site by approximately 30% (Pitei, Foster & Edmonds, 1999; Young et al., 1992). Debridement of callus is within the nurse's scope of practice, assuming that the nurse has the knowledge, skill and judgement to perform this procedure.

Tissue Debridement

The removal of nonviable, contaminated and infected tissue from the wound area has been shown to increase the rate of healing of diabetic foot ulcers (Inlow et al., 2000; Rodeheaver, 2001). In a post-hoc analysis conducted by Steed, Donohoe, Webster & Lindsley (1996), lower rates of healing were correlated with less frequent debridement practices. These observations were confirmed in a prospective trial where sharp debridement may be associated with better outcomes in patients with diabetic foot ulcers (Saap & Falanga, 2002).

Smith (2004) conducted a systematic review to determine the effectiveness of debridement methods for diabetic foot ulcers. Five randomized controlled trials (RCTs) were identified: three involved the use of hydrogels and two involved the use of sharp debridement. The results suggest that hydrogels were significantly more effective than gauze or standard care in healing diabetic foot ulcers. However, sharp

debridement has not been shown to be of significant benefit in promoting wound healing. It should be noted that the clinical trials on sharp debridement are inadequately powered. There is a need for more research to evaluate the effects of a range of widely used debridement methods and of debridement per se.



Sharp debridement is a high-risk procedure. Debridement with a scalpel should be undertaken with caution and performed by specially trained and experienced healthcare professionals.

Subcutaneous debridement with a scalpel is a controlled act that must be carried out by a physician or the delegate. Nurses should be aware of the policies and procedures of their facility.

Infection Control

Infections in a diabetic patient must be treated urgently. Diabetic foot infections can rapidly progress to limb- or life-threatening situations. The amputation rate in diabetic populations with foot infections has been reported to range from 12-92% (Tennvall et al., 2000).

Management of diabetic foot ulcer infections should focus on four integrated parameters of care:

- Controlling bacterial balance;
- Host response/defence;
- Complete pressure offloading; and
- Local wound care.

According to Peacock and Van Winkle (1976), infection occurs when the number of organisms exceeds the ability of local tissue defenses to handle them. Maximizing the host ability to fight the infections should be a major consideration. This includes correction of hyperglycemia, stabilization of other co-morbidities, good nutrition and rest. Local wound care should include wound cleansing and debridement to remove devitalized tissue and reduce bacterial load in the wound (Saap & Falanga, 2002; Steed et al., 1996).

Antimicrobial management of diabetic foot infection should be based on the Ontario Anti-infective Guidelines for Community Acquired Infections (Ontario Anti-infective Review Panel, 2001). The prescribed antibiotic(s) should be based on the results of the culture and sensitivity of the organism(s) in conjunction with the physician's clinical judgement.

Once a treatment plan is developed and initiated, an evaluation period should be established to determine the patient's response to treatment.



Application of moisture retentive dressings in the context of ischemia and or dry gangrene can result in a serious life- or limb-threatening infection.

See Table 3 for Treatment of Infection.

Table 3: Treatment of Wound Infection

Non-limb-threatening infection	Limb-threatening infection	
<p>Superficial infection</p> <ul style="list-style-type: none"> ■ Support host defences ■ Requires a team approach ■ Cleanse and debride wound ■ May be monomicrobial ■ Topical antimicrobials ■ <u>May</u> require oral/IV antibiotics (based on host risk) ■ Offloading ■ Ongoing evaluation based on clinical findings ■ Patient education 	<p>Deep wound infection</p> <ul style="list-style-type: none"> ■ As in superficial infection ■ Polymicrobial ■ Will require oral/IV antibiotics ■ May require surgical debridement ■ Non weight bearing ■ Consider hospitalization ■ Consider Infectious Disease consultation ■ Ongoing evaluation based on clinical findings 	<p>Systemic infection</p> <ul style="list-style-type: none"> ■ As in deep wound infection ■ Will require hospitalization ■ Will require IV antibiotics ■ Ongoing evaluation based on clinical findings ■ Bedrest

RNAO Guideline Development Panel, 2005

A. Non-Limb-Threatening Infections

Ulceration does not need to be present since non-limb-threatening infections can result from small puncture wounds, scratches, nail trauma or heel (fissure) cracks. Mild to moderate infection can usually be managed on an outpatient basis with close supervision by the medical practitioner. Topical antimicrobials can be used to reduce bacterial burden in superficial infections. There are several iodine and silver preparations now available that are safe, effective and economical (Sibbald et al., 2003). Systemic antibiotics may be prescribed by the physician or the Registered Nurse/Extended Class (RN/EC) in the community. See Appendix M for a list of Topical Antimicrobial Agents.

If the wound still fails to heal and there is evidence of increased superficial bacterial burden or delayed healing with no evidence of deep infection, use local antimicrobials with debridement and moisture balance. If there is evidence of deep infection, or if the wound fails to demonstrate signs of healing within two weeks with topical antimicrobials, systemic antibiotics may be considered.

B. Limb-Threatening Infections

Diabetic foot infections in this category may have cellulitis that extends greater than 2 cm beyond the wound border including cardinal signs of infections such as fever, edema, lymphangitis, hyperglycemia, leukocytosis, and/or ischemia (Frykberg et al., 2000). An ulcer that probes to the bone or joint is highly predictive of osteomyelitis (Grayson et al., 1995). Since the patient with diabetes with a relatively severe infection may not necessarily present with these signs and symptoms, it is important to review the entire clinical assessment to guide the clinician to the proper course of treatment. A patient presenting with wet gangrene, deep abscesses, and advancing cellulitis must be transferred to a medical facility for urgent care. Hospitalization is required in order to treat the infection as well as the systemic sequelae. Patients with poor vascular status and deep infections may require vascular surgery and infectious disease consultation. Urgent surgical intervention may be required. Although many wound drainage procedures can be done at the bedside for patients with diabetic ulcers, most will require thorough debridement in the operating room (Frykberg et al., 2000). Even the sickest of patients should be considered for emergent incision, drainage,

and debridement procedures since their illness is directly attributable to the severity of their infection. Life-threatening infections necessitate immediate surgical attention and such procedures should not be delayed while waiting for radiologic or medical workup of other co-morbid conditions (Frykberg et al., 2000).

Polymicrobial infection should be anticipated in patients with a diabetic foot ulcer, with a variety of gram-positive cocci, gram-negative rods, and anaerobic organisms predominating. Empirical antibiotic therapy typically includes broad-spectrum coverage for more common isolates from each of these three categories (Frykberg et al., 2000). Once wound culture results have been obtained, the initial antimicrobial therapy may require adjustment to provide more specific coverage or to provide therapy against resistant organisms. If there is persistent infection while on antibiotic therapy, surgical assessment and wound culture should be revisited. Methicillin-resistant staphylococci aureus (MRSA) has been emerging as an important pathogen in chronic diabetic foot ulcers (Frykberg et al., 2000).

C. Osteomyelitis

Osteomyelitis and joint infection will require excision of bone for microbiological and histopathological evaluation (Frykberg et al., 2000). If the affected bone has been completely resected or amputated, the infection may be treated as a soft-tissue infection. However, if residual bone is present in the wound, the patient will likely require 4-8 weeks of antibiotic therapy based on the culture results (Frykberg et al., 2000). Intravenous or oral agents may be used, depending on the microbial isolates and the infection severity.

Moisture Balance

Dressing selection should promote a moist wound environment that minimizes trauma and risk of infection. Selection should be based on the wound to provide local moisture balance. Modern, moist interactive dressings used for diabetic foot ulcers include foams (high absorbency), calcium alginates (absorbent, hemostasis), hydrogels (moisture balance), hydrocolloids (occlusion), and adhesive membranes (protection) (Inlow et al., 2000). Consideration should be given to the following when choosing a moist wound dressing for a diabetic foot ulcer (Sibbald, Williamson, Orsted, Campbell, Keast, Krasner et al., 2000):

- Assess the wound bed for bacterial balance, exudate level and the need for debridement.
- Select a dressing or combination of dressings that can manage and or control the above wound environment.
- Use a dressing that will keep the wound bed continuously moist and the peri-wound skin dry.
- Choose a dressing that controls exudate but does not dry the ulcer bed.
- Consider the caregiver time when selecting a dressing.
- Eliminate wound dead space by loosely filling all cavities with dressing material.
- Assure that the patient is aware that there is to be reduced pressure to the affected area.
- Evaluate the wound frequently to determine efficacy of treatment plan.

Systematic reviews in the past have shown no differences in chronic wound healing outcomes (Hutchinson et al., 2000; Ovington, 1999). However, in a recent systematic review by Smith (2004), hydrogels were shown to be of some benefit in improving diabetic foot ulcers. Consideration of caregiver time is essential to cost efficiency (Ovington, 1999). For information on dressing selection see Appendix N.

Extrinsic Factors

Recommendation 5.3:

Provide pressure redistribution. (*Level of Evidence = IIa*)

Discussion of Evidence:

Ninety four percent of diabetic foot ulcers occur at areas of increased pressure (Fleischli, Lavery, Vela, Ashry & Lavery, 1997). Elevated plantar pressures coupled with neuropathy (lack of sensation) can lead to callus formation. The callus build-up (hyperkeratosis) is a normal response to the stress of elevated pressures on the foot and if untreated leads to ulcer formation. For a diabetic foot ulcer to heal the repetitive pressure must be reduced. This can be accomplished by the application of a number of external devices. It is important that there is a member of the team skilled in the fabrication and modification of offloading devices, such as a foot care specialist. See Appendix O for examples and considerations in selecting offloading devices.

One randomized controlled trial showed that total contact casting (TCC) was effective in treating well vascularized non-infected plantar forefoot diabetic foot wounds. Healing rates range from 72% to 100% over a course of five to seven weeks (Armstrong, Nguyen, Lavery, van Schie, Boulton & Harkless, 2001). Spencer (2004) conducted a systematic review evaluating the effectiveness of various offloading modalities to treat diabetic foot ulcers. One randomized controlled trial on total contact casting was identified showing weak evidence on its effectiveness in the treatment of diabetic foot ulcers.

It is important that the patient with a diabetic foot ulcer recognizes that pressure is the cause of their foot ulcer and the offloading is required whenever they are on their feet. In a study by Armstrong, Lavery, Kimbriel, Nixon and Boulton (2003) describing adherence to offloading devices, subjects were found to be only 25% compliant with their prescribed device.

Non-healing diabetic foot wounds

Recommendation 5.4:

Evaluate and implement treatment options for non-healable wounds. (*Level of Evidence = IV*)

Discussion of Evidence:

While complete wound closure is widely accepted to be an objective endpoint in wound healing, this may not always be appropriate in assessing outcomes in chronic wounds (Enoch & Price, 2004). There are various factors that can contribute to the chronicity of such wounds.

Examples of factors contributing to poor healing outcomes include:

- Inadequate blood supply;
- Poor glycemic control;
- Non-adherence with treatment plan;
- End-stage renal disease;
- Transplant recipients;
- Differing individual goals;
- Malnutrition;
- Connective tissue disorders;
- Systemic conditions such as sickle cell disease;
- Osteomyelitis;
- Immobility;
- Heart disease;
- Dementia;
- Cancer; and
- Advancing age.

Goals of care must be mutually agreed upon by the individual and the healthcare team, reflecting a realistic outcome based on quality of life. The significance of managing exudate, controlling infection, relieving pain, and minimizing odour in a non-healing wound must be established and accepted as legitimate outcome measures (Enoch & Price, 2004).

- When healing is not the goal, wound management should incorporate:
 - A palliative wound management model that includes pain control, infection control, exudate management and odour control.
 - Keep wound bed dry, moist wound care is not recommended:
 - ◆ If the patient cannot fight infection the moist wound will be a breeding ground for infection.
 - ◆ Use dry dressing.
 - Using a topical, cost effective and potentially cytotoxic antiseptic such as povidine iodine can be considered when the risk of infection outweighs the healing potential.

Evaluation:

Recommendation 6.0:

Evaluate the impact and effectiveness of the treatment plan. (*Level of Evidence = IV*)

Discussion of Evidence:

Assuming that all systemic and local factors have been addressed, Sheehan, Jones, Caselli, Giurini & Veves (2003) have shown that a 50% reduction in wound surface area at four weeks is a good predictor of wound healing at 12 weeks. Furthermore, Flanagan (2003) has shown that a 20% – 40% reduction of wound area in two and four weeks is likely to be a reliable predictive indicator of healing.

Assessment and Management of Foot Ulcers for People with Diabetes

Assessment of the *edge of the wound* will determine if cell migration has begun. According to Schultz, Barillo, Mozingo, Chin & The Wound Bed Advisory Board Members (2004), wound proliferation occurs when keratinocytes and responsive wound cells migrate; thus advancing the edge of the wound. Healthy wounds have a pink wound bed and an advancing wound margin while unhealthy wounds have a dark, friable wound bed and an undermined wound margin.

Reassess:

It should not be expected that all diabetic foot ulcers will have closure of the wound as a primary outcome. Wounds that are unlikely to heal need to have alternative outcome expectations such as wound stabilization, reduced pain, reduced bacterial load and decreased dressing changes (Enoch & Price, 2004).

Ongoing wound assessment should be comprehensive and support the rationale for care. The guideline development panel suggests these questions below as an approach to evaluating outcomes of care.

1. Is the treatment plan effective?
2. How is wound healing evaluated?
3. Is wound closure the only successful wound care outcome?

Recommendation 6.1:

Reassess for additional correctable factors if healing does not occur at the expected rate.

(Level of Evidence = III – IV)

Discussion of Evidence:

Reassessment of the entire treatment program is the first step to establishing a new directed approach.

The most common reason for delayed healing in PWDFU is inadequate pressure offloading. If appropriate offloading is not prescribed, the patient should be referred to a centre specializing in diabetic foot ulcer care. Revisiting adherence to prescribed offloading devices may uncover the reason why the wound is not healing (Armstrong et al., 2003).

Infection should always be considered as a possible cause of non-healing in combination with glycemic control. Revisiting the health history, co-morbidities and overall diabetes management may maximize the desired outcome.

If patient and wound are optimized and edge is still not migrating, consider tissue culture, biopsy and other diagnostic tests to rule out other conditions.

If delayed healing occurs, continuously evaluate. Vascular, infection and pressure parameters can change quickly; frequent monitoring for change in status or parameters is required. See Table 3 for treatment of wound infection in Recommendation 5.2.

If healing is still delayed, adjunctive approaches should be considered. See Recommendation 6.2.

Other Therapies

Recommendation 6.2:

Consider the use of biological agents, adjunctive therapies and/or surgery if healing has not occurred at the expected rate. Review each specific modality for recommendations. *(Level of Evidence = 1a – IV)*

Discussion of Evidence:

Care for diabetic foot ulcers that have not healed at the expected rate may include the use of:

- Biological agents
- Adjunctive therapies
- Surgery (e.g., skin graft, Achilles tendon lengthening, bony reconstruction)

Type of Adjunctive Therapy	Description and Evidence
Electrical Stimulation	<ul style="list-style-type: none"> ■ This procedure involves applying a low level electrical current to the base of the wound or the peri-wound using conductive electrodes. ■ It must be performed by trained healthcare professionals. <p>Evidence: <i>A meta analysis (Foster, Smith, Taylor, Zinkie & Houghton, 2004) of 17 RCTs showed that electrical stimulation was effective in treating chronic wounds (p< 0.0001), included in this analysis were 3 RCTs with patients with diabetic foot ulcers (Baker, Chambers, DeMuth & Villar, 1997; Lundeborg, Eriksson & Malm, 1992; Peters, Lavery, Armstrong & Fleischli, 2001).</i> <i>(Level of Evidence = 1a)</i></p>
Hyperbaric Oxygen Therapy (HBOT)	<ul style="list-style-type: none"> ■ In this procedure, systemic (inhaled) subatmospheric oxygen is delivered via hyperbaric chamber. ■ It increases oxygen tension in the tissues. <p>Evidence: <i>The routine management of diabetic foot ulcers with HBOT is not justified by the evidence found in the systematic review conducted by Kranke, Bennett & Roeckl-Wiedmann (2004). Although HBOT significantly reduced the risk of major amputation and may improve the chance of healing at one year, economic evaluations should be undertaken. With methodological shortcomings and poor reporting of the studies that were reviewed, Kranke et al. (2004) cautions that any benefit from HBOT will need to be examined further using rigorous randomized trials.</i> <i>(Level of Evidence = III)</i></p>

Type of Adjunctive Therapy	Description and Evidence
<p>Topical Negative Pressure (TNP) Therapy</p>	<ul style="list-style-type: none"> ■ It is a subatmospheric pressure device delivered to the wound by an open cell foam dressing covered with a clear membrane over the wound. ■ The dressing is attached to a pump that delivers equalized intermittent or continuous suction within a prescribed range of settings. ■ Vacuum Assisted Closure (VAC®) Therapy is a commercial brand of topical negative pressure. <p>Evidence:</p> <p><i>The two small trials that evaluated the effectiveness of TNP on chronic wound healing provide weak evidence suggesting that TNP may be superior to saline gauze dressings in healing chronic human wounds. Findings: Due to the small sample sizes and methodological limitations of these trials, there is weak evidence to date.</i></p> <p><i>The effect of TNP on cost, quality of life, pain and comfort was not reported. It was not possible to determine which was the optimum TNP regimen</i> (Armstrong, Lavery, Abu-Rumman, Espensen, Vazquez, Nixon et al., 2002; Ballard & McGregor, 2001; Clare, Fitzgibbons, McMullen, Stice, Hayes & Henkel, 2002; McCallon, Knight, Valiulus, Cunningham, McCulloch & Farinas, 2000; Sibbald, Mahoney & VAC Therapy Canadian Consensus Group, 2003).</p> <p><i>A case series of 31 patients with diabetic foot ulcers showed a statistical reduction in wound size at four weeks on the continuous setting at ~100 mm Hg</i> (Teague, Newbatt, Zschape, Daniels, Rankine, Hoeflock et al., 2004). (Level of Evidence = 1b)</p>
Biological Agents	Description and Evidence
<p>Growth Factors</p>	<ul style="list-style-type: none"> ■ Wound bed vascularization can be achieved by applying recombinant human platelet derived growth factor BB(PDGF) ■ Becaplermin gel, also known as Regranex®, is an example of a growth factor. ■ The biological activity of becaplermin is similar to that of naturally occurring PDGF and includes promoting chemotactic requirement and proliferation of cells involved in the wound repair process (Smiell, 1998). <p>Evidence:</p> <p><i>Four multicentre, randomized parallel group studies found that once-daily topical administration of becaplermin gel in conjunction with good ulcer care was effective and well tolerated in patients with full-thickness, lower extremity diabetic ulcers</i> (Smiell, Wieman, Steed, Perry, Sampson & Schwab, 1999). (Level of Evidence = 1b)</p>

Biological Agents

Description and Evidence

Bioactive Agents

- Bioactive agents can be acellular or cellular and have the potential to stimulate, through topical activation the normal or enhanced activity of mechanisms involved in tissue repair.
- Dermagraft® is an example of living tissue equivalents.
- Dermagraft® is a cultured human dermis. It consists of human neonatal and dermal fibroblasts cultured in vitro onto a bioabsorbable mesh to produce a living metabolically active tissue containing normal matrix proteins and cytokines (Gentzkow, Iwasaki, Hershon, Mengel, Prendergast, Ricotta et al., 1996; Gentzkow, Jensen, Pollak, Kroeker, Lerner, Lerner et al., 1999; Marston, Hanft, Norwood & Pollak, 2003) *(Level of Evidence = 1b)*
- Oasis®, Promogran® and Hyalofil® are examples of acellular bioactive agents.
- Oasis® is a freeze dried wound matrix derived from porcine (pig) small intestinal submucosa (Brown-Etris, Cutshall & Hiles, 2002).
- Xenograft: Oasis®, a relatively new product, is a xenogeneic, acellular, collagen matrix derived from porcine small intestinal submucosa in a way that allows extracellular matrix and natural growth factors to remain intact. This provides a scaffold for inducing wound healing.

Evidence:

In a small multicentre clinical study evaluating the efficacy of Oasis® compared to Regranex®, Niezgodna (2004) found similar wound healing outcomes in both treatment groups. (Level of Evidence = IIa)

- Promogran® is a freeze dried sponge prepared from bovine collagen and oxidized regenerated cellulose prepared in acetic acid. It reduces protease MMPs known to promote inflammation in chronic wounds and protect endogenous growth factors.

Evidence:

One RCT comparing Promogran® to moistened gauze dressings showed that at 12 weeks, no statistical differences were found in the healing rates between the two groups (Veves, Sheehan & Pham, 2002). Ghatnekar, Willis & Persson (2002) suggest that Promogran® may be cost effective as a result of reduced dressing frequency. (Level of Evidence = Ib)

- Hyalofil® is a hyaluronic acid ester which is thought to provide structural support, developmental regulation and assists with receptor mediated gene expression as a major molecule in the extra cellular matrix. It affects inflammation, regulation, angiogenesis, granulation formation and re-epithelialization. To date, only anecdotal results are available. *(Level of Evidence = IV)*

Surgery	Description and Evidence
Surgical (Skin Graft – Autologous)	<ul style="list-style-type: none">■ This procedure requires surgical transplant of epidermis and dermis from the same patient’s donor site. <i>(Level of Evidence = IV)</i>
Surgical (Achilles tendon lengthening)	<ul style="list-style-type: none">■ Lengthening the tendon or an attached calf muscle increases ankle dorsiflexion, thus reducing wound healing time and ulcer re-occurrence <i>(Level of Evidence = 1b)</i> <p>Evidence: <i>Mueller et al. (2004) compared the effect of Achilles tendon lengthening to treatment with total contact casting. The outcomes measured were healing rates and ulcer re-occurrence at seven-months follow up and two-year follow up. Although the initial wound healing outcomes were similar, statistical reduction in ulcer re-occurrence was noted at seven-months and at two-years follow up.</i></p>
Other surgical procedures	<ul style="list-style-type: none">■ Surgery for foot deformities can be beneficial in preventing the development and re-occurrence of ulcers.■ Careful patient selection is critical, primarily with regard to an intact vascular supply.■ In appropriate cases, arthroplasty, digital amputation, bunionectomy, metatarsal osteotomy or ray resection, may be indicated (Muha, 1999).■ To date, only anecdotal results are available. <i>(Level of Evidence = IV)</i>

Education Recommendations

Continuing Professional Development:

Recommendation 7.0:

Nurses and other members of the interdisciplinary team need specific knowledge and skills in order to competently assess and participate in the treatment of diabetic foot ulcers.

