Foundations of Best Practice for Skin and Wound Management

BEST PRACTICE RECOMMENDATIONS FOR THE

Prevention and Management of Wounds

Click to go to . . .

Heather L. Orsted RN BN ET MSc

David H. Keast BSc MSc Dip Ed MD CCFP FCFP

Louise Forest-Lalande RN MEd ET

Janet L. Kuhnke RN BA BScN MSc ET

Deirdre O'Sullivan-Drombolis BScPT MClSc (Wound Healing)

Susie Jin RPh CDE CPT CGP

Jennifer Haley BMSc MSC

Robyn Evans BSc MD CCFP IIWCC

WoundsCANADA.ca

The best practice recommendation articles are special publications of *Wound Care Canada*. Together they form the Foundations of Best Practice for Skin and Wound Management, an online resource available for free download from the Wounds Canada website (woundscanada.ca).

These 2017 updates build on the work of previous author teams and incorporate the latest research and expert opinion.

We would like to thank everyone involved in the production of past and present versions of these articles for their hard work, diligence and rigour in researching, writing and producing these valuable resources.

Executive Editor: Sue Rosenthal
Project Editor: Heather L. Orsted
Editorial Assistant: Katie Bassett
Copy Editor: Jessica Rezunyk

Art Direction and Layout: Robert Ketchen
Photo Researcher: Joanne Crone

woundscanada.ca
info@woundscanada.ca

Last updated 2018 01 22.

Foundations of Best Practice for Skin and Wound Management

BEST PRACTICE RECOMMENDATIONS FOR THE Prevention and Management of Wounds

Heather L. Orsted RN BN ET MSc

David H. Keast BSc MSc Dip Ed MD CCFP FCFP

Louise Forest-Lalande RN MEd ET

Janet L. Kuhnke RN BA BScN MSc ET

Deirdre O'Sullivan-Drombolis BScPT MClSc (Wound Healing)

Susie Jin RPh CDE CPT CGP

Jennifer Haley BMSc MSC

Robyn Evans BSc MD CCFP IIWCC

WoundsCANADA.ca

Introduction

Introduction

Wound prevention and management can be challenging, particularly when the patient is living with complicating factors that may increase the risk of new wounds or prolong the healing of existing wounds. However, by using the following three guiding principles, health-care professionals can support optimal prevention and management of skin breakdown:

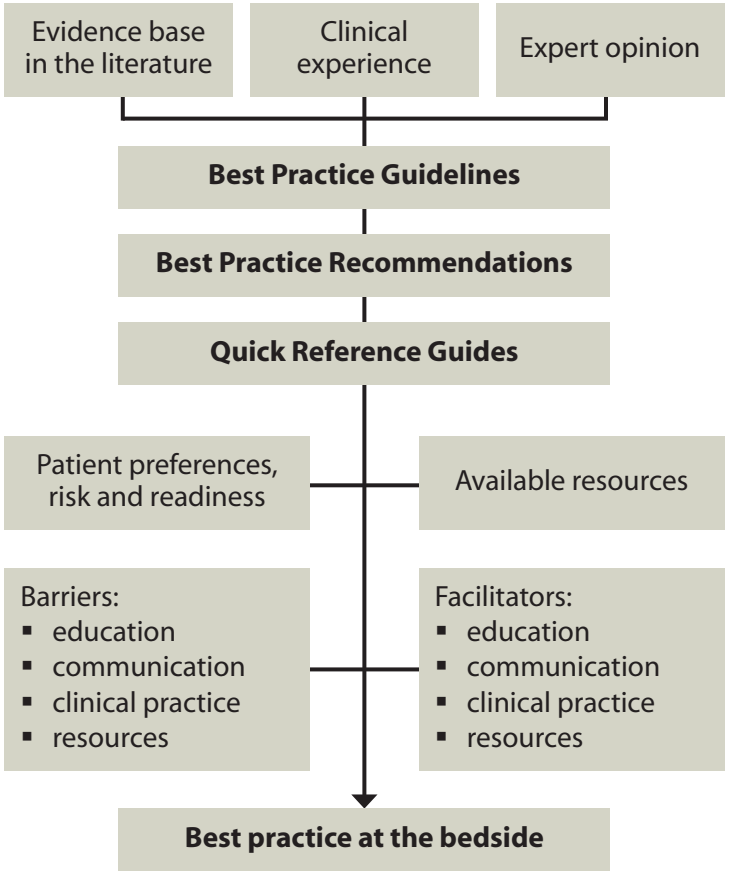
1. the use of a logical and systematic approach, regardless of the specifics, to prevent and manage skin breakdown
2. the constant, accurate and multidirectional flow of meaningful information with the team and across care settings
3. the patient as the core of all decision making

This article, made available by Wounds Canada, outlines a process—or series of consecutive steps—that supports patient-centred care. These steps are organized into a scheme labeled the Wound Prevention and Management Cycle, which guides the clinician through a logical and systematic method for developing a customized plan for the prevention and management of wounds, from the initial assessment to a sustainable plan targeting self-management for the patient.

Pathway to Best Practice

Additional best practice recommendation (BPR) articles on specific wound-related etiologies have evolved from this new and revised framework and can be found on the Wounds Canada website. It is important to note that none of these best practice recommendation articles are intended to serve as clinical practice guidelines. Instead, they organize the existing evidence (found in national and international guidelines as well as in other articles and the latest research) into succinct practice articles and bedside enablers (the Quick Reference Guides, or QRGs). Figure 1 outlines the process of moving from evidence and experience through the development of guides and enablers to best practice at the bedside. It also provides examples of influencing factors in the process.

Figure 1: Pathway to Best Practice[1]



A Best Practice Approach

Health-care professionals must recognize that many internal and external stressors can affect the prevention and healing of wounds. Personal health, the environment and the context in which patients live all impact skin integrity and wound healing. Available local and regional resources also contribute to skin health and wound healing. Ultimately, the body must heal itself, so the purpose of the health-care team is to optimize the body's ability to prevent or heal a wound. Assessments must identify all relevant factors, while interventions must acknowledge and align with a patient's culture and values. This approach, which treats patients as experts in their own lives, assists in the development of attainable goals of care and supports