(Level of Evidence = IV)

Curriculum Support and Resources:

Recommendation 8.0:

Educational institutions are encouraged to incorporate the RNAO Nursing Best Practice Guideline *Assessment and Management of Foot Ulcers for People with Diabetes* into basic RN, RPN, MD and allied health professional curricula. *(Level of Evidence = IV)*

Discussion of Evidence:

Nurses play a vital role in the early detection and ongoing assessment of diabetic foot ulcers. They are also in a pivotal position to facilitate an evidence-based, team approach to treatment (Mason et al., 1999a; Whittemore, 2000). If nurses are to fulfill these roles, they must utilize the nursing process and evidence to support patient care decisions. Nurses need to avail themselves of recognized, accredited continuing educational opportunities that support the interdisciplinary team approach to diabetic foot ulcer care. In order to improve health outcomes for persons with diabetic foot ulcers and increase job satisfaction for nurses, agencies need to provide a full scope of support (financial, education, and human resources) for nurses seeking professional education (Best & Thurston., 2004; Gottrup, 2004).

Refer to Appendix P for a list of resources for diabetic foot ulcer information.

Organization & Policy Recommendations

System Support:

Recommendation 9.0:

Nursing best practice guidelines can be successfully implemented only where there are adequate planning, resources, organizational and administrative support, as well as appropriate facilitation.

Organizations may wish to develop a plan for implementation that includes:

- An assessment of organizational readiness and barriers to education.
- Involvement of all members (whether in a direct or indirect supportive function) who will contribute to the implementation process.
- Dedication of a qualified individual(s) to provide the support needed for the development and implementation process.
- Ongoing opportunities for discussion and education to reinforce the importance of best practices.
- Opportunities for reflection on personal and organizational experience in implementing guidelines.

In this regard, RNAO (through a panel of nurses, researchers and administrators) has developed the *Toolkit: Implementation of Clinical Practice Guidelines*, based on available evidence, theoretical perspectives and consensus. The RNAO strongly recommends the use of this *Toolkit* for guiding the implementation of the best practice guideline on *Assessment and Management of Foot Ulcers for People with Diabetes*. (Level of Evidence = IV)

Resources:

Recommendation 9.1:

Organizations are encouraged to develop policies that acknowledge and designate human, material and fiscal resources to support the nurse and the interdisciplinary team in diabetic foot ulcer management. (Level of Evidence = IV)

Team Development:

Recommendation 9.2:

Organizations are encouraged to establish and support an interdisciplinary, inter-agency team comprised of interested and knowledgeable persons to address and monitor quality improvement in the management of diabetic foot ulcers. *(Level of Evidence = IV)*

Partnerships:

Recommendation 9.3:

Organizations are encouraged to work with community and other partners to develop a process to facilitate patient referral and access to local diabetes resources and health professionals with specialized knowledge in diabetic foot ulcer management. *(Level of Evidence = IV)*

Financial Support:

Recommendation 9.4:

Organizations are encouraged to advocate for strategies and funding to assist patients in obtaining appropriate pressure redistribution devices. *(Level of Evidence = IV)*

Advocacy:

Recommendation 9.5:

Organizations are encouraged to advocate for an increase in the availability and accessibility of diabetic foot ulcer care for all residents of Ontario. *(Level of Evidence = IV)*

Discussion of Evidence:

In order to achieve optimal outcomes for individuals with diabetic foot ulcers, diabetes ulcer care should be platformed around an interdisciplinary healthcare team that can establish and sustain a communication network between the person with diabetes and the necessary healthcare and community systems. Frykberg (1998), through a retrospective review of the literature reported a reduction in non-traumatic amputation rates ranging from 58% to 100% after the implementation of a multidisciplinary approach to foot care. The team should be dedicated to both maintaining the overall well-being of the patient with diabetes and to preserving the integrity of their lower extremities (Inlow et al., 2000). Key players on the team, along with patients and families, may include diabetologists/endocrinologists, vascular surgeons, plastic surgeons, dermatologists, chiropodists/podiatrists, infectious disease specialists, family physicians, nurses specializing in diabetes and wound care, occupational therapists, physiotherapists, and dietitians. Teams can work without walls (not necessarily on the same site, but accessible to each other). However, coordination takes more effort to ensure the goal(s) remain consistent (Inlow et al., 2000). Both the organization and the delivery of diabetes foot care should be comprehensive, supported by evidence-based clinical practice guidelines, and equitable in access throughout the person's lifetime. Diabetes foot ulcer care should be community based and respectful of age, gender, cultural beliefs and socioeconomic dispositions. Organizations have a role to play in advocating and facilitating access to diabetes care and foot ulcer care services.

Graham, Harrison, Bouwers, Davies & Dunn (2002) indicate that in order for guidelines to be implemented successfully, a critical initial step must be the formal adoption of the guideline recommendations into the policy and procedure structure. This key step provides direction regarding the expectations of the organization, and facilitates integration of the guideline into such systems as the quality management process.

New initiatives such as the implementation of a best practice guideline require strong leadership from nurses who understand concepts of planned change, program planning and evaluation and research utilization. This knowledge will empower the nurse to effectively transform organizations in changing practice. This can be achieved by developing a program plan. Pollack (1994) developed a four-step planning process called “pre-start plan”. The process includes mission statement clarification, stakeholder analysis, problem identification, and strength, weakness, opportunities and threats (SWOT) analysis.

Further, it is suggested that the RNAO *Toolkit* (2002b) be considered to assist organizations develop the leadership required for successful implementation. Refer to Appendix Q for a description of the RNAO *Toolkit: Implementation of Clinical Practice Guidelines*.

Research Gaps & Future Implications

The guideline development panel found that there is little research to support:

- Establishment of a standardized assessment and documentation tools for diabetic foot ulcers.
- Dressing choices for local wound care.
- Effectiveness of adjunctive therapies to promote wound healing.
- Effectiveness of various devices utilized for pressure redistribution/offloading.
- Health delivery issues (government support and funding of programs and treatment for diabetic foot ulcer management, cultural beliefs, high risk patient populations).
- Impact of sharp/surgical debridement on wound healing.
- Impact of education on healthcare provider and specific patient outcomes (ulcer healing/re-occurrence).
- Pharmacoeconomics of secondary and tertiary prevention strategies.

The above list, although in no way exhaustive, is an attempt to identify and prioritize the enormous amount of research that is needed in this area. Some of the recommendations in the guideline are based on evidence gained from quantitative and qualitative research. Other recommendations are based on consensus or expert opinion. Further substantive research is required to validate the expert opinion. Increasing the research can impact knowledge that will lead to improved practice and outcomes for patients who experience diabetic foot ulcers.

Evaluation & Monitoring of Guideline

Organizations implementing the recommendations in this nursing best practice guideline are encouraged to consider how the implementation and its impact will be monitored and evaluated. The following table, based on a framework outlined in the RNAO *Toolkit: Implementation of Clinical Practice Guidelines* (2002b), illustrates some indicators for monitoring and evaluation:

Level of Indicator	Structure	Process	Outcome
Objectives	<ul style="list-style-type: none"> To evaluate the supports available in the organization that allow for nurses and the interdisciplinary team to integrate in their practice the assessment and management of diabetic foot ulcers. 	<ul style="list-style-type: none"> To evaluate the changes in practice that lead towards assessment and management of diabetic foot ulcers. 	<ul style="list-style-type: none"> To evaluate the impact of implementation of the recommendations.
Organization/ Unit	<ul style="list-style-type: none"> Review of best practice recommendations by organizational committee(s) responsible for policies and procedures. Availability of patient education resources that are consistent with best practice recommendations. Provision of accessible resource people for nurses and the interdisciplinary team to consult for ongoing support during and after initial implementation period. 	<ul style="list-style-type: none"> Development of forms or documentation systems that encourage documentation of assessment and management of diabetic foot ulcers. Concrete procedures for making referrals to internal and external resources and services. 	<ul style="list-style-type: none"> Incorporation of assessment and management of diabetic foot ulcers in staff orientation program. Referrals internally and externally.
Provider	<ul style="list-style-type: none"> Percentage of healthcare providers attending the best practice guideline education sessions on assessment and management of diabetic foot ulcers. 	<ul style="list-style-type: none"> Self-assessed knowledge of assessment and management of diabetic foot ulcers. Average self-reported awareness levels of community referral sources for patients with diabetic foot ulcers. 	<ul style="list-style-type: none"> Evidence of documentation in the patient's record consistent with the guideline recommendations. Referral to the following services or resources within the community or within the organization as necessary – Chiroprapist/ Podiatrist, Wound Care Clinic, Diabetes Education Centre, Nurses specializing in wound and diabetes care, Dermatologist, Infectious Disease Specialist, Vascular Surgeon, Plastic Surgeon, Family Physician, Endocrinologist/Diabetologist, Dietitian, Occupational Therapist, Physiotherapist. Provision of education and support to patient and family members. Patient/family satisfaction.

Level of Indicator	Structure	Process	Outcome
Patient (<i>new or recurrent diabetic foot ulcer</i>)	<ul style="list-style-type: none"> ■ Percentage of patients admitted to unit/facility or seen at the clinic with diabetic foot ulcers. 	<ul style="list-style-type: none"> ■ Percentage of patients who were assessed and treated using the V.I.P. (vascular supply, infection, and pressure redistribution/offloading) principle. 	<ul style="list-style-type: none"> ■ Improvement in quality of life and satisfaction. ■ Percentage of patients adhering to treatment plan at three months post-discharge. ■ Percentage of patients with ulcers partially or fully healed at three months post-discharge. ■ Percentage of patients who regularly examine their feet. ■ Percentage of patients accessing referral sources in community. ■ Percentage of patients seen or to be seen for referral.
Financial Costs	<ul style="list-style-type: none"> ■ Provision of adequate financial resources for the level of staffing necessary to implement guideline recommendations. 	<p>Cost related to implementing guideline:</p> <ul style="list-style-type: none"> ■ Education and access to on the job supports. ■ New documentation systems. ■ Support systems. ■ Cost related to diagnostic services, equipment, devices and products (e.g., monofilaments, patient resource materials, biological agents, surgical interventions; adjunctive therapies, pressure redistribution/offloading). 	<ul style="list-style-type: none"> ■ Cost efficiency and effectiveness of treatment. ■ Overall resource utilization. ■ Length of stay in health system. ■ Hospital readmission rates. ■ Reintegration into community.

Implementation Strategies

The Registered Nurses' Association of Ontario and the guideline development panel have compiled a list of implementation strategies to assist healthcare organizations or healthcare disciplines who are interested in implementing this guideline. A summary of these strategies follows:

- Have at least one dedicated person such as an advanced practice nurse or a clinical resource nurse who will provide support, clinical expertise and leadership. The individual should also have good interpersonal, facilitation and project management skills.
- Conduct an organizational needs assessment related to diabetic foot ulcer management to identify current knowledge base and further educational requirements.
- Initial needs assessment may include an analysis approach, survey and questionnaire, group format approaches (e.g., focus groups), and critical incidents.
- Establish a steering committee comprised of key stakeholders and interdisciplinary members committed to lead the change initiative. Identify short term and long term goals. Keep a work plan to track activities, responsibilities and timelines.
- Create a vision to help direct the change effort and develop strategies for achieving and sustaining the vision.
- Program design should include:
 - Target population;
 - Goals and objectives;
 - Outcome measures;
 - Required resources (human resources, facilities, equipment); and
 - Evaluation activities.
- Design educational sessions and ongoing support for implementation. The education sessions may consist of presentations, facilitator's guide, handouts, and case studies. Binders, posters and pocket cards may be used as ongoing reminders of the training. Plan education sessions that are interactive, include problem solving, address issues of immediate concern and offer opportunities to practice new skills (Davies & Edwards, 2004).

- Provide organizational support such as having the structures in place to facilitate the implementation. For example, hiring replacement staff so participants will not be distracted by concerns about work and having an organizational philosophy that reflects the value of best practices through policies and procedures. Develop new assessment and documentation tools (Davies & Edwards, 2004).
- Identify and support designated best practice champions on each unit to promote and support implementation. Celebrate milestones and achievements, acknowledging work well done (Davies & Edwards, 2004).
- Organizations implementing this guideline should adopt a range of self-learning, group learning, mentorship and reinforcement strategies that will, over time, build the knowledge and confidence of nurses in implementing this guideline.
- Beyond skilled nurses, the infrastructure required to implement this guideline includes access to specialized equipment and treatment materials. Orientation of the staff to the use of specific products and technologies must be provided and regular refresher training planned.
- Teamwork, collaborative assessment and treatment planning with the patient and family and interdisciplinary team are beneficial in implementing guidelines successfully. Referral should be made as necessary to the following services or resources in the community or within the organization: Chiropodist, Wound Care Clinic, Diabetes Education Centre, Nurses specializing in wound and diabetes care; Dermatologist, Infectious Disease Specialist, Vascular Surgeon, Plastic Surgeon, and other healthcare professionals who provide care to patients with diabetic foot ulcers such as Family Physician, Dietitian, Occupational Therapist and Physiotherapist.
- The RNAO's Advanced/Clinical Practice Fellowships (ACPF) Project is another resource that registered nurses in Ontario may apply for a fellowship and have an opportunity to work with a mentor who has expertise in diabetic foot ulcer management. With the ACPF, the nurse fellow will have the opportunity to hone their skills in assessing and managing diabetic foot ulcers.

In addition to the strategies mentioned above, the RNAO has developed resources that are available on their website. A *Toolkit* for implementing guidelines can be helpful if used appropriately. A brief description about this *Toolkit* can be found in Appendix R. A full version of the document in pdf format is also available at the RNAO website, www.rnao.org/bestpractices.

Process for Update/Review of Guideline

The Registered Nurses' Association of Ontario proposes to update this best practice guideline as follows:

1. Each nursing best practice guideline will be reviewed by a team of specialists (Review Team) in the topic area every three years following the last set of revisions.
2. During the three-year period between development and revision, RNAO Nursing Best Practice Guidelines program staff will regularly monitor for relevant new literature in the subject area.
3. Based on the results of the monitor, program staff will recommend an earlier revision period. Appropriate consultation with a team of members comprised of original panel members and other specialists in the field will help inform the decision to review and revise the guideline earlier than the three-year milestone.
4. Three months prior to the three year review milestone, the program staff will commence the planning of the review process by:
 - a. Inviting specialists in the field to participate in the Review team. The Review Team will be comprised of members from the original panel as well as other recommended specialists.
 - b. Compiling feedback received, questions encountered during the dissemination phase as well as other comments and experiences of implementation sites.
 - c. Compiling new clinical practice guidelines in the field, systematic reviews, meta-analysis papers, technical reviews, randomized controlled trial research, and other relevant literature.
 - d. Developing a detailed work plan with target dates and deliverables.

The revised guideline will undergo dissemination based on established structures and processes.

References

- Abbott, C. A., Carrington, A. L., Ashe, H., Bath, S., Every, L. C., Griffiths, J. et al. (2002). The North-West Diabetes Foot Care Study: Incidence of, and risk factors for, new diabetic foot ulceration in a community-based patient cohort. *Diabetes Medicine*, 19 377-384.
- Abouaasha, F., van Schie, C. H., Griffiths, G. D., Young, R. J., & Boulton, A. J. (2001). Plantar tissue thickness is related to peak plantar pressure in the high-risk diabetic foot. *Diabetes Care*, 24(7), 1270-1274.
- Adler, A. I., Boyko, E. J., Ahroni, J. H., & Smith, D. G. (1999). Lower-extremity amputation in diabetes: The independent effects of peripheral vascular disease, sensory neuropathy, and foot ulcers. *Diabetes Care*, 22(7), 1029-1037.
- Adler, A. I., Stratton, I. M., Neil, H. A. W., Yudkin, J. S., Matthews, D. R., Cull, C. A. et al. (2000). Association of systolic blood pressure with macrovascular and microvascular complications of type 2 diabetes (UKPDS 36): Prospective observational study. *British Medical Journal*, 321 412-419.
- AGREE Collaboration (2001). Appraisal of guidelines for research and evaluation. AGREE Collaboration [Electronic version]. Available: <http://www.agreecollaboration.org/>
- Alderson, P., Green, S., & Higgins, J. (Eds) (2004). Cochrane Reviewer's Handbook 4.2.2 (updated Dec. 2003). [Electronic version]. Available: <http://www.cochrane.org/resources/handbook/>
- American Association of Diabetes Educators (1999). The 1999 scope of practice for diabetes educators and the standards of practice for diabetes educators. American Association of Diabetes Educators [Electronic version]. Available: <http://www.aadenet.org>
- American Diabetes Association (ADA) (1999). Consensus development conference on diabetic foot wound care. *Ostomy/Wound Management*, 45(9), 2-47.
- American Diabetes Association (ADA) (2001). American Diabetes Association: Clinical practice recommendations 2001. *Diabetes Care*, 24(Suppl 1), S1-S133.
- Apelqvist, J. (1998). Wound healing in diabetes – Outcome and costs. *Clinics in Podiatric Medicine and Surgery*, 15(1), 21-39.
- Apelqvist, J., Bakker, K., van Houtum, W. H., Nabuurs-Franssen, M. H., & Schaper, N. C. (2000). International consensus and practical guidelines on the management and the prevention of the diabetic foot. *Diabetes/Metabolism Research and Reviews*, 16(Suppl 1), S84-S92.
- Apelqvist, J., Castenfors, J., Larsson, J., Stenström, A., & Agardh, C.-D. (1989). Prognostic value of systolic ankle and toe blood pressure levels in outcome of diabetic foot ulcer. *Diabetes Care*, 12(6), 373-378.
- Armstrong, D. G. & Lavery, L. A. (1998a). Evidence-based options for offloading diabetic wounds. *Clinics in Podiatric Medicine and Surgery*, 15(1), 95-105.
- Armstrong, D. G., Lavery, L. A., Abu-Rumman, P., Espensen, H., Vazquez, R., Nixon, B. P. et al. (2002). Outcomes of subatmospheric pressure dressing therapy on wounds of the diabetic foot. *Ostomy/Wound Management*, 48(4), 64-68.
- Armstrong, D. G., Lavery, L. A., & Bushman, T. R. (1998). Peak foot pressures influence the healing time of diabetic foot ulcers treated with total contact casts. *Journal of Rehabilitation Research and Development*, 35(1), 1-5.
- Armstrong, D. G., Lavery, L. A., & Harkless, L. B. (1998a). Who is at risk of diabetic foot ulceration? *Clinics in Podiatric Medicine and Surgery*, 15(1), 11-19.
- Armstrong, D. G., Lavery, L. A., & Harkless, L. B. (1998b). Validation of a diabetic wound classification system: The contribution of depth, infection, and ischemia to risk of amputation. *Diabetes Care*, 21(5), 855-859.
- Armstrong, D. G., Lavery, L. A., Kimbriel, H. R., Nixon, B. P., & Boulton, A. J. (2003). Activity patterns of patients with diabetic foot ulceration: Patients with active ulceration may not adhere to a standard pressure offloading regimen. *Diabetes Care*, 26(9), 2595-2597.
- Armstrong, D. G., Lavery, L. A., Sariaya, M., & Ashry, H. (1996). Leukocytosis is a poor indicator of acute osteomyelitis of the foot in diabetes mellitus. *The Journal of Foot and Ankle Surgery*, 35(4), 280-283.
- Armstrong, D. G., Nguyen, H. C., Lavery, L. A., van Schie, C. H. M., Boulton, A. J. M., & Harkless, L. B. (2001). Offloading the diabetic foot wound: A randomized clinical trial. *Diabetes Care*, 24(6), 1019-1022.
- Armstrong, D. G., van Schie, C. H. M., & Boulton, A. J. M. (2001). Offloading foot wounds in people with diabetes. In D. L. Krasner, G. T. Rodeheaver, & R. G. Sibbald (Eds.), *Chronic wound care: A clinical source book for healthcare professionals*. (3rd ed.). Wayne, PA: HMP Communications.

Assessment and Management of Foot Ulcers for People with Diabetes

- Australian Centre for Diabetes Strategies (2001). National evidence based guidelines for the management of type 2 diabetes mellitus – Draft for public consultation – 6 April 2001 for the identification & management of diabetic foot disease. Australian Centre for Diabetes Strategies [Electronic version]. Available: http://www.diabetes.net.au/PDF/evidence_based_healthcare/FootProblems.pdf
- Baker, C., Ogden, S., Prapaipanich, W., Keith, C., Beattie, L. C., & Nickeson, L. (1999). Hospital consolidation: Applying stakeholder analysis to merger life cycle. *Journal of Nursing Administration*, 29(3), 11-20.
- Baker, L. L., Chambers, R., DeMuth, S. K., & Villar, F. (1997). Effects of electrical stimulation on wound healing in patients with diabetic ulcers. *Diabetes Care*, 20(3), 405-412.
- Ballard, J. L., Eke, C. C., Bunt, T. J., & Killeen, J. D. (1995). A prospective evaluation of transcutaneous oxygen measurements in the management of diabetic foot problems. *Journal of Vascular Surgery*, 22(4), 485-492.
- Ballard, K. & McGregor, F. (2001). Use of Vacuum-Assisted Closure therapy following foot amputation. *British Journal of Nursing*, 10(15), S6-S12.
- Bennett, P. J., Stocks, A. E., & Whittam, D. J. (1996). Analysis of risk factors for neuropathic foot ulceration in diabetes mellitus. *Journal of the American Podiatric Medical Association*, 86 112-116.
- Bennett, R. L. (1999). *The practical guide to the genetic family history*. New York, N. Y.: John Wiley & Sons, Inc.
- Best, M. F. & Thurston, N. E. (2004). Measuring nurse job satisfaction. *Journal of Nursing Administration*, 34(6), 283-290.
- Birke, J. A., Patout Jr., C. A., & Foto, J. G. (2000). Factors associated with ulceration and amputation in the neuropathic foot. *Journal of Orthopaedic and Sports Physical Therapy*, 30(2), 91-97.
- Birke, J. A., Pavich, M. A., Patout Jr., C. A., & Horswell, R. (2002). Comparison of forefoot ulcer healing using alternative offloading methods in patients with diabetes mellitus. *Advances in Skin and Wound Care*, 15(5), 210-215.
- Black, N., Murphy, M., Lamping, D., McKee, M., Sanderson, C., Ashkam, J. et al. (1999). Consensus development methods: Review of best practice in creating clinical guidelines. *Journal of Health Services Research and Policy*, 4(4), 236-248.
- Bonham, P. (2001). A critical review of the literature: part I: diagnosing osteomyelitis in patients with diabetes and foot ulcers. *Journal of Wound, Ostomy and Continence Nurses Society*, 28(2), 73-88.
- Boulton, A. J. (1991). Clinical presentation and management of diabetic neuropathy and foot ulceration. *Diabetes Medicine*, 8(Spec No.), S52-S57.
- Boulton, A. J., Kirsner, R. S., & Vileikyte, L. (2004). Clinical practice. Neuropathic diabetic foot ulcers. *New England Journal of Medicine*, 351(1), 48-55.
- Boulton, A. J., Meneses, P., & Ennis, W. J. (1999). Diabetic foot ulcers: A framework for prevention and care. *Wound Repair and Regeneration*, 7(1), 7-16.
- Bowker, J. H. & Pfeifer, M. A. (2001). *Levin and O'Neals The diabetic foot*. (6th ed.) St. Louis, MO: Mosby, Inc.
- Boyko, E. J., Ahroni, J. H., Davignon, D., Stensel, V., Prigeon, R. L., & Smith D.G. (1997). Diagnostic utility of the history and physical examination for peripheral vascular disease among patients with diabetes mellitus. *Journal of Clinical Epidemiology*, 50(6), 659-668.
- Boyko, E. J., Ahroni, J. H., Stensel, V., Forsberg, R. C., Davignon, D. R., & Smith, D. G. (1999). A prospective study of risk factors for diabetic foot ulcers: The Seattle diabetic foot study. *Diabetes Care*, 22(7), 1036-1042.
- Brown-Etris, M., Cutshall, W. D., & Hiles, M. C. (2002). A new biomaterial derived from small intestine submucosa and developed into a wound matrix device. *Wounds*, 14(4), 150-166.
- Bureau of Primary Health Care (2005). Bureau of Primary Health Care Program Information: Lower Extremity Amputation Prevention (LEAP) Program. Bureau of Primary Health Care [Electronic version]. Available: <http://www.bphc.hrsa.gov/leap/leapprograminfo.htm>
- Calhoun, J. H., Overgaard, K. A., Stevens, C. M., Dowling, J. P. F., & Mader, J. T. (2002). Diabetic foot ulcers and infections: Current concepts. *Advances in Skin and Wound Care*, 15(1), 31-45.
- Campbell, V. L., Graham, R. A., Kidd, M. R., Molly, F. H., O'Rourke, R. S., & Coagiuri, S. (2000). The lower limb in people with diabetes – position statement of the Australian Diabetes Society. *MJA*, 173(369), 372.
- Canadian Diabetes Association (CDA) (1998). 1998 Clinical practice guidelines for the management of diabetes in Canada. *Canadian Medical Association Journal*, 159(8 Suppl), S1-S29.

- Canadian Diabetes Association (CDA) (2003). 2003 Clinical practice guidelines: Foot care. Canadian Diabetes Association [Electronic version]. Available: <http://www.diabetes.ca/cpg2003/downloads/FootCare.pdf>
- Canadian Diabetes Association – Diabetes Educator Section (2000). *Standards for diabetes education in Canada*. Toronto: Canadian Diabetes Association.
- Caputo, G. M., Cavanagh, P. R., Ulbrecht, J. S., Gibbons, G. W., & Karchmer, A. W. (1994). Assessment and management of foot disease in patients with diabetes. *New England Journal of Medicine*, 331(13), 854-860.
- Carter, K. (1995). An integrated approach. *Nursing Times*, 91(22), 62-66.
- Caselli, A., Pham, H., Giurini, J. M., Armstrong, D. G., & Veves, A. (2002). The forefoot-to-rearfoot plantar pressure ratio is increased in severe diabetic neuropathy and can predict foot ulceration. *Diabetes Care*, 25 1066-1071.
- Centres for Disease Control and Prevention (2004). Awareness of family health history as a risk factor for disease – United States, 2004. Centres for Disease Control and Prevention [Electronic version]. Available: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5344a5.htm>
- Clare, M. P., Fitzgibbons, T. C., McMullen, S. T., Stice, R. C., Hayes, D. F., & Henkel, L. (2002). Experience with the Vacuum Assisted Closure negative pressure technique in the treatment of non-healing diabetic and dysvascular wounds. *Foot and Ankle International*, 23(10), 896-901.
- Crane, M. & Branch, P. (1998). The healed diabetic foot. What next? *Clinics in Podiatric Medicine and Surgery*, 15(1), 155-174.
- CREST - Clinical Resource Efficiency and Support Team (1998). Guidelines for the management of the diabetic foot: Recommendations for practice. Clinical Resource Efficiency and Support Team [Electronic version]. Available: http://www.crestni.org.uk/publications/diabetic_foot.pdf
- Cutting, K. F. & Harding, K. G. (1994). Criteria for identifying wound infection. *Journal of Wound Care*, 3(4), 198-201.
- Dargis, V., Pantlejeva, O., Jonushaite, A., Vileikyte, L., & Boulton, A. J. (1999). Benefits of a multidisciplinary approach in the management of recurrent diabetic foot ulceration in Lithuania: A prospective study. *Diabetes Care*, 22(9), 1428-1431.
- Davies, B. & Edwards, N. (2004). RNs measure effectiveness of best practice guidelines. *Registered Nurse Journal*, 16(1), 21-23.
- Dawson, K. G., Gomes, D., Gerstein, H., Blanchard, J. F., & Kahler, K. H. (2002). The economic cost of diabetes in Canada, 1998. *Diabetes Care*, 25(8), 1303-1307.
- Diabetes Control and Complications Trial (DCCT) Research Group (1993). The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *The New England Journal of Medicine*, 329(14), 977-986.
- Diabetes Education Study Group of the European Association for the Study of Diabetes (2001). Living: Empowerment, education, self-care and lifestyle. IDDM consensus guidelines [Electronic version]. Available: <http://www.staff.ncl.ac.uk/philip.home/iddmch2.htm>
- Diabetes Nursing Interest Group & Registered Nurses' Association of Ontario (2004). Diabetes foot: Risk assessment education program. Images of the diabetic foot. Registered Nurses' Association of Ontario [Electronic version]. Available: www.rnao.org/bestpractices/PDF/BPG_Foot_Diabetes_Workshop_slides.pdf
- Dow, G., Browne, A., & Sibbald, R. G. (1999). Infection in chronic wounds: Controversies in diagnosis and treatment. *Ostomy/Wound Management*, 45(8), 23-27, 29-40.
- Edelson, G. W., Armstrong, D. G., Lavery, L. A., & Caicco, G. (1996). The acutely infected diabetic foot is not adequately evaluated in an inpatient setting. *Journal of the American Podiatric Medical Association*, 87(6), 260-265.
- Eggers, P. W., Gohdes, D., & Pugh, J. (1999). Non-traumatic lower extremity amputations. The Medicare end-stage renal disease population. *Kidney International*, 56(4), 1524-1533.
- Eneroth, M., Apelqvist, J., & Stenstrom, A. (1997). Clinical characteristics and outcomes in 223 diabetic patients with deep foot infections. *Foot and Ankle International*, 18(11), 716-722.
- Enoch, S. & Price, P. (2004). Should alternative endpoints be considered to evaluate outcomes in chronic recalcitrant wounds? World Wide Wounds [Electronic version]. Available: <http://worldwidewounds.com>
- Falanga, V. & Sabolinski, M. L. (2000). Prognostic factors for healing of venous and diabetic ulcers. *Wounds*, 12(5 Suppl A), 42A-46A.

Assessment and Management of Foot Ulcers for People with Diabetes

- Fernando, D. J., Masson, E. A., Veves, A., & Boulton, A. J. (1991). Relationship of limited joint mobility to abnormal foot pressures and diabetic foot ulceration. *Diabetes Care*, *14*(1), 8-11.
- Field, M. & Lohr, K. N. (1990). *Guidelines for clinical practice: Directions for a new program*. Washington, D. C.: Institute of Medicine, National Academy Press.
- Flanagan, M. (2003). Improving accuracy of wound measurement in clinical practice. *Ostomy/Wound Management*, *49*(10), 28-40.
- Fleischli, J. G., Lavery, L. A., Vela, S. A., Ashry, H., & Lavery, D. C. (1997). Comparison of strategies for reducing pressure at the site of neuropathic ulcers. *Journal of American Podiatric Medical Association*, *87*(10), 466-472.
- Foster, A., Smith, W. C., Taylor, E. T., Zinkie, L. M., & Houghton, P. E. (2004). The effectiveness of electrical stimulation to promote wound closure: A systematic review. Unpublished work. University of Western Ontario, Ontario, Canada.
- Foundation for Accountability. (1996). Measuring health care quality: Diabetes. [AHCPublication no. 96-N021]. Rockville, MD, Agency for Health Care Policy and Research.
- Frykberg, R. G. (1998). The team approach in diabetic foot management. *Advances in Wound Care*, *11*(2), 71-77.
- Frykberg, R. G., Armstrong, D. G., Giurini, J., Edwards, A., Kravette, M., Kravitz, S. et al. (2000). Diabetic foot disorders: A clinical practice guideline. American College of Foot and Ankle Surgeons [Electronic version]. Available: <http://www.acfas.org/diabeticcpq.html>
- Frykberg, R. G., Lavery, L. A., Pham, H., Harvey, C., Harkless, L., & Veves, A. (1998). Role of neuropathy and high foot pressures in diabetic foot ulceration. *Diabetes Care*, *21*(10), 1714-1719.
- Gardner, S. E., Frantz, R. A., & Doebbling, B. N. (2001). The validity of the clinical signs and symptoms used to identify localized chronic wound infection. *Wound Repair and Regeneration*, *9*(3), 178-186.
- Getzkow, G. D., Iwasaki, S. D., Hershon, K. S., Mengel, M., Prendergast, J. J., Ricotta, J. J. et al. (1996). Use of dermagraft, a cultured human dermis, to treat diabetic foot ulcers. *Diabetes Care*, *19*(4), 350-354.
- Getzkow, G. D., Jensen, J. L., Pollak, R. A., Kroeker, R. O., Lerner, J. M., Lerner, M. et al. (1999). Improved healing on diabetic foot ulcers after grafting with a living human dermal replacement. *Wounds*, *11*(3), 77-84.
- Ghatnekar, O., Willis, M., & Persson, U. (2002). Cost-effectiveness of treating deep diabetic foot ulcers with Promogran in four European countries. *Journal of Wound Care*, *11*(2), 70-74.
- Glasgow, E. R. (1999). Outcomes of and for diabetes education research. *Diabetes Educator*, *25*(6), 74-88.
- Goldman, R. J. & Salcido, R. (2002). More than one way to measure a wound: An overview of tools and techniques. *Advances in Skin & Wound Care*, *15*(5), 236-245.
- Gordois, A., Scuffham, P., Shearer, A., Oglesby, A., & Tobian, J. A. (2003). The health care costs of diabetic peripheral neuropathy in the US. *Diabetes Care*, *26*(6), 1790-1795.
- Gottrup, F. (2004). Optimizing wound treatment through health care structuring and professional education. *Wound Repair and Regeneration*, *12* (2), 120-128.
- Graham, I. D., Harrison, M. B., Brouwers, M., Davies, B. L., & Dunn, S. (2002). Facilitating the use of evidence in practice: Evaluating and adapting clinical practice guidelines for local use by health care organizations. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, *31*(5), 599-611.
- Grayson, M. L., Balaugh, K., Levin, E., & Karchmer, A. W. (1995). Probing to bone in infected pedal ulcers: A clinical sign of underlying osteomyelitis in diabetic patients. *Journal of American Medical Association*, *273* 721-723.
- Health Canada (2000). Diabetes among aboriginal (First Nations, Inuit and Metis) people in Canada. Health Canada [Electronic version]. Available: http://www.hc-sc.gc.ca/fnihb/cp/adi/publications/the_evidence.pdf
- Health Canada (2002). Diabetes in Canada. Centre for Chronic Disease Prevention and Control Population and Public Health Branch, Health Canada [Electronic version]. Available: http://www.phac-aspc.gc.ca/publicat/dic-dac2/pdf/dic-dac2_en.pdf
- Herruzo-Cabrera, R., Vizcaino-Alcaide, M. J., Pinedo-Castillo, C., & Rey-Calero, J. (1992). Diagnosis of local infection of a burn by semiquantitative culture of the eschar surface. *Journal of Burn Care and Rehabilitation*, *13*(6), 639-641.
- Hunt, D. (2001). Diseases of the feet: Foot ulcers and amputations in people with diabetes mellitus. In H. C. Gerstein & R. B. Haynes (Eds.), *Evidence-based Diabetes Care* (pp. 515-522). Hamilton: B. C. Decker Inc.
- Hutchinson, A., McIntosh, A., Feder, R. G., Home, P. D., Mason, J., O'Keefe, C. et al. (2000). Clinical guidelines and evidence review for type 2 diabetes: Prevention and management of foot problems. Royal College of General Practitioners [Electronic version]. Available: <http://www.rcgp.org.uk/rcgp/clinspec/guidelines/diabetes/contents.asp>

- Indian and Inuit Health Committee & Canadian Pediatric Society (1994). Diabetes and the First Nations. *The Canadian Journal of Pediatrics*, 1(7), 222-224.
- Inlow, S., Kalla, T. P., & Rahman, J. (1999). Downloading plantar foot pressures in the diabetic patient. *Ostomy/Wound Management*, 45(10), 28-38.
- Inlow, S., Orsted, H., & Sibbald, R. G. (2000). Best practices for the prevention, diagnosis and treatment of diabetic foot ulcers. *Ostomy/Wound Management*, 46(11), 55-68.
- Institute for Clinical Systems Improvement (2000). Healthcare guideline: Management of type 2 diabetes mellitus. Institute for Clinical Systems Improvement [Electronic version]. Available: <http://www.icsi.org/knowledge/detail.asp?catID=29&itemID=182>
- Johnson, J. E., Kennedy, E. J., Shereff, M. J., Patel, N. C., & Collier, B. D. (1996). Prospective study of bone, indium-111-labeled white blood cell, and gallium-67 scanning for the evaluation of osteomyelitis in the diabetic foot. *Foot and Ankle International*, 17(1), 10-16.
- Kalani, M., Brismar, K., Fagrell, B., Ostergren, J., & Jorneskog, G. (1999). Transcutaneous oxygen tension and toe blood pressure as predictors for outcome of diabetic foot ulcers. *Diabetes Care*, 22(1), 147-151.
- Keenan, A. M., Tindel, N. L., & Alavi, A. (1989). Diagnosis of pedal osteomyelitis in diabetic patients using current scintigraphic techniques. *Archives of Internal Medicine*, 149(10), 2262-2266.
- Knowles, E. A., Armstrong, D. G., Hayat, S. A., Khawaja, K. I., Malik, R. A., & Boulton, A. J. M. (2002). Offloading diabetic foot wounds using the scotchcast boot: A retrospective study. *Ostomy/Wound Management*, 48(9), 50-53.
- Kranke, P., Bennett, M., & Roeckl-Wiedmann, I. (2004). Hyperbaric oxygen therapy for chronic wounds (Cochrane Review). In *The Cochrane Library*, Issue 4. Oxford: Update Software Ltd.
- Krasner, D. (1998). Diabetic ulcers of the lower extremity: A review of comprehensive management. *Ostomy/Wound Management*, 44(4), 56-75.
- Krasner, D. L. & Sibbald, R. G. (2001). Diabetic foot ulcer care: Assessment and management. In J.H.Bowker & M. A. Pfeifer (Eds.), *Levin and O'Neals The Diabetic Foot*. (6th ed.) (pp. 283-300). St. Louis, MO: Mosby, Inc.
- Kravitz, S. R., McGuire, J., & Shanahan, S. D. (2003). Physical assessment of the diabetic foot. *Advances in Skin and Wound Care*, 16(2), 68-75.
- Lavery, L. A., Armstrong, D. G., Vela, S. A., Quebedeau, T. L., & Fleishchli, J. G. (1998). Practical criteria for screening patients at high risk for diabetic foot ulceration. *Archives of Internal Medicine*, 158 157-162.
- Lavery, L. A., Armstrong, D. G., Wunderlich, R. P., Tredwell, J., & Boulton, A. J. M. (2003). Predictive value of foot pressure assessment as part of a population-based diabetes disease management program. *Diabetes Care*, 26(4), 1069-1073.
- Lavery, L. A. & Gazewood, J. D. (2000). Assessing the feet of patients with diabetes. *Journal of Family Practice*, 49(11 Suppl), S9-S16.
- Ledoux, W. R., Shofer, J. B., Ahroni, J. H., Smith, D. G., Sangeorzan, B. J., & Boyko, E. J. (2003). Biomechanical differences among pes cavus, neutrally aligned, and pes planus feet in subjects with diabetes. *Foot and Ankle International*, 24 845-850.
- Lehto, S., Ronnema, T., Pyorala, K., & Laakso, M. (1996). Risk factors predicting lower extremity amputations in patients with NIDDM. *Diabetes Care*, 19(6), 607-612.
- Levin, M. E. (2001). Pathogenesis and general management of foot lesions in the diabetic patient. In J. H. Bowker & M. A. Pfeifer (Eds.), *Levin and O'Neals The Diabetic Foot*. (6th ed.) (pp. 222). St. Louis, MO: Mosby, Inc.
- Lipsky, B. A. (1997). Osteomyelitis of the foot in diabetic patients. *Clinical Infectious Diseases*, 25(6), 1318-1326.
- Longmaid III, H. E. & Kruskal, J. B. (1995). Imaging infections in diabetic patients. *Infectious Disease Clinics of North America*, 9(1), 163-182.
- Lundeberg, T. C. M., Eriksson, S. V., & Malm, M. (1992). Electrical nerve stimulation improves healing of diabetic ulcers. *Annals of Plastic Surgery*, 29(4), 328-331.
- Maciejewski, M. L., Reiber, G. E., Smith, D. G., Wallace, C., Hayes, S., & Boyko, E. J. (2004). Effectiveness of diabetic therapeutic footwear in preventing reulceration. *Diabetes Care*, 27(7), 1774-1782.
- Madjar, I. & Walton, J. A. (2001). What is problematic about evidence. In J. M. Morse, J. M. Swanson, & A. J. Kuzel (Eds.), *The Nature of Qualitative Evidence* (pp. 28-45). Thousand Oaks, Sage.

Assessment and Management of Foot Ulcers for People with Diabetes

- Margolis, D. J., Kantor, J., & Berlin, J. A. (1999). Healing of diabetic neuropathic foot ulcers receiving standard treatment: A meta-analysis. *Diabetes Care*, 22(5), 692-695.
- Marston, W. A., Hanft, J., Norwood, P., & Pollak, R. (2003). The efficacy and safety of dermagraft in improving the healing of chronic diabetic foot ulcers. Results of prospective randomized trial. *Diabetes Care*, 26(6), 1701-1705.
- Mason, J., O'Keefe, C. O., Hutchinson, A., McIntosh, A., Young, R., & Booth, A. (1999a). A systematic review of foot ulcer in patients with type 2 diabetes mellitus. II: treatment. *Diabetic Medicine*, 16 889-909.
- Mason, J., O'Keefe, C., McIntosh, A., Hutchinson, A., Booth, A., & Young, R. J. (1999b). A systematic review of foot ulcer in patients with type 2 diabetes mellitus. I: prevention. *Diabetic Medicine*, 16 801-812.
- Mayfield, J. A., Reiber, G. E., Sanders, L. J., Janisse, D., & Pogach, L. M. (1998). Preventive foot care in people with diabetes. *Diabetes Care*, 21(12), 2161-2177.
- McCabe, C. J., Stevenson, R. C., & Dolan, A. M. (1998). Evaluation of a diabetic foot screening and protection programme. *Diabetes Medicine*, 15 80-84.
- McCallon, S. K., Knight, C. A., Valiulus, J. P., Cunningham, M. W., McCulloch, J. M., & Farinas, L. P. (2000). Vacuum-Assisted Closure versus saline-moistened gauze in the healing of postoperative diabetic foot wounds. *Ostomy/Wound Management*, 46(8), 28-34.
- McGuckin, M., Goldman, M., Bolton, L., & Salcido, R. (2003). The clinical relevance of microbiology in acute and chronic wounds. *Advances in Skin and Wound Care*, 16(1), 12-23.
- McNeely, M. J., Boyko, E. J., Ahroni, J. H., Stensel, V. L., Reiber, G. E., Smith, D. G. et al. (1995). The independent contributions of diabetic neuropathy and vasculopathy in foot ulceration: How great are the risks? *Diabetes Care*, 18(2), 216-219.
- Meier, M. R., Desrosiers, J., Bourassa, P., & Blaszczyk, J. (2001). Effect of type 2 diabetic peripheral neuropathy on gait termination in the elderly. *Diabetologia*, 44(5), 585-592.
- Ministry of Health Malaysia (2003). Clinical practice guidelines: Management of diabetic foot. Ministry of Health Malaysia [Electronic version]. Available: <http://www.acadmed.org.my/cpg/Draft%20CPG%20%20management%20of%20diabetic%20foot.pdf>
- Morris, H. L., Jones, V., & Harding, K. G. (2001). Wound care: Putting theory into practice – The Cardiff Wound Healing Research Unit in the United Kingdom. In D. L. Krasner, G. T. Rodeheaver, & R. G. Sibbald (Eds.), *Chronic Wound Care: A Clinical Source Book for Healthcare Professionals*. (3rd ed.) (pp. 135-144). Wayne, PA: HMP Communications.
- Moss, S. E., Klein, R., & Klein, B. E. K. (1996). Long-term incidence of lower-extremity amputations in a diabetic population. *Archives Family Medicine*, 5(7), 391-398.
- Mueller, M. J., Sinacore, D. R., Hastings, M. K., Strube, M. J., & Johnson, J. E. (2004). Effect of Achilles tendon lengthening on neuropathic plantar ulcers. A randomized clinical trial. *Journal of Bone and Joint Surgery*, 86A(4), 870.
- Muha, J. (1999). Local wound care in diabetic foot complications: Aggressive risk management and ulcer treatment to avoid amputation. *Postgraduate Medicine*, 106(1), 97-102.
- Murray, H. J., Young, M. J., Hollis, S., & Boulton, A. J. (1996). The association between callus formation, high pressures and neuropathy in diabetic foot ulceration. *Diabetes Medicine*, 13(11), 979-982.
- National Health and Medical Research Council (1998). A guide to the development, implementation and evaluation of clinical practice guidelines. National Health and Medical Research Council [Electronic version]. Available: <http://www.nhmrc.gov.au/publications/pdf/cp30.pdf>
- New Zealand Guidelines Group (NZGG) (2000). *Primary care guidelines for the management of core aspects of diabetes*. Wellington: New Zealand Guidelines Group.
- Niezgoda, J. A. (2004, May). *A multicentre clinical study for evaluating small intestine submucosa (SIS) for full-thickness diabetic foot ulcers*. Presented at the 17th Annual Symposium on Advanced Wound Care Medical Research Forum, Florida.
- Ohkubo, Y., Kishikawa, H., Araki, E., Miyata, T., Isami, S., Motoyoshi, S. et al. (1995). Intensive insulin therapy prevents the progression of diabetic microvascular complications in Japanese patients with non-insulin-dependent diabetes mellitus: A randomized prospective 6-year study. *Diabetes Research and Clinical Practice*, 28 103-117.
- Ontario Anti-infective Review Panel (2001). *Anti-infective guidelines for community-acquired infections*. (2nd ed.) Toronto: Publications Ontario.
- Ontario Public Health Association (1996). *Making a difference! A workshop on the basics of policy change*. Toronto, Canada: Government of Ontario.

- Ovington, L. G. (1999). Dressings and adjunctive therapies: AHCPR guidelines revisited. *Ostomy/Wound Management*, 45(1A Supple), 94S-106S.
- Pataky, Z., Golay, A., Faravel, L., Da Silva, J., Makoundou, V., Peter-Riesch, B. et al. (2002). The impact of callosities on the magnitude and duration of plantar pressure in patients with diabetes mellitus. A callus may cause 18,600 kilograms of excess plantar pressure per day. *Diabetes Metabolism*, 28(5), 356-361.
- Peacock, E. & Van Winkle, W. (1976). *Surgery and biology of wound repair*. (2nd ed.) Philadelphia, PA: W. B. Saunders.
- Pecoraro, R. E., Ahroni, J. H., Boyko, E. J., & Stensel, V. L. (1991). Chronology and determinants of tissue repair in diabetic lower-extremity ulcers. *Diabetes*, 40 1305-1313.
- Perry, C. R., Pearson, R. L., & Miller, G. A. (1991). Accuracy of cultures of material from swabbing of the superficial aspect of the wound and needle biopsy in the perioperative assessment of osteomyelitis. *Journal of Bone and Joint Surgery*, 73(5), 745-749.
- Peters, E. J., Lavery, L. A., Armstrong, D. G., & Fleischli, J. G. (2001). Electric stimulation as an adjunct to heal diabetic foot ulcers: A randomized clinical trial. *Archives of Physical Medicine and Rehabilitation*, 82(6), 721-725.
- Pham, H., Armstrong, D. G., Harvey, C., Harkless, L. B., Giurini, J. M., & Veves, A. (2000). Screening techniques to identify people at high risk for diabetic foot ulceration. *Diabetes Care*, 23(5), 606-611.
- Pinzur, M., Slovenkai, M. P., & Trepman, E. (1999). Guideline for diabetic foot care. The Diabetes Committee of the American Orthopaedic Foot and Ankle Society. *Foot and Ankle International*, 20(11), 695-702.
- Pitei, D. L., Foster, A., & Edmonds, M. (1999). The effect of regular callus removal on foot pressures. *Journal of Foot and Ankle Surgery*, 38(4), 251-255-306.
- Pollack, C. D. (1994). Planning for success: The first steps in new program development. *Journal of School Nursing*, 10(3), 11-15.
- Ramsey, S., Newton, K., Blough, D., McCulloch, D. K., Sandhu, N., Reiber, G. et al. (1999). Incidence, outcomes, and cost of foot ulcers in patients with diabetes. *Diabetes Care*, 22(3), 382-387.
- Registered Nurses' Association of Ontario (2002a). *Client Centred Care*. Toronto, Canada: Registered Nurses' Association of Ontario.
- Registered Nurses' Association of Ontario (2002b). *Toolkit: Implementation of Clinical Practice Guidelines*. Toronto, Canada: Registered Nurses' Association of Ontario.
- Registered Nurses' Association of Ontario (2004). *Reducing Foot Complications for People with Diabetes*. Toronto, Canada: Registered Nurses' Association of Ontario.
- Reiber, G. E., Boyko, E. J., & Smith, D. G. (1995). Lower extremity foot ulcers and amputations in diabetes. In National Diabetes Data Group (US) (Ed.), *Diabetes in America* (pp. 409-428). Bethesda, MD: National Institutes of Health, National Institute of Diabetes & Digestive & Kidney Diseases.
- Reiber, G. E., Pecoraro, R. E., & Koepsell, T. D. (1992). Risk factors for amputation in patients with diabetes mellitus: A case-control study. *Annals of Internal Medicine*, 117(2), 97-105.
- Reiber, G. E., Smith, D. G., Wallace, C., Sullivan, K., Hayes, S., Vath, C. et al. (2002). Effect of therapeutic footwear on foot reulceration in patients with diabetes: A randomized controlled trial. *Journal of the American Medical Association*, 287(19), 2552-2558.
- Reiber, G. E., Vileikyte, L., Boyko, E. J., Del Aguila, M., Smith, D. G., Lavery, L. A. et al. (1999). Causal pathways for incident lower-extremity ulcers in patients with diabetes from two settings. *Diabetes Care*, 22(1), 157-162.
- Ribu, L. & Wahl, A. (2004). Living with diabetic foot ulcers: A life of fear, restrictions, and pain. *Ostomy/Wound Management*, 50(2), 57-67.
- Rodeheaver, G. T. (2001). Wound cleansing, wound irrigation, wound disinfection. In D. L. Krasner, G. T. Rodeheaver, & R. G. Sibbald (Eds.), *Chronic wound care: A clinical source book for healthcare professionals*. (3rd ed.) (pp. 369-383). Wayne, PA: HMP Communications.
- Royal Melbourne Hospital (2002). Evidence based guidelines for the inpatient management of acute diabetes related foot complications. Melbourne Health [Electronic version]. Available: http://www.mh.org.au/ClinicalEpidemiology/new_files/Foot%20guideline%20supporting.pdf
- Saap, L. J. & Falanga, V. (2002). Debridement performance index and its correlation with complete closure of diabetic foot ulcers. *Wound Repair and Regeneration*, 10(6), 354-359.
- Sales, C., Goldsmith, J., & Veith, F. J. (1994). *Handbook of Vascular Surgery*. St. Louis, MO: Quality Medical Publishing.
- Schultz, G. S., Barillo, D. J., Mozingo, D. W., Chin, G. A., & The Wound Bed Advisory Board Members (2004). Wound bed preparation and a brief history of TIME. *International Wound Journal*, 1(1), 19-32.

Assessment and Management of Foot Ulcers for People with Diabetes

- Seaman, S. (2000). Considerations for the global assessment and treatment of patients with recalcitrant wounds. *Ostomy/Wound Management*, 46(1ASuppl), 10S-29S.
- Shaw, J. E. & Boulton, A. J. M. (1997). The pathogenesis of diabetic foot problems: An overview. *Diabetes*, 46(Suppl 2), S58-S61.
- Sheehan, P., Jones, P., Caselli, A., Giurini, J. M., & Veves, A. (2003). Percent change in wound area of diabetic foot ulcers over a 4-week period is a robust predictor of complete healing in a 12-week prospective trial. *Diabetes Care*, 26(6), 1879-1882.
- Sibbald, R. G., Mahoney, J., & VAC Therapy Canadian Consensus Group (2003). A consensus report on the use of vacuum-assisted closure in chronic, difficult-to-heal wounds. *Ostomy/Wound Management*, 49(11), 52-66.
- Sibbald, R. G., Orsted, H. L., Schultz, G. S., Coutts, P., & Keast, D. (2003). Preparing the wound bed 2003: Focus on infection and inflammation. *Ostomy/Wound Management*, 49(11), 24-51.
- Sibbald, R. G., Williamson, D., Orsted, H. L., Campbell, K., Keast, D., Krasner, D. et al. (2000). Preparing the wound bed – Debridement, bacterial balance, and moisture balance. *Ostomy/Wound Management*, 46(11), 14-35.
- Sinacore, D. & Mueller, M. J. (2000). Pedal ulcers in older adults with diabetes mellitus. *Topics in Geriatric Rehabilitation*, 16(2), 11-23.
- Smieja, M., Hunt, D. L., Edelman, D., Etchells, E., Cornuz, J., & Simel, D. L. (1999). Clinical examination for the detection of protective sensation in the feet of diabetic patients. International Cooperative Group for Clinical Examination Research. *Journal of General Internal Medicine*, 14(7), 418-424.
- Smiell, J. M. (1998). Clinical safety of becaplermin (rhPDGF-BB) gel. Becaplermin Studies Group. *American Journal of Surgery*, 176(2A Suppl), 68S-73S.
- Smiell, J. M., Wieman, T. J., Steed, D. L., Perry, B. H., Sampson, A. R., & Schwab, B. H. (1999). Efficacy and safety of becaplermin (recombinant human platelet-derived growth factor-BB) in patients with nonhealing, lower extremity diabetic ulcers: A combined analysis of four randomized studies. *Wound Repair and Regeneration*, 7(5), 335-346.
- Smith, J. (2004). Debridement of diabetic foot ulcers (Cochrane Review). In *The Cochrane Library*, Issue 4. Oxford: Update Software Ltd.
- Spencer, S. (2004). Pressure relieving interventions for preventing and treating diabetic foot ulcers (Cochrane Review). In *The Cochrane Library*, Issue 4. Oxford: Update Software Ltd.
- Steed, D. L., Donohoe, D., Webster, M. W., & Lindsley, L. (1996). Effect of extensive debridement and treatment on the healing of diabetic foot ulcers. Diabetic Ulcer Study Group. *Journal of American College of Surgeons*, 183(1), 61-64.
- Stotts, N. (1995). Determination of bacterial bioburden in wounds. *Advances in Wound Care*, 8(4), 28-46.
- Stratton, I. M., Adler, A. I., Neil, H. A., Matthews, D. R., Manley, S. E., Cull, C. A. et al. (2000). Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): A prospective observational study. *British Medical Journal*, 321 405-412.
- Sumpio, B. E. (2000). Foot ulcers. *New England Journal of Medicine*, 343(11), 787-793.
- Tallman, P., Muscare, E., Carson, P., Eaglstein, W. H., & Falanga, V. (1997). Initial rate of healing predicts complete healing of venous ulcers. *Archives of Dermatology*, 133(10), 1231-1234.
- Teague, L. M., Newbatt, E., Zschape, D., Daniels, T. R., Rankine, A., Hoeflock, J. et al. (2004, July). *Outcomes of 31 patients receiving negative pressure therapy for the treatment of diabetic foot wounds*. Presented at the 2nd Wound Healing World Congress meeting in Paris, France.
- Tennvall, G. R., Apelqvist, J., & Eneroth, M. (2000). Costs of deep foot infections in patients with diabetes mellitus. *Pharmacoeconomics*, 18(3), 225-238.
- The University of York – NHS Centre for Reviews and Dissemination (1999). Complications of diabetes: Screening for retinopathy; management of foot ulcers. Centre for Reviews and Dissemination [Electronic version]. Available: <http://www.york.ac.uk/inst/crd/ehc54.pdf>
- Tyrrell, W. (2002). The causes and management of foot ulceration. *Nursing Standard*, 16(30), 52-62.
- United Kingdom Prospective Diabetes Study (UKPDS) Group 33 (1998). Intensive blood-glucose control with sulphonylurea or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes. *Lancet*, 352 837-863.
- Valk, G. D., Kriegsman, D. M. W., & Assendelft, W. J. J. (2002). Patient education for preventing diabetic foot ulceration. A systematic review. *Endocrinology and Metabolism Clinics of North America*, 31(2002), 633-658.

- Valk, G. D., Kriegsman, D. M. W., & Assendelft, W. J. J. (2004). Patient education for preventing diabetic foot ulceration (Cochrane Review). In *The Cochrane Library*, Issue 4. Oxford: Update Software Ltd.
- van Rijswijk, L. & Polansky, M. (1994). Predictors of time to healing deep pressure ulcers. *Ostomy/Wound Management*, 40(8), 40-42, 44.
- Veves, A., Sheehan, P., & Pham, H. T. (2002). A randomized, controlled trial of Promogran (a collagen/oxidized regenerated cellulose dressing) vs. standard treatment in the management of diabetic foot ulcers. *Archives Surgery*, 137(7), 822-827.
- Vowden, K. & Vowden, P. (2002). Wound bed preparation. World Wide Wounds [Electronic version]. Available: <http://www.worldwidewounds.com/2002/april/Vowden/Wound-Bed-Preparation.html>
- Whittemore, R. (2000). Strategies to facilitate lifestyle change associated with diabetes mellitus. *Journal of Nursing Scholarship*, 32(3), 225-232.
- Young, M. J., Cavanagh, P. R., Thomas, G., Johnson, M. M., Murray, H., & Boulton, A. J. (1992). The effect of callus removal on dynamic plantar foot pressures in diabetic patients. *Diabetes Medicine*, 9 55-57.
- Young, T. K. (2003). Review of research on aboriginal populations in Canada: Relevance to their health needs. *British Medical Journal*, 327(7412), 419-422.
- Young, T. K., Szathmary, E. J., Evers, S., & Wheatley, B. (1990). Geographical distribution of diabetes among the native population of Canada: A national survey. *Social Science & Medicine*, 31(2), 129-139.
- Zangaro, G. A. & Hull, M. M. (1999). Diabetic neuropathy: Pathophysiology and prevention of foot ulcers. *Clinical Nurse Specialist*, 13(2), 57-65.
- Zimny, S., Schatz, H., & Pfohl, U. (2003). The effects of applied felted foam on wound healing and healing times in the therapy of neuropathic diabetic foot ulcers. *Diabetic Medicine*, 20 622-625.
- Zimny, S., Schatz, H., & Pfohl, M. (2004). The role of limited joint mobility in diabetic patients with an at-risk foot. *Diabetes Care*, 27(4), 942-946.

Bibliography

- Adler, S. G., Pahl, M., & Selding, M. F. (2000). Deciphering diabetic nephropathy: Progress using genetic strategies. *Current Opinion in Nephrology & Hypertension*, 9(2), 99-106.
- Albert, S. (2002). Cost-effective management of recalcitrant diabetic foot ulcers. *Clinics in Podiatric Medicine and Surgery*, 19(2002), 483-491.
- Alberta Heritage Foundation for Medical Research (2002). A selected inventory of abstracts for systematic reviews on podiatry services. Alberta Heritage Foundation for Medical Research [Electronic version]. Available: <http://www.ahfmr.ab.ca/hta/hta-publications/infopapers/ip16.pdf>
- American College of Foot and Ankle Surgeons (2002). Better, faster healing for chronic foot ulcers. *The Johns Hopkins Medical Letter*, 3.
- American Diabetes Association (2002). Position Statement: Preventive foot care in people with diabetes. *Diabetes Care*, 25(Suppl 1), S69-S70
- Apelqvist, J. & Larsson, J. (2000). What is the most effective way to reduce incidence of amputation in the diabetic foot? *Diabetes/Metabolism Research and Reviews*, 16(Suppl 1), S75-S83.
- Apelqvist, J., Ragnarson-Tennvall, G., & Larsson, J. (1995). Topical treatment of diabetic foot ulcers: An economic analysis of treatment alternatives and strategies. *Diabetic Medicine*, 12 123-128.
- Armstrong, D. G. (2001). Is diabetic foot care efficacious or cost effective? *Ostomy/Wound Management*, 47(4), 28-32.
- Armstrong, D. G. & Athanasiou, K. A. (1998). The edge effect: How and why wounds grow in size and depth. *Clinics in Podiatric Medicine and Surgery*, 15(1), 105-108.
- Armstrong, D. G. & Lavery, L. A. (1998b). Diabetic foot ulcers: Prevention, diagnosis and classification. *American Family Physician*, 57(6), 1325-1332-1337-1338.
- Armstrong, D. G. & Lavery, L. A. (2004). Offloading the diabetic foot. Evidence-based options for offloading diabetic wounds. Diabetes [Electronic version]. Available: <http://www.diabetic-foot.net/id51.htm>

Assessment and Management of Foot Ulcers for People with Diabetes

- Armstrong, D. G., Lavery, L. A., & Harkless, L. B. (1996). Treatment-based classification system for assessment and care of diabetic feet. *Journal of the American Podiatric Medical Association*, 86(7), 311-316.
- Armstrong, D. G., Lavery, L. A., & Wunderlich, R. P. (1998). Risk factors for diabetic foot ulceration: A logical approach to treatment. *Journal of Wound, Ostomy and Continence Nurses Society*, 25(3), 123-128.
- Armstrong, D. G. & Nguyen, H. C. (2000). Edema reduction by mechanical compression improved the healing of foot infection in patients with diabetes mellitus. *Archives Surgery*, 135 1405-1409.
- Armstrong, D. G., Nguyen, H. C., & Lavery, L. A. (2002). Total contact casts were better than removable cast walkers or half shoes for healing diabetic neuropathic foot ulcers. *Evidence Based Nursing*, 5 15.
- Aucoin, J. W. (1998). Program planning: Solving the problem. In K. Kelly-Thomas (Ed.), *Clinical and nursing staff development: Current competence, future focus* (pp. 213-239). Philadelphia: Raven Publishers.
- Bale, S., Baker, N., Crook, H., Rayman, A., Rayman, G., & Harding, K. G. (2001). Exploring the use of an alginate dressing for diabetic foot ulcers. *Journal of Wound Care*, 10(3), 81-84.
- Bauer, N. (20 A.D.). Limitations of the ankle brachial index (ABI). *World Council Enterostomal Therapist*, 20(4), 33-35.
- Bennett, S. P., Griffiths, G. D., Schor, A. M., Leese, G. P., & Schor, S. L. (2003). Growth factors in the treatment of diabetic foot ulcers. *British Journal of Surgery*, 90(2), 133-146.
- Birke, J. A. & Rolfsen, R. J. (1998). Evaluation of a self-administered sensory testing tool to identify patients at risk of diabetes-related foot problems. *Diabetes Care*, 21(1), 23-25.
- Boulton, A. J. M. (1996). The pathogenesis of diabetic foot problems: An overview. *Diabetic Medicine*, 13 S12-S16.
- Bowering, C. K. (2001). Diabetic foot ulcers: Pathophysiology, assessment, and therapy. *Canadian Family Physician*, 47 1007-1016.
- Brem, H., Balledux, J., Bloom, T., Kerstein, M. D., & Hollier, L. (2000). Healing of diabetic foot ulcers and pressure ulcers with human skin equivalent: A new paradigm in wound healing. *Archives Surgery*, 135(6), 627-634.
- Brill, L. R. & Stone, J. A. (2001). New treatments for lower extremity ulcers. *Patient Care*, 13-26.
- Browne, A., Vearncombe, M., & Sibbald, R. G. (2001). High bacterial load in asymptomatic diabetic patients with neurotrophic ulcers retards wound healing after application of dermagraft. *Ostomy/Wound Management*, 47(10), 44-49.
- Brownlee, M. (1992). Glycation products and the pathogenesis of diabetic complications. *Diabetes Care*, 15(12), 1835-1843.
- Cavanagh, P. R., Young, M. J., Adams, J. E., Vickers, K. L., & Boulton, A. J. M. (1994). Radiographic abnormalities in the feet of patients with diabetic neuropathy. *Diabetes Care*, 17(3), 201-209.
- Cianic, P. & McCarren, M. (1993). Hyperbaric oxygen treatment. *Diabetes Forecast*, 16 57-62.
- Cullen, B., Smith, R., McCulloch, E., Silcock, D., & Morrison, L. (2002). Mechanism of action of Promogran, a protease modulating matrix, for the treatment of diabetic foot ulcers. *Wound Repair and Regeneration*, 10 16-25.
- Cuzzell, J. (2003). Wound assessment and evaluation: Diabetic ulcer protocol. *Dermatology Nursing*, 15(2), 153.
- Davis, E. (1995). Focus on teamwork. *Nursing Times*, 91(22), 55-62.
- Day, M. R., Fish, S. E., & Day, R. D. (1998). The use and abuse of wound care materials in the treatment of diabetic ulcerations. *Clinics in Podiatric Medicine and Surgery*, 15(1), 139-150.
- Day, M. R. & Harkless, L. B. (1997). Factors associated with pedal ulceration in patients with diabetes mellitus. *Journal of the American Podiatric Medical Association*, 87(8), 365-369.
- Deakins, D. (1997). Foot care tips for people with diabetes. *Lippincott's Primary Care Practice*, 1(5), 561-562.
- Doctor, N., Pandya, S., & Soupe, A. (1992). Hyperbaric oxygen therapy in diabetic foot. *Journal of Post Graduate Medicine*, 38 12-14.
- Donohoe, M. E., Fletton, J. A., Hook, A., Powells, R., Robinson, I., Stead, J. W. et al. (2000). Improving foot care for people with diabetes mellitus – a randomized controlled trial of an integrated care approach. *Diabetic Medicine*, 17 581-587.
- Edelman, D., Matchar, D. B., & Oddone, E. Z. (1996). Clinical and radiographic findings that lead to intervention in diabetic patients with foot ulcers: A nationwide survey of primary care physicians. *Diabetes Care*, 19(7), 755-757.
- Edelson, G. (1998). Systemic and nutritional considerations in diabetic wound healing. *Clinics in Podiatric Medicine and Surgery*, 15(1), 41-47.

- Edmonds, M., Bates, M., Doxford, M., Gough, A., & Foster, A. (2000). New treatments in ulcer healing and wound infection. *Diabetes/Metabolism Research and Reviews*, 16(Suppl 1), S51-S54.
- El-Tahawy, A. T. (2000). Bacteriology of diabetic foot infections. *Saudi Medical Journal*, 21(4), 344-347.
- Embil, J. M., Papp, K., Sibbald, G., Tousignant, J., Smiell, J. M., Wong, B. et al. (2000). Recombinant human platelet-derived growth factor-BB (becaplermin) for healing chronic lower extremity diabetic ulcers: An open-label clinical evaluation of efficacy. *Wound Repair and Regeneration*, 8(3), 162-168.
- Espensen, E. H., Nixon, B. P., Lavery, L. A., & Armstrong, D. G. (2002). Use of Subatmospheric (VAC) therapy to improve bioengineered tissue grafting in diabetic foot wounds. *Journal of the American Podiatric Medical Association*, 92(7), 395-397.
- Evans, D. & Land, L. (2004). Topical negative pressure for treating chronic wounds (Cochrane Review). In *The Cochrane Library* Issue 4. Oxford: Update Software Ltd.
- Eze, A., Camerota, A. J., Cisek, P. L., Holland, B., Kerr, R. P., Veeramasuneni, R. et al. (1996). Intermittent calf and foot compression increases lower extremity blood flow. *American Journal of Surgery*, 172(2), 130-135.
- Finch, P. M. & Hyder, E. (1999). Treatment of diabetic ulceration using Dermagraft. *The Foot*, 1999(9), 156-163.
- Fisken, R. A. & Digby, M. (1996). Which dressing for diabetic foot ulcers? *Practical Diabetes International*, 13(4), 107-109.
- Fitzgerald, E. & Illback, R. J. (1993). Program planning and evaluation: Principles and procedures for nurse managers. *Orthopaedic Nursing*, 12(5), 39-44.
- Frykberg, R. G. (1998). Diabetic foot ulcers: Current concepts. *Journal of Foot and Ankle Surgery*, 37(5), 440-446.
- Frykberg, R. G. (2002). Diabetic foot ulcers: Pathogenesis and management. *American Family Physician*, 66(9), 1655-1662.
- Gardner, S. E., Frantz, R. A., & Schmidt, F. L. (1997). Effect of electrical stimulation on chronic wound healing: A meta-analysis. *Wound Repair and Regeneration*, 7(6), 495-503.
- Gardner, S. E., Frantz, R. A., Troia, C., Eastman, S., MacDonald, M., Buresh, K. et al. (2001). A tool to assess clinical signs and symptoms of localized infection in chronic wounds: Development and reliability. *Ostomy/Wound Management*, 47(1), 40-47.
- Gilmore, J. E., Allen, J. A., & Hayes, J. R. (1993). Autonomic function in neuropathic diabetic patients with foot ulceration. *Diabetes Care*, 16(1), 61-67.
- Goldman, R. J., Brewley, B. I., & Golden, M. A. (2002). Electrotherapy reoxygenates inframalleolar ischemic wounds on diabetic patients – A case series. *Advances in Skin and Wound Care*, 15(3), 112-120.
- Government of Manitoba (1999). Diabetes foot symposium – Discussion paper. [Electronic version]. Available: <http://www.gov.mb.ca/health/diabetes/documents/footsymp/footd.pdf>
- Halpin-Landry, J. E. & Goldsmith, S. (1999). Feet first – Diabetes care. *American Journal of Nursing*, 99(2), 26-34.
- Han, P. & Ezquerro, R. (2002). Diabetic foot wound care algorithms. *Journal of the American Podiatric Medical Association*, 92(6), 336-348.
- Hartemann-Heurtier, A., Ha Van, G., Danan, J. P., Koskas, F., Jacqueminet, S., Golmard, J. L. et al. (2002). Outcome of severe diabetic foot ulcers after standardized management in a specialised unit. *Diabetes Metab*, 28(6), 477-484.
- Hartsell, H., Fitzpatrick, D., Brand, R., Frantz, R., & Saltzman, C. (2002). Accuracy of a custom-designed activity monitor: Implications for diabetic foot ulcer healing. *Journal of Rehabilitation Research and Development*, 39(3), 395-400.
- Holstein, P., Ellitsgaard, N., Olsen, B. B., & Ellitsgaard, V. (2001). Decreasing the incidence of major amputations in people with diabetes. *VASA, Suppl 58* 28-31.
- Hutchinson, A., McIntosh, A., Feder, G., Home, P. D., & Young, R. (2004). Clinical guideline for type 2 diabetes (foot care). National Electronic Library for Health [Electronic version]. Available: <http://www.nelh.nhs.uk/guidelinesdb/html/Diabetes-ft.htm>
- Johnston, B. (1998). Managing change in healthcare redesign: A model to assist staff in promoting healthy change. *Nursing Economics*, 16(1), 12-17.
- Kerstein, M. D., Welter, V., Gahtan, V., & Roberts, A. B. (1997). Toe amputation in the diabetic patient. *Surgery*, 122(3), 546-547.
- Klein, R., Klein, B. E. K., Moss, S. E., & Cruickshanks, K. J. (1994). Relationship of hyperglycemia to the long-term incidence and progression of diabetic retinopathy. *Archives of Internal Medicine*, 154(19), 2169-2178.
- Knowles, A. (1996). Diabetic foot ulceration. *Nursing Times*, 92(11), 65-69.

Assessment and Management of Foot Ulcers for People with Diabetes

- Krupski, W. (1991). The peripheral vascular consequences of smoking. *Annals of Vascular Surgery*, 5(3), 291-304.
- Lalau, J. D., Bresson, R., Charpentier, P., Coliche, V., Erlher, S., Ha Van, G. et al. (2002). Efficacy and tolerance of calcium alginate versus vaseline gauze dressings in the treatment of diabetic foot lesions. *Diabetes Metab*, 28(223), 229.
- Lapidos, S., Christiansen, K., Rothschild, S. K., & Halstead, L. (2002). Creating interdisciplinary training for healthcare professionals: The challenges and opportunities for home health care. *Home Health Care Management and Practice*, 14(5), 338-343.
- Lavery, L. A., Armstrong, D. G., & Walker, S. C. (1997). Healing rates of diabetic foot ulcers associated with midfoot fracture due to Charcot's arthropathy. *Diabetic Medicine*, 14 46-49.
- Lawrence, I. G., Lear, J. T., & Burden, A. C. (1997). Alginate dressings and the diabetic foot ulcer. *Practical Diabetes International*, 14(2), 61-62.
- Lee, J. S., Lu, M., Lee, V. S., Russell, D., Bahr, C., & Lee, E. T. (1993). Lower-extremity amputation: Incidence, risk factors, and mortality in the Oklahoma Indian Diabetes Study. *Diabetes*, 42(6), 876-882.
- LeFrock, J. L. & Joseph, W. S. (1995). Bone and soft-tissue infections of the lower extremity in diabetics. *Clinics in Podiatric Medicine and Surgery*, 12(1), 87-103.
- Litzelman, D. K., Marriott, D. J., & Vinicor, F. (1997). Independent physiological predictors of foot lesions in patients with NIDDM. *Diabetes Care*, 20(8), 1273-1278.
- Litzelman, D. K., Slemenda, C. W., Langefeld, C. D., Hays, L. M., Welch, M. A., Bild, D. E. et al. (1993). Reduction of lower extremity clinical abnormalities in patients with non-insulin-dependent diabetes mellitus: A randomized, controlled trial. *Annals of Internal Medicine*, 119(1), 36-41.
- Lobmann, R., Ambrosch, A., Schultz, G., Waldmann, K., Schiweck, S., & Lehnert, H. (2002). Expression of matrix-metalloproteinases and their inhibitors in the wounds of diabetic and non-diabetic patients. *Diabetologia*, 45 1011-1016.
- Mancini, L. & Ruotolo, V. (1997). Infection of the diabetic foot. *RAYs*, 22(4), 544-549.
- Margolis, D., Cromblemholme, T., & Herlyn, M. (2000). Clinical protocol: Phase 1 trial to evaluate the safety of H5.020CMV.PDGF-B for the treatment of diabetic insensate foot ulcers. *Wound Repair and Regeneration*, 8(6), 480-493.
- McCulloch, J. & Knight, A. (2002). Noncontact normothermic wound therapy and offloading in the treatment of neuropathic foot ulcers in patients with diabetes. *Ostomy/Wound Management*, 48(3), 38-44.
- Millington, J. & Norris, T. (2000). Effective treatment strategies for diabetic foot wounds. *The Journal of Family Practice*, 49(11 Suppl), S40-S48.
- Monami, M., Mannucci, E., & Giulio, M. (2002). Use of an oxidized regenerated cellulose and collagen composite for healing of chronic diabetic foot ulcers – A report of two cases. *Diabetes Care*, 25(10), 1892-1893.
- Mudge, B. P., Harris, G., Gilmont, R. R., Adamson, B. S., & Rees, R. S. (2002). Role of glutathione redox dysfunction in diabetic wounds. *Wound Repair and Regeneration*, 10(1), 52-58.
- Mueller, M. J., Strube, M. J., & Allen, B. T. (1997). Therapeutic footwear can reduce plantar pressures in patients with diabetes and transmetatarsal amputation. *Diabetes Care*, 20(4), 637-641.
- Mülhauser, I. (1994). Cigarette smoking and diabetes: An update. *Diabetic Medicine*, 11 336-343.
- National Centre for Chronic Disease Prevention and Health Promotion (2004). The prevention and treatment of complications of diabetes mellitus: A guide for primary care practitioners. Centers for Disease Control and Prevention [Electronic version]. Available: <http://www.cdc.gov/diabetes/pubs/complications/foot.htm>
- Nelson, R. G., Gohdes, D. M., Everhart, J. E., Hartner, J. A., Zwemer, F. L., Pettitt, D. J. et al. (1988). Lower extremity amputations in NIDDM – 12-yr follow-up study in Pima Indians. *Diabetes Care*, 11(1), 8-16.
- Nursing First Nations Communities (2002). Clinical practice of nurses in primary care. Government of Canada [Electronic version]. Available: www.hc-sc.gc.ca/fnihb/ons/resources/clinical_guidelines/downloads.htm
- O'Rourke, I., Heard, S., Treacy, J., Gruen, R., & Whitbread, C. (2002). Risks to feet in the top end: Outcomes of diabetic foot complications. *ANZ Journal of Surgery*, 72(4), 282-286.
- Oyibo, S. O., Jude, E., Taraweh, I., Nguyen, H., Harkless, L. B., & Boulton, A. J. M. (2001). A comparison of two Diabetic Foot Ulcer Classification Systems: The Wagner and the University of Texas wound classification systems. *Diabetes Care*, 24(1), 84-88.
- Paola, L. D., Cogo, A., Deanesi, W., Stocchiero, C., & Colletta, V. C. (2002). Using hyaluronic acid derivatives and cultured autologous fibroblasts and keratinocytes in a lower limb wound in a patient with diabetes: A case report. *Ostomy/Wound*

Management, 48(9), 46-49.

Pecoraro, R. E., Reiber, G. E., & Burgess, E. M. (1990). Pathways to diabetic limb amputation. Basis for prevention. *Diabetes Care*, 13(5), 513-521.

Peters, E. J. G. & Lavery, L. A. (2001). Effectiveness of the Diabetic Foot Risk Classification System of the International Working Group on the diabetic foot. *Diabetes Care*, 24(8), 1442-1447.

Pham, H. T., Economides, P. A., & Veves, A. (1998). The role of endothelial function on the foot – Microcirculation and wound healing in patients with diabetes. *Clinics in Podiatric Medicine and Surgery*, 15(1), 85-93.

Pham, H. T., Rich, J., & Veves, A. (2000). Wound healing in a diabetic foot ulceration: A review and commentary. *Wounds*, 12(4), 79-81.

Pham, H. T., Rosenblum, B. I., Lyons, T. E., Giurini, J. M., Chrzan, J. S., Habershaw, G. M. et al. (1999). Evaluation of a human skin equivalent for the treatment of diabetic foot ulcers in a prospective, randomized, clinical trial. *Wounds*, 11(4), 79-86.

Piaggese, A., Baccetti, F., Rizzo, L., Romanelli, M., Navalesi, R., & Benzi, L. (2001). Sodium carboxyl-methyl-cellulose dressing in the management of deep ulcerations of diabetic foot. *Diabetic Medicine*, 18 320-324.

Pinzur, M. S., Kernan-Schroeder, D., Emanuele, N. V., & Emanues, M.-A. (2001). Development of a nurse-provided health system strategy for diabetic foot care. *Foot and Ankle International*, 22(9), 744-746.

Pollak, R. (2000). Use of graftskin in diabetic foot ulcers: Case presentations. *Wounds*, 12(5 Suppl A), 37A-41A.

Price, P. & Harding, K. (2000). The impact of foot complications on health-related quality of life in patients with diabetes. *Journal of Cutaneous Medicine and Surgery*, 4(1), 45-50.

Reiber, G. E., Lipsky, B. A., & Gibbons, G. W. (1998). The burden of diabetic foot ulcers. *The American Journal of Surgery*, 176(Suppl 2A), 5S-10S.

Reiber, G. E., Smith, D. G., Carter, J., Fotieo, G., Deery II, G., Sangeorzan, J. A. et al. (2001). A comparison of diabetic foot ulcer patients managed in VHA and non-VHA settings. *Journal of Rehabilitation Research and Development*, 38(3), 309-317.

Reiber, G. E., Smith, D. G., Wallace, C. M., Vath, C. A., Sullivan, K., Hayes, S. et al. (2002). Footwear used by individuals with diabetes and a history of foot ulcer. Department of Veterans Affairs [Electronic version]. Available: www.vard.org/jour/02/39/5/pdf/reiber.pdf

Reichard, P., Berglund, B., Britz, A., Cars, I., Nilsson, B. Y., & Rosenqvist, U. (1991). Intensified conventional insulin treatment retards the microvascular complications of insulin-dependent diabetes mellitus (IDDM): The Stockholm Diabetes Intervention Study (SDIS) after 5 years. *Journal of Internal Medicine*, 230(2), 101-108.

Robertshaw, L., Robersthaw, D. A., & Whyte, I. (2001). Audit of time taken to heal diabetic foot ulcers. *Practical Diabetes International*, 18(1), 6-9.

Robson, M. C., Steed, D. L., McPherson, J. M., & Pratt, B. M. (2002). Effects of transforming growth factor B2 on healing in diabetic foot ulcers; A randomized controlled safety and dose-ranging trial. The Journal of Applied Research in Clinical and Experimental Therapeutics [Electronic version]. Available: <http://www.jrnlappliedresearch.com/articles/Vol2Iss2/Robsonspr02.htm>

Rourke, I., Heard, S., Treacy, J., Gruen, R., & Whitbread, C. (2002). Risks to feet in the top end: Outcomes of diabetic foot complications. *ANZ Journal of Surgery*, 72 282-286.

Ryan, S., Perrier, L., & Sibbald, R. G. (2003). Searching for evidence-based medicine in wound care: An introduction. *Ostomy/Wound Management*, 49(11), 67-75.

Sams, H. H., Chen, J., & King, L. E. (2002). Graftskin treatment of difficult to heal diabetic foot ulcers: One center's experience. *Dermatologic Surgery*, 28(8), 698-703.

Scottish Intercollegiate Guidelines Network (1997). *Implementation of the St. Vincent Declaration. The care of diabetic patients in Scotland. Management of diabetic foot disease. A national clinical guideline recommended for use in Scotland by the Scottish Intercollegiate Guidelines Network.* Scotland: Scottish Intercollegiate Guideline Network.

Selby, J. V. & Zhang, D. (1995). Risk factors for lower extremity amputation in persons with diabetes. *Diabetes Care*, 18(4), 509-516.

Sharp, A. (2004). Alginate dressings and the healing of diabetic foot ulcers – Wound Care. FindArticles [Electronic version]. Available: http://www.findarticles.com/p/articles/mi_m0MDQ/is_4_5/ai_97185454/print

Assessment and Management of Foot Ulcers for People with Diabetes

- Sinacore, D. R. (1998). Healing times of diabetic ulcers in the presence of fixed deformities of the foot using total contact casting. *Foot and Ankle International*, 19(9), 613-618.
- Smith, J. & Hunt, D. L. (2003). Review: Debridement using hydrogel seems to be better than standard wound care for healing diabetic foot ulcer. *ACP Journal Club*, 139(1), 16.
- Sone, J. & Cianci, P. (1997). Adjunctive role of hyperbaric oxygen therapy in the treatment of lower extremity wounds in patients with diabetes. *Diabetes Spectrum*, 10 1-11.
- Sorensen, J. C. (1998). Living skin equivalents and their application in wound healing. *Clinics in Podiatric Medicine and Surgery*, 15(1), 129-137.
- Springett, K. (2000). Foot ulceration in diabetic patients. *Nursing Standard*, 14(26), 65-71.
- Springett, K. (2002). The impact of diabetes on wound management. *Nursing Standard*, 16(30), 72-8.
- Steed, D., Edington, H., & Webster, M. (1996). Recurrence rate of diabetic neurotrophic foot ulcers healed using topical application of growth factors released from platelets. *Wound Repair and Regeneration*, 4 230-233.
- Steinberg, J., Beursterien, K., Plante, K., Nordin, J., Chaikoff, E., Arcona, S. et al. (2002). A cost analysis of a living skin equivalent in the treatment of diabetic foot ulcers. *Wounds*, 14(4), 142-149.
- Stone, J. A. & Brill, L. R. (2003). Wound healing for foot ulcers. *Diabetes Self-Management*, 20(1), 38-49.
- Stotts, N. A. & Wipke-Tevis, D. D. (2001). Co-factors in impaired wound healing. In D. L. Krasner, G. T. Rodeheaver, & R. G. Sibbald (Eds.), *Chronic Wound Care: A Clinical Source Book for Healthcare Professionals*. (3rd ed.) (pp. 265-272). Wayne, PA: HMP Communications.
- Strowig, S. & Raskin, P. (1992). Glycemic control and diabetic complications. *Diabetes Care*, 15(9), 1126-1140.
- Sundberg, J. (1997). *A retrospective review of the use of Iodosorb (cadexomer iodine) in the treatment of chronic ulcers*. Poster presented at the European Wound Management Association Conference "New approaches to the management of chronic wounds" in Milan, Italy.
- Sykes, M. T. & Godsey, J. B. (1998). Vascular evaluation of the problem diabetic foot. *Clinics in Podiatric Medicine and Surgery*, 15(1), 49-83.
- van der Meer, J. W. M., Koopmans, P. P., & Lutterman, J. A. (1995). Antibiotic therapy in diabetic foot infection. *Diabetic Medicine*, 13 548-551.
- Vazquez, J. R., Short, B., Findlow, A., Nixon, B. P., Boulton, A. J. M., & Armstrong, D. G. (2003). Outcomes of hyaluronan therapy in diabetic foot wounds. *Diabetes Research and Clinical Practice*, 59(2003), 123-127.
- Wall, I., Davies, C., Hill, K., Wilson, M. J., Stephens, P., Harding, K. G. et al. (2002). Potential role of anaerobic cocci in impaired human wound healing. *Wound Repair and Regeneration*, 10(6), 346-353.
- Ward, A., Metz, L., Oddone, E. Z., & Edelman, D. (1999). Foot education improves knowledge and satisfaction among patients at high risk for diabetic foot ulcer. *The Diabetes Educator*, 25(4), 560-567.
- White, R. J., Cooper, R., & Kingsley, A. (2001). Wound colonization and infection: The role of topical antimicrobials. *British Journal of Nursing*, 10(9), 563-578.
- Zhou, L. H., Nahm, W. K., Badiavas, E., Yufit, T., & Falanga, V. (2002). Slow release iodine preparation and wound healing: In vitro effects consistent with lack of in vivo toxicity in human chronic wounds. *British Journal of Dermatology*, 146(3), 365-374.
- Zimny, S., Schatz, H., & Pfohl, M. (2002). Determinants and estimation of healing times in diabetic foot ulcers. *Journal of Diabetes and its Complications*, 16(2002), 327-332.
- Zoorob, R. J. & Hagen, M. D. (1997). Guidelines on the care of diabetic nephropathy, retinopathy and foot disease. American Family Physician [Electronic version]. Available: <http://www.aafp.org/afp/971115ap/zoorob.html>

Appendix A: Search Strategy for Existing Evidence

STEP 1 – DATABASE Search

A database search for existing diabetes foot ulcer guidelines was conducted by a university health sciences library. A computerized search of the Medline, Embase and CINAHL databases for guidelines and other literature published from January 1, 1995 to December 2003 was conducted using the following search terms: “diabetic foot ulcers”, “foot ulceration”, NOT “venous leg ulcers or arterial ulcers”, “peripheral neuropathy”, “diabetes complications”, “prevention”, “assessment”, “management”, “amputation”, “factors influencing wound healing”, “patient/family education”, “randomized controlled trials”, “systematic reviews”, “practice guideline(s)”, “clinical practice guideline(s)”, “standards”, “consensus statement(s)”, “consensus”, “evidence-based guidelines” and “best practice guidelines”.

STEP 2 – Structured Website Search

One individual searched an established list of websites for content related to the topic area. This list of sites, reviewed and updated in October 2002, was compiled based on existing knowledge of evidence-based practice websites, known guideline developers, and recommendations from the literature. Presence or absence of guidelines was noted for each site searched as well as date searched. The websites at times did not house a guideline but directed to another website or source for guideline retrieval. Guidelines were either downloaded if full versions were available or were ordered by phone/e-mail.

- Agency for Healthcare Research and Quality: <http://www.ahrp.gov>
- Alberta Heritage Foundation for Medical Research – Health Technology Assessment: <http://www.ahfmr.ab.ca/hta>
- Alberta Medical Association – Clinical Practice Guidelines: <http://www.albertadoctors.org>
- American College of Chest Physicians: <http://www.chestnet.org/guidelines>
- American Medical Association: <http://www.ama-assn.org>
- British Medical Journal – Clinical Evidence: <http://www.clinicalevidence.com>
- Canadian Coordinating Office for Health Technology Assessment: <http://www.ccohta.ca>
- Canadian Task Force on Preventive Healthcare: <http://www.ctfphc.org>
- Centers for Disease Control and Prevention: <http://www.cdc.gov>
- Centre for Evidence-Based Mental Health: <http://www.cebmh.com>
- Centre for Evidence-Based Pharmacotherapy: <http://www.aston.ac.uk/lhs/teaching/pharmacy/cebpt>
- Centre for Health Evidence: <http://www.cche.net/che/home.asp>
- Centre for Health Services and Policy Research: <http://www.chspr.ubc.ca>
- Clinical Resource Efficiency Support Team (CREST): <http://www.crestni.org.uk>
- CMA Infobase: Clinical Practice Guidelines: <http://mdm.ca/cpgsnew/cpgs/index.asp>
- Cochrane Database of Systematic Reviews: <http://www.update-software.com/cochrane>
- Database of Abstracts of Reviews of Effectiveness: <http://nhscrd.york.ac.uk/darehp.htm>
- Evidence-Based On-Call: <http://www.eboncall.org>
- Government of British Columbia – Ministry of Health Services: <http://www.hlth.gov.bc.ca/msp/protoguides/index.html>
- Institute for Clinical Systems Improvement: <http://www.icsi.org/index.asp>
- Institute of Child Health: <http://www.ich.ucl.ac.uk/ich>
- Joanna Briggs Institute: <http://www.joannabriggs.edu.au/about/home.php>

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- Medic8.com: <http://www.medic8.com/ClinicalGuidelines.htm>
- Medscape Women's Health: <http://www.medscape.com/womenshealthhome>
- Monash University Centre for Clinical Effectiveness: <http://www.med.monash.edu.au/healthservices/cce/evidence>
- National Guideline Clearinghouse: <http://www.guidelines.gov>
- National Institute for Clinical Excellence: <http://www.nice.org.uk>
- National Library of Medicine Health Services/Technology Assessment: <http://hstat.nlm.nih.gov/hq/Hquest/screen/HquestHome/s/64139>
- Netting the Evidence: A SchARR Introduction to Evidence-Based Practice on the Internet: <http://www.shef.ac.uk/scharr/ir/netting>
- New Zealand Guidelines Group (NZGG): <http://www.nzgg.org.nz>
- NHS Centre for Reviews and Dissemination: <http://www.york.ac.uk/inst/crd>
- NHS Nursing & Midwifery Practice Development Unit: <http://www.nmpdu.org>
- NHS R & D Health Technology Assessment Programme: <http://www.hta.nhsweb.nhs.uk/htapubs.htm>
- PEDro: The Physiotherapy Evidence Database: <http://www.pedro.fhs.usyd.edu.au/index.html>
- Queen's University at Kingston: <http://post.queensu.ca/~bhc/gim/cpgs.html>
- Royal College of General Practitioners: <http://www.rcgp.org.uk>
- Royal College of Nursing: <http://www.rcn.org.uk/index.php>
- Royal College of Physicians: <http://www.rcplondon.ac.uk>
- Sarah Cole Hirsch Institute: <http://fpb.cwru.edu/HirshInstitute>
- Scottish Intercollegiate Guidelines Network (SIGN): <http://www.sign.ac.uk>
- Society of Obstetricians and Gynecologists of Canada Clinical Practice Guidelines: http://www.sogc.medical.org/sogcnet/index_e.shtml
- The Canadian Cochrane Network and Centre: <http://cochrane.mcmaster.ca>
- The Qualitative Report: <http://www.nova.edu/ssss/QR>
- Trent Research Information Access Gateway: <http://www.shef.ac.uk/scharr/triage/TRIAGEindex.htm>
- TRIP Database: <http://www.tripdatabase.com>
- U.S. Preventive Service Task Force: <http://www.ahrq.gov/clinic/uspstfix.htm>
- University of California, San Francisco: <http://medicine.ucsf.edu/resources/guidelines/index.html>
- University of Laval – Directory of Clinical Information Websites: <http://132.203.128.28/medecine>
- University of York – Centre for Evidence-Based Nursing: <http://www.york.ac.uk/health-sciences/centres/evidence/cebn.htm>

STEP 3 – Search Engine Web Search

A website search for existing diabetic foot ulcer guidelines was conducted via the search engine “Google”, using the search terms identified above. One individual conducted this search, noting the results of the search term results, the websites reviewed, date and a summary of the results. The search results were further critiqued by a second individual who identified guidelines and literature not previously retrieved.

STEP 4 – Hand Search/Panel Contributions

Additionally, panel members were already in possession of a few of the identified guidelines. In some instances, a guideline was identified by panel members and not found through the previous search strategies. These were guidelines that were developed by local groups or specific professional associations and had not been published to date.

STEP 5 – Core Screening Criteria

This above search method revealed eight guidelines, several systematic reviews and numerous articles related to diabetic foot ulcers.

The final step in determining whether the clinical practice guideline would be critically appraised was to have two individuals screen the guidelines based on the following criteria. These criteria were determined by panel consensus:

- Guideline was in English, international in scope.
- Guideline dated no earlier than 1997.
- Guideline was strictly about the topic area.
- Guideline was evidence-based, (e.g. contained references, description of evidence, sources of evidence).
- Guideline was available and accessible for retrieval.

RESULTS OF THE SEARCH STRATEGY

The results of the search strategy and the decision to critically appraise identified guidelines are detailed below. Seven guidelines met the screening criteria and were critically appraised using the *Appraisal of Guidelines for Research and Evaluation* (AGREE Collaboration, 2001) instrument.

TITLE OF THE PRACTICE GUIDELINES CRITICALLY APPRAISED

Australian Centre for Diabetes Strategies (2001). National evidence based guidelines for the management of type 2 diabetes mellitus – Draft for public consultation – 6 April 2001 for the identification & management of diabetic foot disease. Australian Centre for Diabetes Strategies [Electronic version]. Available: http://www.diabetes.net.au/PDF/evidence_based_healthcare/FootProblems.pdf

CREST – Clinical Resource Efficiency and Support Team (1998). Guidelines for the management of the diabetic foot: Recommendations for practice. Clinical Resource Efficiency and Support Team [Electronic version]. Available: http://www.crestni.org.uk/publications/diabetic_foot.pdf

Frykberg, R. G., Armstrong, D. G., Giurini, J., Edwards, A., Kravette, M., Kravitz, S. et al. (2000). Diabetic foot disorders: A clinical practice guideline. American College of Foot and Ankle Surgeons [Electronic version]. Available: <http://www.acfas.org/diabeticcpg.html>

Hutchinson, A., McIntosh, A., Feder, R. G., Home, P. D., Mason, J., O’Keefe, C. et al. (2000). Clinical guidelines and evidence review for type 2 diabetes: Prevention and management of foot problems. Royal College of General Practitioners [Electronic version]. Available: <http://www.rcgp.org.uk/rcgp/clinspec/guidelines/diabetes/contents.asp>

Inlow, S., Orsted, H., & Sibbald, R. G. (2000). Best practices for the prevention, diagnosis and treatment of diabetic foot ulcers. *Ostomy/Wound Management*, 46(11), 55-68.

Ministry of Health Malaysia (2003). Clinical practice guidelines: Management of diabetic foot. Ministry of Health Malaysia [Electronic version]. Available: <http://www.acadmed.org.my/cpg/Draft%20CPG%20%20management%20of%20diabetic%20foot.pdf>

Royal Melbourne Hospital (2002). Evidence based guidelines for the inpatient management of acute diabetes related foot complications. Melbourne Health [Electronic version]. Available: http://www.mh.org.au/ClinicalEpidemiology/new_files/Foot%20guideline%20supporting.pdf

Appendix B: Glossary of Terms

A1C (formerly referred to as Glycosylated Hemoglobin or HBA1C): The A1C test measures the average glycemia over the preceding 2-3 months and, thus, assesses glycemic control. When the A1C is done every three months, it can detect whether glycemic control has been reached and maintained within the target range and also reflects departures from the target range.

Abscess: A circumscribed collection of pus that forms in tissue as a result of acute or chronic localized infection. It is associated with tissue destruction and frequently swelling.

Anhydrosis: Failure of the sweat glands to produce sweat, resulting in dryness in the skin, often a result of damaged nerves or neuropathy.

Ankle Brachial Pressure Index (ABPI): A comparison between the brachial systolic pressure and ankle systolic pressure. It gives an indication of arterial perfusion. The normal resting pressure is 1.0.

Antibiotic: An agent that is synthesized from a living organism (e.g., penicillin from mold) and can kill or halt the growth of microbes or bacteria.

Antimicrobial: An agent that is used to kill bacteria or microbes, that is not synthesized from a living organism (e.g., iodine or silver).

Antiseptic (Topical): Product with antimicrobial activity designed for use on skin or other superficial tissues; may damage cells.

Callus: An area of skin that is abnormally thick or hard, usually from continual pressure or friction, sometimes over a bony prominence.

Cellulitis: An infection of the skin characterized most commonly by local heat, redness (erythema), pain and swelling.

Claw Toes: Same as hammer toes.

Culture (Swab): Techniques involving the use of a swab to remove bacteria from a wound and place them in a growth medium for propagation and identification.

Diabetic Neuropathy: Peripheral, somatic or autonomic nerve damage attributable solely to diabetes mellitus.

Edge of Wound: It is an important part of the algorithm for wound management in diabetic foot ulcers. It provides an outcome statement (goal of care), provides structure for care (enabler), and it supports the use of a common language to determine healing (links practitioners). It determines if cell migration has begun.

Exuberant Granulation Tissue: New granulation tissue that is proliferating above the normal rate.

Fissures: A long, narrow opening or gap that can extend into other cavities or areas of the body.

Friable Tissue: Granulation tissue that bleeds easily with minimal stimulation. Normal healthy tissue is not friable.

F-Scan mat: Measures dynamic plantar pressures (foot pressure in standing and walking positions). This device measures peak pressures under the forefoot and the rear foot and is used to assist healthcare providers in reducing pressure areas to the foot.

Hallux Deformity: A deformity of the great toe.

Hammer Toes: A hammer toe is a toe that is contracted at the middle joint, which may cause severe pressure and pain. The ligaments and tendons that have tightened cause the toe's joints to curl downwards and may occur in any toe except the great toe.

Infection: The presence of bacteria or other micro-organisms in sufficient quantity to damage tissue or impair healing. Clinical experience has indicated that wounds can be classified as infected when the wound tissue contains 10^5 or greater micro-organisms per gram of tissue. Clinical signs of infection may not be present, especially in the immuno-compromised patient or the patient with a chronic wound.

Local Clinical Infection. A clinical infection that is confined to the wound and within a few millimeters of its margins – e.g., purulent exudate, odour, erythema, warmth, tenderness, edema, pain, fever, and elevated white cell count.

Systemic Clinical Infection. A clinical infection that extends beyond the margins of the wound. Some systemic infectious complications of pressure ulcers include cellulitis, advancing cellulitis, osteomyelitis, meningitis, endocarditis, septic arthritis, bacteremia, and sepsis.

Insensate: A word that describes a region of the body where the person cannot feel a stimulus. An example is when a monofilament is applied using proper technique, if the person does not feel the filament, that area of the foot is described as insensate.

Malnutrition: State of nutritional insufficiency due to either inadequate dietary intake or defective assimilation or utilization of food ingested.

Metatarsal Heads: The “metatarsal region” of the foot is the area on the bottom of a foot just before the toes, more commonly referred to as the ball-of-the-foot.

MRSA: Methicillin-resistant staphylococcus aureus (MRSA) is a strain of the staphylococcus bacterium which is resistant to the main groups of antibiotics.

Onychomycosis: Fungal infection in the toe nails. Nails may appear dry, thickened, white or yellow and flaky.

Pallor: White, pale, blanched colour of a limb when in the upright position.

Pes Cavus: A foot characterized by an abnormally high arch. Hyperextension of the toes may be present which can give the foot the appearance of a claw.

Pes Planus: A foot that has a fallen arch and appears abnormally flat or spread out.

Photoplethysmography: Photoplethysmography uses infra-red light to assess changes in the blood volume in the micro-circulation.

Rubor: Dark purple to bright red colour of a limb when in a dependent position.

Sensory Ataxia: Is an impairment of one's sense of body position. It may be characterized by striking the ground forcibly with the bottom of the foot as well as a stiff fling of the leg with walking.

Specificity: The chance of having a negative test result given that one does not have a disease.

Sensitivity: The chance of having positive test result given that one does have a disease.

Toe Pressure: See photoplethysmography.



Appendix C: University of Texas Foot Classification System – Categories 0-3: Risk Factors for Ulceration

Category 0: No Pathology

- Patient diagnosed with Diabetes Mellitus
- Protective sensation intact
- Ankle Brachial Pressure Index (ABPI) > 0.80 and toe systolic pressure >45 mmHg
- Foot deformity may be present
- No history of ulceration

POSSIBLE TREATMENT FOR CATEGORY 0

- Two to three visits a year to assess neurovascular status, dermal thermometry, and foci of stress
- Possible shoe accommodations
- Patient education

Category 1: Neuropathy, No Deformity

- Protective sensation absent
- Ankle Brachial Pressure Index (ABPI) > 0.80 and toe systolic pressure >45 mmHg
- No history of ulceration
- No history of diabetic neuropathic osteoarthropathy (Charcot's joint)
- No foot deformity

POSSIBLE TREATMENT FOR CATEGORY 1

Same as Category 0 plus:

- Possible shoe gear accommodation (pedorthic/orthotist consultation)
- Quarterly visits to assess shoe gear and monitor for signs of irritation

Category 2: Neuropathy with Deformity

- Protective sensation absent
- Ankle Brachial Pressure Index (ABPI) >0.80 and toe systolic pressure >45 mmHg
- No history of neuropathic ulceration
- No history of Charcot's joint
- Foot deformity present (focus of stress)

POSSIBLE TREATMENT FOR CATEGORY 2

Same as Category 1 plus:

- Pedorthic/orthotist consultation for possible custom molded/extra depth shoe accommodation
- Possible prophylactic surgery to alleviate focus of stress (e.g., correction of hammer toe or bunion deformity)

Category 3: History of Pathology

- Protective sensation absent
- Ankle Brachial Pressure Index (ABPI) >0.80 and toe systolic pressure >45 mmHg
- History of neuropathic ulceration
- History of Charcot's joint
- Foot deformity present (focus of stress)

POSSIBLE TREATMENT OF CATEGORY 3

Same as Category 2 plus:

- Pedorthic/orthotist consultation for custom molded/extra depth shoe accommodation
- Possible prophylactic surgery to alleviate the focus of stress (e.g., correction of bunion or hammer toe)
- More frequent visits may be indicated for monitoring

Appendix D: University of Texas Foot Classification System – Categories 4-6: Risk Factors for Amputation

Category 4A: Neuropathic Wound

- Protective sensation absent
- Ankle Brachial Pressure Index (ABPI) > 0.80 and toe systolic pressure >45 mmHg
- Foot deformity normally present
- Non-infected neuropathic ulceration (**ALL UT* STAGE A wounds**)
- No acute diabetic neuropathic osteoarthorpathy (Charcot's joint) present

POSSIBLE TREATMENT FOR CATEGORY 4A

Same as Category 3 plus:

- Pressure reduction program instituted
- Wound care program instituted

Category 4B: Acute Charcot's Joint

- Protective sensation absent
- Ankle Brachial Pressure Index (ABPI) > 0.80 and toe systolic pressure >45 mmHg
- Non-infected neuropathic ulceration may be present
- Diabetic neuropathic osteoarthorpathy (Charcot's joint) present

POSSIBLE TREATMENT FOR CATEGORY 4B

- Pressure reduction program instituted
- Thermometric and radiographic monitoring
- If ulcer is present, treatment same as Category 4A

Category 5: The Infected Diabetic Foot

- Protective sensation may or may not be present
- Infected wound
- Charcot's Joint may be present
- **ALL UT* STAGE B wounds**

POSSIBLE TREATMENT FOR CATEGORY 5

- Debridement of infected, necrotic tissue and/or bone, as indicated
- Possible hospitalization, antibiotic treatment regimen
- Medical management

Category 6: The Ischemic Limb

- Protective sensation may or may not be present
- Ankle Brachial Pressure Index (ABPI) <0.80 and toe systolic pressure <45 mmHg or Pedal Transcutaneous Oxygen Tension < 40 mmHg
- Ulceration may be present
- **ALL UT* STAGE C AND D wounds**

POSSIBLE TREATMENT OF CATEGORY 6

- Vascular consult, possible revascularization
- If infection present, treatment same as for Category 5. Vascular consultation concomitant with control of sepsis.

Legend: *UT = University of Texas

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Appendix E:

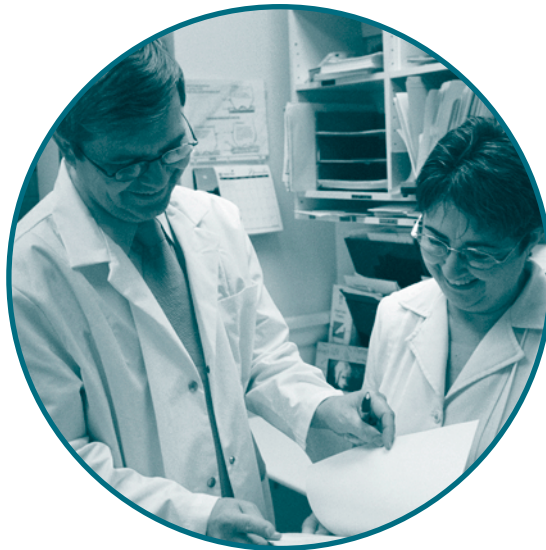
University of Texas Health Science Center

San Antonio Diabetic Wound Classification System

GRADES				
	0	I	II	III
A	Pre- or post-ulcerative lesion	Superficial wound, not involving tendon, capsule, or bone	Wound penetrating to tendon or capsule	Wound penetrating to bone or joint
B	Pre- or post-ulcerative lesion, completely epithelialized with infection	Superficial wound, not involving tendon, capsule, or bone with infection	Wound penetrating to tendon or capsule with infection	Wound penetrating to bone or joint with infection
C	Pre- or post-ulcerative lesion, completely epithelialized with ischemia	Superficial wound, not involving tendon, capsule, or bone with ischemia	Wound penetrating to tendon or capsule with ischemia	Wound penetrating to bone or joint with ischemia
D	Pre- or post-ulcerative lesion, completely epithelialized with infection and ischemia	Superficial wound, not involving tendon, capsule, or bone with infection and ischemia	Wound penetrating to tendon or capsule with infection and ischemia	Wound penetrating to bone or joint with infection and ischemia

Reprinted with permission:

Armstrong, D., Lavery, L. A. & Harkless, L. B. (1998b). Validation of a diabetic wound classification system: The contribution of depth, infection and ischemia to risk of amputation. *Diabetes Care*, 21(5), 855-859. Copyright© 1998 American Diabetes Association.



Appendix F: Diabetic Foot Care – Patient Handout

Any healthcare team member can assess the patient and/or caregiver's knowledge regarding their foot care. This patient handout was designed to assist team members in reviewing basic foot care strategies. Each item is explained in details on p.84 while p.85 is an easy to use checklist that encourages the patient to check each important aspect of care, using a simple check mark in each box. The “make notes” section is intended to remind patients to discuss any changes or questions with their healthcare provider.

As a person with diabetes, you and your feet are special!



Keep your feet clean

- Check temperature of water using your elbow
- Wash feet daily using lukewarm water and mild soap
- Dry feet gently, especially between your toes



Check your feet daily between and under all toes as well as top and bottom of both feet

- Use good lighting and wear your glasses
- Use a mirror to see the bottom of your foot
- Get help if you cannot see your feet well
- Check for: dry skin, hard areas, blisters, breaks in the skin
- Feel for changes in temperature and look for changes in colour or size
- Any changes you should get help right away



Keep your feet soft to prevent problems

- Use a lotion daily after your bath (eg. Uremol, Lac-Hydrin or Lubriderm)
- Do not put lotion between your toes or on open sores



Nail care is best done after a bath or shower-nails are soft then

- Shape nails even with the end of your toes using an emery board
- Never use a sharp pointed instrument
- Use a soft nail brush daily
- If you have hard areas of skin, thick or curled toenails, or have trouble seeing, you should see your doctor or a foot care specialist that your doctor suggests



Good footwear is very important to prevent breaks in the skin

- Shop for shoes in the afternoon when your feet are a little larger
- Shop at a shoe store suggested by your doctor and tell them that you have diabetes-use the same shoe store regularly
- Never go barefoot or wear sandals because your feet can get injured easily then, which can lead to infection
- Wear cotton socks in your shoes to allow your feet to breathe
- Shake out your shoes before you put them on to make sure there is nothing inside









Record and report any changes in your feet

Remember you and your feet are special! Take the time to visit your doctor and diabetes education centre to keep your diabetes and health well managed. Record and report any changes in your feet.

Information from: Love Your Feet, Convatec and Foot Care for Diabetics, Diabetes Education Centre, Credit Valley Hospital

Reprinted with permission: Laurie Goodman, RN, BA, IIWCC, Nurse Clinician, Skin & Wound Care, Credit Valley Hospital.

Foot Care Record	Mon	Tues	Wed	Thur	Fri	Sat	Sun
Wash 							
Look 							
Use Lotion 							
Trim Nails 							
Check Shoes 							
Make Notes 							

Reprinted with permission: Laurie Goodman, RN, BA, IIVCC, Nurse Clinician, Skin & Wound Care, Credit Valley Hospital.

Appendix G: Diagnostic Tests to Determine Vascular Supply

Diagnostic Test	Description
Arterial Duplex Scan	<ul style="list-style-type: none"> ■ Non-invasive ultrasound test that can identify macro- and microvascular changes in the arterial tree. ■ Used to diagnose aneurysm for large vessel stenosis >50%. ■ Patients with suspected superficial artery stenosis and claudication may undergo duplex scanning to identify a lesion that is amenable to angioplasty, before subjected to angiogram (Sales, Goldsmith & Veith 1994). ■ Non-invasive arterial duplex scan as having sensitivity and specificity rates greater than 90% (Kravitz, McGuire & Shanahan, 2003).
Transcutaneous Oxygen (T _c pO ₂)	<ul style="list-style-type: none"> ■ Measures absolute oxygen partial pressure in the dermis. According to Goldman and Salcido (2002), T_cpO₂ less than 20 mmHg gives a guarded prognosis for healing. ■ 40 mmHg is a good indication for healing (Goldman & Salcido, 2002). ■ T_cpO₂ should be measured on upper leg and dorsum of the foot for best results. ■ Areas of callus, edema or bony prominences produce inaccurate results. ■ Valuable for evaluating perfusion and is a good predictor of amputation in the lower limbs (Adler, Boyko, Ahroni & Smith, 1999; Ballard, Eke, Bunt & Killeen, 1995; Lehto, Ronnema, Pyorala & Laakso, 1996; Mayfield, Reiber, Sanders, Janisse & Pogach, 1998; Pecoraro, Ahroni, Boyko & Stensel, 1991; Reiber et al., 1992). ■ T_cpO₂ < 30 mmHg was an independent predictor of diabetic foot ulceration (McNeely, Boyko, Ahroni, Stensel, Reiber, Smith et al., 1995).
Toe and Ankle Pressures	<ul style="list-style-type: none"> ■ Systolic toe and ankle pressures are measured with a fitted occluding cuff placed most often around the base of the first toe and around both ankles. ■ Toe pressure of >45 mmHg is necessary for optimal healing (Apelqvist, Castenfors, Larsson, Stenström & Agardh, 1989; Frykberg et al., 2000). ■ Most patients with toe blood pressures >30mmHg healed with conservative management (Apelqvist et al., 1989; Kalani, Brismar, Fagrell, Ostergren & Jornekog, 1999; Royal Melbourne Hospital, 2002). ■ With ankle pressures > 80 mmHg, most patients had an amputation or died before healing occurred (Apelqvist et al., 1989). ■ Kalani et al. (1999) suggests a cut-off of 25mmHg for T_cpO₂ and 30mmHg for toe blood pressure as predictors of wound healing, with T_cpO₂ being the better predictor in patients with diabetes and chronic foot ulcers. Toe pressures, however, may be more technically and economically feasible.
Ankle-Brachial Pressure Index (ABPI)	<ul style="list-style-type: none"> ■ ABPI or ratio of systolic blood pressure in the lower extremity to blood pressure in the arm is a common clinical measure of reduced circulation (Boyko et al., 1999). <p><i>Caution:</i></p> <ul style="list-style-type: none"> ■ This should not be the sole diagnostic test performed. ■ In patients with diabetes, ABPI results can be unreliable (falsely negative) due to calcification of the arterial vessels (Apelqvist et al., 1989).

References:

- Adler, A. I., Boyko, E. J., Ahroni, J. H., & Smith, D. G. (1999). Lower-extremity amputation in diabetes: The independent effects of peripheral vascular disease, sensory neuropathy, and foot ulcers. *Diabetes Care*, 22(7), 1029-1037.
- Apelqvist, J., Castenfors, J., Larsson, J., Stenström, A., & Agardh, C.-D. (1989). Prognostic value of systolic ankle and toe blood pressure levels in outcome of diabetic foot ulcer. *Diabetes Care*, 12(6), 373-378.
- Ballard, J. L., Eke, C. C., Bunt, T. J., & Killeen, J. D. (1995). A prospective evaluation of transcutaneous oxygen measurements in the management of diabetic foot problems. *Journal of Vascular Surgery*, 22(4), 485-492.
- Boyko, E. J., Ahroni, J. H., Stensel, V., Forsberg, R. C., Davignon, D. R., & Smith, D. G. (1999). A prospective study of risk factors for diabetic foot ulcers: The Seattle diabetic foot study. *Diabetes Care*, 22(7), 1036-1042.
- Frykberg, R. G., Armstrong, D. G., Giurini, J., Edwards, A., Kravette, M., Kravitz, S. et al. (2000). Diabetic foot disorders: A clinical practice guideline. American College of Foot and Ankle Surgeons [Electronic version]. Available: <http://www.acfas.org/diabeticcpq.html>
- Goldman, R. J. & Salcido, R. (2002). More than one way to measure a wound: An overview of tools and techniques. *Advances in Skin and Wound Care*, 15(5), 236-245.
- Kalani, M., Brismar, K., Fagrell, B., Ostergren, J., & Jorneskog, G. (1999). Transcutaneous oxygen tension and toe blood pressure as predictors for outcome of diabetic foot ulcers. *Diabetes Care*, 22(1), 147-151.
- Kravitz, S. R., McGuire, J., & Shanahan, S. D. (2003). Physical assessment of the diabetic foot. *Advances in Skin and Wound Care*, 16(2), 68-75.
- Lehto, S., Ronnema, T., Pyorala, K., & Laakso, M. (1996). Risk factors predicting lower extremity amputations in patients with NIDDM. *Diabetes Care*, 19(6), 607-612.
- Mayfield, J. A., Reiber, G. E., Sanders, L. J., Janisse, D., & Pogach, L. M. (1998). Preventive foot care in people with diabetes. *Diabetes Care*, 21(12), 2161-2177.
- McNeely, M. J., Boyko, E. J., Ahroni, J. H., Stensel, V. L., Reiber, G. E., Smith, D. G. et al. (1995). The independent contributions of diabetic neuropathy and vasculopathy in foot ulceration: How great are the risks? *Diabetes Care*, 18(2), 216-219.
- Pecoraro, R. E., Ahroni, J. H., Boyko, E. J., & Stensel, V. L. (1991). Chronology and determinants of tissue repair in diabetic lower-extremity ulcers. *Diabetes*, 40 1305-1313.
- Reiber, G. E., Pecoraro, R. E., & Koepsell, T. D. (1992). Risk factors for amputation in patients with diabetes mellitus: A case-control study. *Annals of Internal Medicine*, 117(2), 97-105.
- Royal Melbourne Hospital (2002). Evidence based guidelines for the inpatient management of acute diabetes related foot complications. Melbourne Health [Electronic version]. Available: http://www.mh.org.au/ClinicalEpidemiology/new_files/Foot%20guideline%20supporting.pdf
- Sales, C., Goldsmith, J., & Veith, F. J. (1994). *Handbook of Vascular Surgery*. St. Louis, MO: Quality Medical Publishing.

Appendix H: Diagnostic Tests and Imaging to Determine Infection

Diagnostic tests

Accessibility and interpretation of these tests may be limited to certain areas of specialty. Diagnostic tests are performed in conjunction with the clinical assessment. Utilizing isolated test results in isolation may lead the clinician to a misdiagnosis (RNAO Guideline Development Panel, 2005).

- **Wound cultures**

Cultures of the wound should be obtained to guide antibiotic therapy effectively and accurately. Bacterial swabs can provide information on the predominant flora within a non-progressing, deteriorating or heavily exudating wound. See Appendix I for swab techniques. Blood cultures are useful if sepsis is suspected (Perry, Pearson & Miller, 1991). Bacterial swabs or wound cultures do not diagnose infection but they can be used as guidance for antimicrobial therapy. The diagnosis of infection is based on clinical symptoms and signs.

- **C-reactive protein**

The sensitivity and specificity of serological markers of infection, e.g., C-reactive protein, tends to increase with more severe infection (Royal Melbourne Hospital, 2002).

- **White Blood Cell Count (WBC) and Erythrocyte Sedimentation Rate (ESR)**

Elevated lab values should alert the clinician to the possibility of sepsis; however, normal values should not be used to rule out infection (Armstrong et al., 1996). These lab tests are helpful but must be considered in conjunction with the clinical assessments of infection.

Imaging

Imaging presentation will vary and should only be conducted to establish or confirm a suspected diagnosis and/or direct patient management. Accessibility and interpretation may be limited to certain areas of specialty:

- **X-Ray**

Plain X-rays are a useful primary imaging tool as they may reveal changes consistent with osteomyelitis, the presence of foreign bodies, tissue gas or bony abnormalities (Bonham, 2001). Bone destruction and periosteal changes are not usually evident for 10-21 days following infection (Royal Melbourne Hospital, 2002).

- **Bone / Gallium scans**

Gallium 67citrate is a nuclear medicine technique that is not used as frequently today due to more accurate alternative imaging studies (Frykberg et al., 2000; Johnson, Kennedy, Shereff, Patel & Collier, 1996; Keenan, Tindel & Alavi, 1989; Longmaid III & Kruskal, 1995). Edelson, Armstrong, Lavery & Caicco (1996) established that the technetium bone scan is an expensive, non-specific test for evaluating bony pathology (e.g., osteomyelitis).

- **CT scan**

CT scans may be indicated in the assessment of suspected bone and joint pathology not evident on plain radiographs (Frykberg et al., 2000; Lipsky, 1997).

- **Magnetic Resonance Imaging (MRI)**

MRI has superior sensitivity and specificity (approximately 90-95% for each) for diagnosing osteomyelitis. If plain X-ray is not sufficient MRI may be subsequently ordered to confirm the diagnosis and to determine the extent of osteomyelitis.

References:

Armstrong, D. G., Lavery, L. A., Sariaya, M. & Ashry, H. (1996). Leukocytosis is a poor indicator of acute osteomyelitis of the foot in diabetes mellitus. *The Journal of Foot and Ankle Surgery*, 35(4), 280-283.

Bonham, P. (2001). A critical review of the literature: part I: diagnosing osteomyelitis in patients with diabetes and foot ulcers. *Journal of Wound, Ostomy and Continence Nurses Society*, 28(2), 73-88.

Edelson, G. W., Armstrong, D. G., Lavery, L. A. & Caicco, G. (1996). The acutely infected diabetic foot is not adequately evaluated in an inpatient setting. *Journal of the American Podiatric Medical Association*, 87(6), 260-265.

Frykberg, R. G., Armstrong, D. G., Giurini, J., Edwards, A., Kravette, M., Kravitz, S. et al. (2000). Diabetic foot disorders: A clinical practice guideline. American College of Foot and Ankle Surgeons [Electronic version]. Available: <http://www.acfas.org/diabeticcpq.html>

Johnson, J. E., Kennedy, E. J., Shereff, M. J., Patel, N. C. & Collier, B. D. (1996). Prospective study of bone, indium-111-labeled white blood cell, and gallium-67 scanning for the evaluation of osteomyelitis in the diabetic foot. *Foot and Ankle International*, 17(1), 10-16.

Keenan, A. M., Tindel, N. L. & Alavi, A. (1989). Diagnosis of pedal osteomyelitis in diabetic patients using current scintigraphic techniques. *Archives of Internal Medicine*, 149(10), 2262-2266.

Lipsky, B. A. (1997). Osteomyelitis of the foot in diabetic patients. *Clinical Infectious Diseases*, 25(6), 1318-1326.

Longmaid III, H. E. & Kruskal, J. B. (1995). Imaging infections in diabetic patients. *Infectious Disease Clinics of North America*, 9(1), 163-182.

Perry, C. R., Pearson, R. L. & Miller, G. A. (1991). Accuracy of cultures of material from swabbing of the superficial aspect of the wound and needle biopsy in the perioperative assessment of osteomyelitis. *Journal of Bone and Joint Surgery*, 73(5), 745-749.

Royal Melbourne Hospital (2002). Evidence based guidelines for the inpatient management of acute diabetes related foot complications. Melbourne Health [Electronic version]. Available: http://www.mh.org.au/ClinicalEpidemiology/new_files/Foot%20guideline%20supporting.pdf

Appendix I: Wound Swabbing Technique

Obtain a wound culture when clinical signs and symptoms of infection are present.

NB: In Ontario, the Ontario Laboratories Act requires a physician's order to process the culture.

Semi-quantitative Swab Sample Technique:

Semi-quantitative swab results are equally effective with quantitative biopsy results if the wound is properly prepared (Dow et al., 1999).

- Use sterile cotton tipped swab and culture medium in a pre-packaged collection and transport system available from the hospital or Gamma, MDS or CML laboratories. Community nurses should not allow transport medium to freeze or become overheated in the car before using it.
- Thoroughly rinse wound with normal saline (non-bacteristatic).
- Don't swab pus, exudate, hard eschar or necrotic tissue.
- Rotate the swab tip in a 1 cm square area of clean granulation tissue using enough pressure to release tissue exudate for a period of 5 seconds. *This may be painful so warn the patient of the possibility of pain and pre-medicate with analgesic if possible.*
- Remove protective cap from culture medium and insert cotton tipped applicator into the culture medium without contaminating the applicator.
- Transport to the laboratory at room temperature within 24 hours.

Interpretation of semi-quantitative results:

Many labs that service the community do not provide quantitative results or report gram stains. The following chart can be used to compare semi-quantitative results with a quantitative report.

Surface Cultures Growth at 24 – 48 hours				Rx
Quantitative Growth (Colony Forming Units/ Gm)	Gram Stain Results	Sector (1+ to 4+)	Semi-quantitative result (terms will vary with each lab)	Suggested Antibiotic Treatment
<10 to the 3 rd	No growth	No growth	No growth	None
>= 10 to the 3 rd	No growth	I	Scant or light	None
>=10 to the 4 th	No growth	I, II	Small to moderate	None
>=10 to the 5 th	No growth	I, II, III	Moderate to heavy	Treat if localized signs of infection present
>=10 to the 6 th	Bacteria observed	I, II, III, IV	Large or heavy	Treat – considered infected

Prepared by and reprinted with permission of Connie Harris, RN, ET, IIWCC 2000.

References:

Dow, G., Browne, A. & Sibbald, R. G. (1999). Infection in chronic wounds: Controversies in diagnosis and treatment. *Ostomy/Wound Management*, 45(8), 23-27, 29-40.

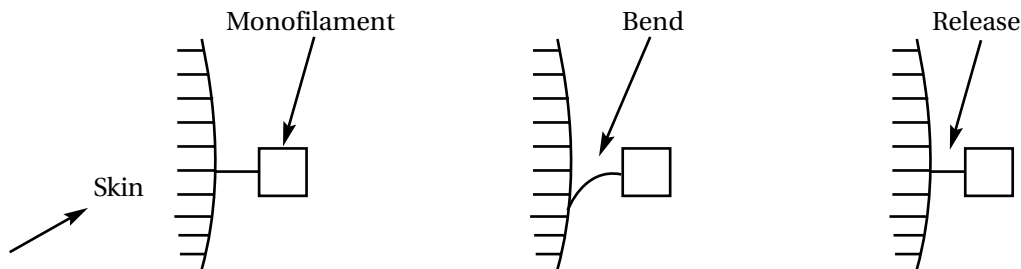
Herruzo-Cabrera, R., Vizcaino-Alcaide, M. J., Pinedo-Castillo, C. & Rey-Calero, J. (1992). Diagnosis of local infection of a burn by semiquantitative culture of the eschar surface. *Journal of Burn Care and Rehabilitation*, 13(6), 639-641.

Stotts, N. (1995). Determination of bacterial bioburden in wounds. *Advances in Wound Care*, 8(4), 28-46.

Appendix J: Use of the Semmes-Weinstein Monofilament

Directions for use of Semmes- Weinstein Monofilament

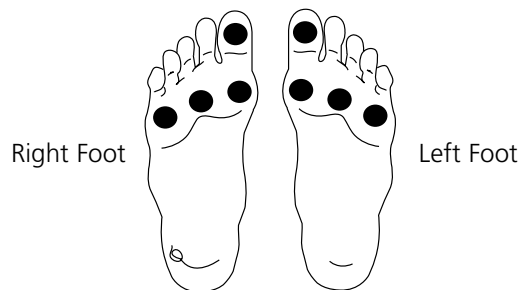
1. Assess integrity of monofilament (no bends/breaks).
2. Show the monofilament to the patient. Place the end of the monofilament on his/her hand or arm to show that the testing procedure will not hurt.
3. Ask the patient to turn his/her head and close his/her eyes or look at the ceiling.
4. Hold the monofilament perpendicular to the skin.



5. Place the end of the monofilament on the sole of the foot. Ask the patient to say 'yes' when he/she feels you touching his/her foot with the monofilament. **DO NOT ASK THE PATIENT "did you feel that?"** If the patient does not say "yes" when you touch a given testing site, continue on to another site. When you have completed the sequence **RETEST** the area(s) where the patient did not feel monofilament.
6. Push the monofilament until it bends, then hold for 1-3 seconds.
7. Lift the monofilament from the skin. Do not brush or slide along the skin.
8. Repeat the sequence randomly at each testing site on the foot (see pictures below).

Sites on the sole of the foot for monofilament testing

Loss of protective sensation = absent sensation at one or more sites



Notes

Apply only to intact skin. Avoid calluses, ulcerated or scarred areas. **DO NOT** use a rapid or tapping movement.

- If the monofilament accidentally slides along the skin, retest that area later in the testing sequence.
- Store the monofilament according to the manufacturer's instructions.
- Clean the monofilament according to agency infection control protocols.

Reference: Registered Nurses' Association of Ontario (2004). *Reducing Foot Complications for People with Diabetes*. Toronto, Canada: Registered Nurses' Association of Ontario.

Appendix K: Suggestions for Assessing and Selecting Shoes and Socks

Shoes

- Shoes should be comfortable and well-fitting.
- Have both feet measured each time shoes are bought.
- Buy new shoes late in the day since feet often swell or enlarge during the day. Buy shoes to fit the larger foot if there is a difference.
- Choose shoes with a wide and deep toe box (test depth with a looney put in sideways, test width by outlining your foot on a piece of paper and placing the shoe over the drawing).
- When buying shoes, wear the type of socks that you will be wearing with those shoes.
- Choose shoes made of calfskin or soft leather, if possible.
- Buy shoes with laces. These provide more support, distribute pressure around the sides and top and allow adjustment for swelling.
- Shoes should have good, non-skid soles, closed toes and heels, with no ridges, wrinkles or seams in the linings (good running shoes or walking shoes are recommended).
- Avoid slip-on shoes, shoes with pointed toes and sandals, especially sandals with thongs between the toes.
- Do not wear shoes with heels higher than 1 inch (2.5cm) as they increase pressure on the metatarsal heads.
- Break new shoes in gradually, adding one hour of wearing time each day. Frequently inspect the feet, looking for areas of redness that indicate potential problems.
- Do not wear any shoes longer than six hours without removing. Each pair of shoes fits differently and distributes pressure differently.
- Check shoes before wearing for small stones or puckered or bunched up areas.

Socks

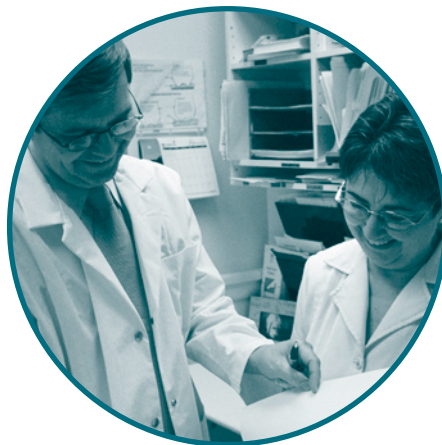
- Wear clean socks everyday. Cotton or wool is best to absorb perspiration.
- Socks should fit well. Avoid tight elastic at the top.
- If wearing knee-high hosiery, make sure it has a wide band at the top.
- Check socks for irritation or bunching. Avoid seams if possible.
- Do not wear mended socks; they may cause an area of pressure.
- Do not wear socks with holes; they may cause an area of friction.

Adapted from: Zangaro, G. A. & Hull, M. M. (1999). Diabetic neuropathy: Pathophysiology and prevention of foot ulcers. *Clinical Nurse Specialist*, 13(2) 57-65

Appendix L: Factors Affecting Wound Healing

Systemic Factors Affecting Wound Healing	Local Factors Affecting Wound Healing	Extrinsic Factors Affecting Wound Healing
<ul style="list-style-type: none"> ■ Age ■ Anemia ■ Anti-inflammatory drugs ■ Auto-immune disorders ■ Blood supply ■ Cytotoxic drugs ■ Fever ■ Hypotension ■ Jaundice ■ Malignant disease ■ Malnutrition ■ Obesity ■ Renal Failure ■ Systemic infection ■ Trauma ■ Smoking ■ Vasculopathy ■ Vitamin deficiency ■ Zinc deficiency 	<ul style="list-style-type: none"> ■ Blood supply ■ Denervation ■ Edema ■ Hematoma ■ Iatrogenic causes <ul style="list-style-type: none"> • psychosocial/cognitive impairment • poor surgical • use of cytotoxic agents ■ Local infection ■ Mechanical stress ■ Radiation ■ Suture material ■ Type of tissue 	<ul style="list-style-type: none"> ■ Cultural beliefs ■ Footwear <ul style="list-style-type: none"> • shoes • orthotics ■ Offloading devices

RNAO Guideline Development Panel, 2005



Appendix M: Topical Antimicrobial Agents

TOPICAL ANTIMICROBIAL AGENTS

Agent		Spectrum							Comments
		SA	MRSA	Strep	PS	F	Anaerobic	VRE	
Safe & Effective	Cadexomer Iodine	✓	✓	✓	✓	✓	✓	✓	Broad spectrum. Effective for fungi & virus. Widely available. Sheet requires wound contact. Caution if on thyroid medication.
	Ionized Silver	✓	✓	✓	✓	✓	✓	✓	Broad Spectrum. Effective for fungi & virus. Sheet requires wound contact.
	Silver Sulphadiazine	✓	✓	✓	✓		✓		Limited potential for resistance. Available in paste or ointment. Do not use if sulfa sensitive.
	Polymyxin B Sulphate – Bacitracin Zinc	✓	✓	✓	✓		✓		Sheet requires wound contact.
Selective Use	Metronidazole gel/cream						✓		Reserve for anaerobes & odour control.
	Benzyl/ Peroxide	✓		✓	✓		✓		Reserve for MRSA & other resistant gram positive.
	Acetic Acid				✓				Used in 0.25% (e.g. 1/4 of 1.0% maximum concentration).
	Mupuricin Bactroban	✓	✓	✓					Should be reserved for MRSA colonization.
	Povidone iodine	✓	✓	✓	✓	✓	✓	✓	Use with caution. This agent is cytotoxic.
	Chlorhexidine	✓	✓	✓	✓	✓	✓	✓	Use during inflammatory phase. Cytotoxic during proliferative phase.
Caution	Gentamycin	✓		✓	✓				Reserve for oral/IV use.
	Fucidic Acid	✓	✓	✓					Sensitizer.
	Polymixin B Sulphate Bacitracin Zinc Neomycin	✓	✓	✓	✓		✓		Potent Sensitizer.
Not Recommended	Alcohol Hydrogen peroxide Hypochlorite solution (Dakens)								Cytotoxic. No antimicrobial properties. Cytotoxic.
Legend: (SA = Staphylococcus Aureus), (MRSA = Methicillin Resistant Staph Aureus), (Strep = Streptococci), (PS = Pseudomona), (F = Fungi – Mucor, Aspergillus, Candida Albicans, Candida Tropicalis, Candida Glabrata, & Saccharomyces), (VRE = Vancomycin-Resistant Enterococci)									

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Appendix N: A Guide to Dressing Foot Wounds

There is limited evidence that any specific dressing type enhances the speed of healing of diabetic foot ulcers. It is clear, however, that a moist wound environment results in more rapid wound healing. Many factors need to be considered when selecting a dressing and these factors may change over time, necessitating a change in dressing type. Influencing factors include wound type, wound depth, presence and volume of exudates, presence of infection, surrounding skin condition, likelihood of re-injury and cost. Dressings should never be commenced in isolation and should be a part of the treatment package of debridement, dressings, pressure offloading and when clinically indicated, antibiotics. This list is not exhaustive. These are common products used in Ontario. Please check with local suppliers to see what specific dressings are used in your region.

Note: Read the product monographs for specific details.

Wound Care Products

Examples	Description	Indications	Considerations
<p>CLEANSERS Normal Saline Shur-Cleans</p> <p>Dermagran cleanser Restore Other</p>	<p>Normal saline preferred. Physiologic. Not harmful to tissue. Commercial wound cleansers. May contain surfactants to assist with removal of debris. Adjustable spray nozzle provides variable pressures for cleansing (from gentle flush to 15 psi).</p>	<p>Cleanses wound debris with minimal trauma.</p>	<p>Levels of toxicity vary among commercial wound cleansers. Some contain antimicrobial agents, which may be toxic to new tissue. Read literature and product monograph to determine safety.</p> <p>Cleansers contain mild preservatives, which stabilize the product but may cause irritation and increase toxicity.</p> <p>Ease of use facilitates patient independence.</p> <p>Risk of contamination is reduced in unclean situations.</p> <p>Caution – Wound cleansers are for wounds. Skin cleansers are for intact skin only.</p>
<p>Ranked according to toxicity AHCPR (1994)</p>			

Examples	Description	Indications	Considerations
TRANSPARENT ADHESIVE DRESSINGS Bioclusive MeFilm Opsite FlexiFix Opsite Tegaderm	Semi- permeable adhesive sheets. Impermeable to water molecules and bacteria. Incapable of absorbing moisture. Transparency permits wound visualization. Some are shaped to fit problem areas. Non-sterile roll is intended for use on intact skin or as a secondary cover dressing.	Wounds at risk for contamination. Protects intact skin from friction or irritants. Secondary cover dressing to enhance moisture and odour containment. A flexible outer dressing for uneven areas. Superficial wounds, skin breaks with minimal drainage. Supports autolytic debridement.	Can be cut to accommodate difficult areas or used as adhesive strips to waterproof dressing edges. Moisture resistance allows for bathing. Use with caution on fragile peri-wound skin. For removal, stretch product to break adhesive bond and prevent skin stripping. Decrease wound pain by protecting superficial nerve endings. Use of liquid skin barriers on peri-wound skin increases adhesion. Not suitable if skin is evidencing yeast infection. Removal by stretching the edges will minimize superficial tears.

Moisture Retentive: Non-Adherents

NON-IMPREGNATED Alldress ETE Melolite Mepitel Primapore Release Tegapore Telfa Others	Varied densities, sizes and shapes of woven mesh. Some have plastic coating to create semi-occlusion. Minimal absorption capability. Mepitel is a silicone mesh.	Wound contact layer to: <ul style="list-style-type: none"> ■ Protect fragile tissue ■ Maintain some wound hydration ■ Protect post-operative incision ■ Prevent painful dressing adherence 	Some mesh dressings can remain in place up to 7 days. Outer absorbent dressings can be replaced as needed. Plastic coated products may macerate peri-wound skin. Protect skin with suitable barrier. Layering tulle dressings increases semi-occlusion. Slight overlap onto peri-wound skin stabilizes dressing and decreases pain. Most require secondary cover dressing to absorb drainage and enhance stability. Some are self-adhesive. Products containing antiseptics and antibiotics reported to assist with local bacterial control in a contaminated wound. Long term use increases risk of local sensitization and the development of resistant bacteria. Infection requires appropriate systemic management. Consider alternative product if dressing adheres.
IMPREGNATED/ TULLE Adaptic Bactigras Fucidin Jelonet Sofratulle	Tulle dressings contain either petrolatum, antiseptics or antibiotics. Some tulle dressings contain minimal amounts of antibiotic. *see Topical Antimicrobial Agents, Appendix M		

Wound Hydration: Hydrocolloids

Examples	Description	Indications	Considerations
<p>HYDROCOLLOIDS</p> <ul style="list-style-type: none"> Comifeel Comifeel Plus Cutinova Hydro DuoDERM CGF RepliCare Restore SignaDress Tegasorb Triad Others 	<p>Available as adhesive sheets, powders or pastes.</p> <p>May contain gelatin, sodium carboxymethylcellulose, and pectin.</p> <p>Sheet dressings have an occlusive or semi-occlusive polyurethane outer layer.</p> <p>Thickness, size, absorption capability, and transparency varies.</p> <p>Minimal to moderate absorbency. Some have tapered or adhesive borders to increase stability.</p> <p>Interactive dressings.</p> <p>Do not confuse characteristic odour with infection.</p> <p>Comes in thick and thin versions.</p>	<p>Wounds with minimal drainage.</p> <p>Wounds requiring autolytic debridement.</p> <p>Promotes granulation and epithelialization.</p> <p>Protects from contamination.</p> <p>An aesthetic cover dressing.</p> <p>A moisture retentive secondary dressing.</p> <p>Protects underlying skin from tape injury.</p> <p>May be used for prevention.</p>	<p>Sheets can be customized to fit difficult areas.</p> <p>Size must always extend 2.5-5 cm beyond wound margins to ensure adherence and wear time.</p> <p>Use of additional tapes or transparent film dressings to edges may improve stability in areas of high stress.</p> <p>Caution with use of adhesive dressings on fragile peri-wound skin.</p> <p>Dressings create an occlusive barrier.</p> <p>May remain in place for 3-7 days. Frequency of change is determined by amount of drainage and before leakage occurs.</p> <p>Can be used over absorbent alginates or hydrofibers to contain drainage.</p> <p>Change by 3-4 days.</p> <p>Not advised for copiously draining wounds.</p> <p>If signs and symptoms of clinical infection should develop, appropriate medical treatment should be initiated.</p> <p>Use is not appropriate if infection suspected.</p> <p>Use liquid skin barriers on peri-wound skin to decrease risk of maceration and to increase adherence.</p>

Wound Hydration: Hydrogels

Examples	Description	Indications	Considerations
<p>HYDROGELS Curagel DuoDERM Gel Intrasite Gel Normgel Nu-Gel Puriclens Restore Gel Tegagel Wound'Dres Others</p>	<p>Polymers with high water content. Moisture donating. Non-toxic. Non-adherent. Some contain preservatives. Available as liquid gels, in solid sheets or imbedded into gauze dressings.</p>	<p>Granulating wounds. Prevents dressing adherence, bleeding or pain. Wounds requiring autolytic debridement. Minimally exudating wounds. Maintains wound moisture, decreasing need for frequent changes.</p>	<p>Monitor closely for infection during autolysis. Protect peri-wound skin from maceration with suitable barrier. Cross-hatch eschar to promote penetration of gel. Gel can be applied to gauze ribbon packing to fill deep areas and promote autolytic debridement . Secondary dressing is required to retain moisture, absorb excess drainage and to stabilize gels over wounds. Can be used in combination with transparent films, foams, hydrocolloids or other non-adherent cover dressing. Not advised for copiously draining wounds. Wear time varies from 1 to 3 days according to amount of drainage (read product monograph). Sheet gels can be cut to slightly larger than wound. Prevent contamination of opened product. Handle and discard according to the product monograph.</p>

Absorbent Dressings: Alginates

Examples	Description	Indications	Considerations
<p>ALGINATES Algisite CalciCare Curasorb Fibracol Kaltostat Melgisorb Seasorb Tegagen</p>	<p>Absorbs moderate to large amounts. Sheets or fibrous ropes of calcium sodium alginate. Seaweed derivative. Applied in dry state. As drainage is absorbed, it converts to a gelatinous mass. Hemostatic capabilities. Calcium and sodium interact to promote clotting. Non-adhesive. Fibracol contains collagen. Tegagen offers a choice of a high gelling or a high integrity product. Review product monograph and wound needs.</p>	<p>Wounds with visible depth requiring soft filler. Exudating wounds during autolytic debridement. Bleeding wounds. Post sharp debridement. Reduces the need for bulky dressings.</p>	<p>Remove residue by flushing with saline. If dressing dries and adheres due to decreased moisture, review product choices. Select alternative or extend wear time of alginate. Maximum wear time is 5 days. Requires moisture retentive cover dressing to avoid drying by evaporation. Occlusive cover dressings can enhance absorptive capabilities. Maintains wound cleansing in gel state. Low tensile strength. Do not use in a wound without a visible base.</p>

Absorbent Dressings: Hydrofibre, Hypertonic Gauze

Examples	Description	Indications	Considerations
<p>HYDROFIBRE Aquatec</p>	<p>Soft, non-woven fibrous sheet or packing strip of sodium carboxymethylcellulose. Highly absorbent.</p> <p>Apply dry. Converts to a solid gel when activated by moisture.</p> <p>Fibres maintain integrity in gel-state, facilitating intact removal. Non-adhesive. Vertically absorbs, contains drainage.</p>	<p>Pack wounds with a visible base.</p> <p>Supports debridement of exudating wounds.</p> <p>Prevents trauma to fragile wound tissue.</p> <p>Manages large amounts of drainage.</p> <p>Prevents leakage and peri-skin breakdown.</p> <p>Promotes comfort.</p> <p>Decreases dressing bulk.</p>	<p>Concentrates drainage.</p> <p>Dressing can extend beyond wound margin onto peri-skin.</p> <p>Flush to remove all residue.</p> <p>Product may slightly increase in size with absorbing action.</p> <p>Vertical absorption prevents maceration of peri-wound skin.</p> <p>Layering dressing increases absorption capability.</p> <p>Wear time is 1-4 days depending on volume of drainage.</p> <p>Tensile strength decreases when over-saturated.</p> <p>Not compatible with ointments or creams.</p> <p>Do not use in a wound without a visible base.</p>
<p>HYPERTONIC SALINE DRESSING Curasalt Mesalt Hypergel</p>	<p>Sheet, ribbon gauze, or gel impregnated with salt concentrate</p> <p>Product absorbs drainage, becoming an isotonic normal saline dressing.</p>	<p>Copiously draining wounds.</p> <p>Debridement of slough.</p> <p>Infected wounds.</p> <p>Consider gel for dry necrosis</p>	<p>Apply in a dry state to wound.</p> <p>May damage granulation tissue if drainage is minimal. Adequate wound drainage is essential to prevent dressing adherence or damage from concentrated salts.</p> <p>Evaluate for alternative product choice when drainage decreases or wound base becomes clean.</p> <p>May be painful for sensitive patient.</p> <p>Consider risk of loose fibres if cutting products.</p> <p>Moisture-retentive cover dressing is advised.</p>

Absorbent Dressings: Foams

Examples	Description	Indications	Considerations
<p>FOAMS Allewyn Cutinova Hydrasorb Lyofoam Extra Mepilex Polymem 3M Foam Tielle Biotain</p>	<p>Non-adherent polyurethane foam. Various thickness. Some are semi-occlusive and only for use as cover dressings. Others may be used to fill wound defect. Read product monograph. Bordered adhesive products may provide occlusion. Flexibility and moldability varies.</p>	<p>Absorbs small, moderate to copious amounts of drainage. Aesthetic cover dressing. Reduces dressing bulk. Protects peri-wound skin from irritation and maceration.</p>	<p>Product integrity is maintained despite copious discharge. Secure dressing with slight pressure to enhance absorption. May not support autolysis if drainage is minimal. Porous foams may not maintain moist wound base, requiring suitable cover dressing. Do not overpack the cavity products. Assure product has contact with wound base. Extend wear time as volume of drainage decreases to a maximum of 4 to 7 days. Maintain peri-wound skin with a protective barrier* if drainage is excessive. Some occlusive products facilitate odour containment. Foam dressings do not provide pressure relief. *See: Skin Barriers</p>

Absorbent Dressings: Composites, Odour Specific

Examples	Description	Indications	Considerations
<p>Antimicrobial Silver Agents: Acticoat Aquacel AG Contreet Actisorb</p> <p>Iodine Agents: Iodosorb</p>	<p>See Appendix M</p> <p>Please refer to manufacturer's product monograph.</p> <p>Superficial broad spectrum coverage, gram \pm, fungi, MRSA, & VRE.</p> <p>Cadexomer iodine in paste or ointment 0.9% slow-release.</p> <p>Changes from brown to yellow colour.</p>	<p>Critically colonized or infected wounds.</p> <p>Critically colonized or infected wounds</p>	<p>May be used in conjunction with systemic antibiotic.</p> <p>Expect to see discolouration in wound bed (graying)</p> <p>Maximum dose of iodosorb is 150 mg/week.</p> <p>Flush iodosorb to remove residue.</p>
<p>COMPOSITES CombiDERM CombiDERM ACD Tielle Exudry Versiva</p>	<p>Highly absorbent multi-layered island dressings.</p> <p>Inner layers absorb and retain drainage, preventing pooling at wound base.</p> <p>Combination of several products prevents lateral migration of drainage.</p>	<p>Copiously draining wounds.</p> <p>Maintains a moist wound environment.</p> <p>Aesthetic cover.</p> <p>Reduces dressing bulk.</p> <p>Improves integrity of macerated skin.</p>	<p>Non adherent to wound base.</p> <p>Wear time determined by volume of drainage (2-7 days).</p> <p>Patient independence is enhanced by ease of application.</p> <p>Some products are self-adhesive to skin.</p> <p>Adhesive styles may facilitate odour containment.</p>

Examples	Description	Indications	Considerations
<p>CHARCOAL Actisorb Plus CarboFLEX Carbonet Odour Absorbent Dressing</p>	<p>Activated charcoal in some products works by adsorption. Products containing odour absorbent charcoal layered within product. Ability to absorb odour varies. Some contain silver to enhance antibacterial capability. CarboFlex contains alginate and hydrofibre in the contact layer to also absorb drainage.</p>	<p>Actisorb adsorbs endotoxins. Any odorous wound during autolytic debridement.</p>	<p>Ensure underlying infection has been evaluated and treated, prior to use. Choose highly absorptive products when drainage is copious. Some products can be applied directly to the wound base. Other products become inactivated when wet. Ensure that dressing edges are sealed for maximum odour containment.</p>
<p>Skin Barriers</p>			
<p>LIQUID BARRIERS Coloplast ConvaCare No Sting Skin Gel Skin Prep Sween Others</p>	<p>Quickly drying liquid to provide a thin layer of skin protection. Durability varies. Some contain alcohol of variable amounts. Available as moistened wipes, applicators or spray.</p>	<p>Protects peri-wound skin from maceration, irritation or tape injury. Enhances adhesion of some cover dressings. Provide increased protection of peri-wound skin for scant to copious exudate.</p>	<p>Products containing alcohol can cause transient burning or stinging if skin is broken. Products without alcohol increases comfort and may be used on intact or broken skin. Allow product to dry before cover dressing is applied. Not for use on open wounds.</p>

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Appendix O: Offloading Devices

The selection of the appropriate device is based on the following considerations:

1. The ability to effectively remove all pressures from the ulcer site.
2. Cost effectiveness of the device.
3. Ease of use and/or skill required for the application of the device.
4. Characteristics of the diabetic ulceration.
5. The ability to encourage patient adherence.

Offloading Device	Advantages	Disadvantages
Total Contact Cast (TCC) <i>A well-molded minimally padded cast that maintains contact with the entire aspect of the foot and lower leg</i>	<ul style="list-style-type: none"> ■ Highest healing rates (gold standard) ■ Distributes pressure over the entire plantar surface ■ Completely offloads ■ Protects foot from infection ■ Controls edema ■ Maintains patient adherence as non-removable 	<ul style="list-style-type: none"> ■ Requires trained technician ■ Cannot assess foot on a daily basis ■ Affects sleeping and bathing ■ Exacerbate postural instability or cause poor balance ■ Cannot use if wound infected ■ Cannot be used in the neuro-ischemic limb
Scotchcast Boot <i>A fibreglass boot that reduces pressure over the wound</i>	<ul style="list-style-type: none"> ■ Lighter with high integral strength ■ Removable for examination ■ Can be non-removable for poorly adherent patients ■ Promotes continued ambulation 	<ul style="list-style-type: none"> ■ If removable – poor adherence ■ Has not yet been compared in studies to other forms of offloading for efficacy
Removable walker <i>A commercially available removable boot that reduces plantar pressures</i>	<ul style="list-style-type: none"> ■ Easily removable allowing wound inspection and treatment ■ Allows more comfortable bathing and sleeping ■ Can be used for infected wounds and superficial ulcers 	<ul style="list-style-type: none"> ■ Removable nature of cast reduces adherence ■ No clinical data to support its efficacy compared to TCC
Halfshoes <i>Offer support only under the rear and mid-foot</i>	<ul style="list-style-type: none"> ■ Inexpensive ■ Easy to apply 	<ul style="list-style-type: none"> ■ Less effective than TCC ■ Hampers gait
Healing Sandals <i>Application of a rigid rocker to the bottom of a shoe or sandal</i>	<ul style="list-style-type: none"> ■ Limit dorsiflexion therefore distributes pressure of metatarsal heads ■ Lightweight and stable ■ Reusable 	<ul style="list-style-type: none"> ■ Requires significant amount of time and experience to produce therefore not easily accessible ■ Not as efficient compared to other methods of offloading
Mabal Shoe <i>Cross between healing sandal and TCC</i>	<ul style="list-style-type: none"> ■ Removable (inspection) ■ Better contact with foot than healing sandal ■ Comparative rates of healing with TCC 	<ul style="list-style-type: none"> ■ Removable (reduces adherence) ■ Expertise required to make & apply
Felted Foam <i>Bilayered felted foam over the plantar surface with opening for the wound</i>	<ul style="list-style-type: none"> ■ Inexpensive ■ Accessible 	<ul style="list-style-type: none"> ■ Can produce pressure and shear at wound edges ■ No studies to suggest its efficacy in offloading
Crutches, Walkers, and Wheelchairs	<ul style="list-style-type: none"> ■ If used consistently will offload pressure ■ Rentable 	<ul style="list-style-type: none"> ■ Requires upper body strength and endurance ■ May not be used all the time ■ Difficulty in navigating indoors ■ Can increase pressures on contralateral side
Therapeutic Footwear Depth inlay shoes	<ul style="list-style-type: none"> ■ Beneficial in <i>preventing</i> ulcerations 	<ul style="list-style-type: none"> ■ No proof of efficacy in healing ulcers ■ Allow up to 900% more pressure in forefoot than TCC and removable walker

References:

- Armstrong, D. G. & Lavery, L. A. (1998a). Evidence-based options for offloading diabetic wounds. *Clinics in Podiatric Medicine and Surgery*, 15(1), 95-105.
- Armstrong, D. G, Lavery, L. A., Kimbriel, H. R., Nixon, B. P., & Boulton, A. J. M. (2003). Activity patterns of patients with diabetic foot ulceration: Patients with active ulceration may not adhere to a standard pressure offloading regimen. *Diabetes Care*, 26(9), 2595-2597.
- Armstrong, D. G., Nguyen, H. C., Lavery, L. A., Van Schie, C. H. M., Boulton, A. J. M., & Harkless, L. B. (2001). Offloading the diabetic foot wound: A randomized clinical trial. *Diabetes Care*, 24(6), 1019-1022.
- Armstrong, D. G., van Schie, C. H. M., & Boulton, A. J. M. (2001). Offloading foot wounds in people with diabetes. In D. L. Krasner, G. T. Rodehaver, & R. G. Sibbald (Eds.), *Chronic wound care: A clinical resource book for healthcare professionals*. (3rd ed.). (pp. 599-615). Wayne, PA: HMP Communications.
- Birke, J. A., Pavich, M. A., Patout Jr., C. A., & Horswell, R. (2002). Comparison of forefoot ulcer healing using alternative offloading methods in patients with diabetes mellitus. *Advances in Skin & Wound Care*, 15(5), 210-215.
- Fleischli, J. G., Lavery, L. A., Vela, S. A., Ashry, H., & Lavery, D. C. (1997). Comparison of strategies for reducing pressure at the site of neuropathic ulcers. *Journal of the American Podiatric Medical Association*, 87(10), 466-472.
- Inlow, S., Kalla, T. P., & Rahman, J. (1999). Downloading plantar foot pressures in the diabetic patient. *Ostomy/Wound Management*, 45(10), 28-38.
- Knowles, E. A., Armstrong, D. G., Hayat, S. A., Khawaja, K. I., Malik, R. A., & Boulton, A. J. M. (2002) Offloading diabetic foot wounds using the scotchcast boot: A retrospective study. *Ostomy/Wound Management*, 48(9), 50-53.
- Zimny, S., Schatz, H., & Pfoh, U. (2003). The effects of applied felted foam on wound healing and healing times in the therapy of neuropathic diabetic foot ulcers. *Diabetes Medicine*, 20 622-625.

Appendix P:

Resources for Diabetic Foot Ulcer Information

The following websites provide information on diabetic foot ulcers. These are examples only and are not intended to be a comprehensive listing.

Organizations

- American Academy of Wound Management – www.AAWM.org
- American Academy Wound. Net – www.Wound.net
- American Physical Therapy Association – www.APTA.org
- Association for the Advancement of Wound Care – www.AAWC1.com
- Australian Wound Management Association – www.AWMA.com.au
- Canadian Association of Enterostomal Therapy – www.CAET.ca
- Canadian Association of Wound Care – www.CAWC.net
- Centres for Disease Control – www.CDC.gov
- IDF Consultative Section on the Diabetic Foot/IWGDF – www.diabetic-foot-consensus.com
- Journal of Wound Care – www.journalofwoundcare.com
- National Coalition of Wound Care – linked to AAWC
- Tissue Viability Society – www.TVS.org.uk
- Wound Care Information Network – www.medicaledu.com/wndguide.htm
- Wound Healer – www.woundhealer.com
- Wound Healing Society – www.woundheal.org
- Wound, Ostomy & Continence Nurses Society – www.WOCN.org

Corporations

- Carrington – www.carringtonlabs.com
- Coloplast – www.us.coloplast.com
- Convatec – www.convatec.com/en-ca
- Hollister – www.hollister.com
- ICN – www.icncanada.com
- Johnson & Johnson – www.jnjgateway.com
- Kendall – www.kendallhq.com
- 3M – www.mmm.com or www.3m.com
- Molnlycke – www.molnlycke.com
- Smith & Nephew – www.wound.smith-nephew.com/ca-en/wound

Essential Services for Pressure Offloading

- **Orthotic fabrication**
custom-made, adjustments, braces, aircast or TCC

- **Regular shoe fitting**
width fittings, comfort laced walking shoes

- **Specialty shoe fitting**
deep toe box, post-op boots, custom made shoes

- **Shoe modification**
rocker sole, sole widening

- **Assistive devices**
canes and walkers, hosiery, heel protectors

Service Providers

- **Pedorthists**
 - orthotics, shoes, shoe mods
 - Canada: www.pedorthic.ca
 - U.S.: www.pedorthics.org

- **Orthotists**
 - orthotics, braces, TCC, shoe mods
 - Canada: www.pando.ca
 - U.S.: www.oandp.org

- **Chiropodists/Podiatrists**
 - orthotics, soft tissue management
 - Ontario: www.cocoo.on.ca
 - Canada: www.podiatrycanada.org

- **Occupational Therapists**
 - assistive devices, orthotics
 - Canada: www.caot.ca
 - U.S.: www.aota.org



Appendix Q: Description of the Toolkit

Toolkit: Implementation of Clinical Practice Guidelines

Best practice guidelines can only be successfully implemented if there are: adequate planning, resources, organizational and administrative support as well as appropriate facilitation. RNAO, through a panel of nurses, researchers and administrators has developed the *Toolkit: Implementation of Clinical Practice Guidelines* based on available evidence, theoretical perspectives and consensus. The *Toolkit* is recommended for guiding the implementation of any clinical practice guideline in a healthcare organization.

The *Toolkit* provides step-by-step directions to individuals and groups involved in planning, coordinating, and facilitating the guideline implementation. Specifically, the *Toolkit* addresses the following key steps in implementing a guideline:

1. Identifying a well-developed, evidence-based clinical practice guideline
2. Identification, assessment and engagement of stakeholders
3. Assessment of environmental readiness for guideline implementation
4. Identifying and planning evidence-based implementation strategies
5. Planning and implementing evaluation
6. Identifying and securing required resources for implementation

Implementing guidelines in practice that result in successful practice changes and positive clinical impact is a complex undertaking. The *Toolkit* is one key resource for managing this process.

The *Toolkit* is available through the Registered Nurses' Association of Ontario. The document is available in a bound format for a nominal fee, and is also available free of charge from the RNAO website. For more information, an order form or to download the *Toolkit*, please visit the RNAO website at www.rnao.org/bestpractices.



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Nursing Best Practice Guideline

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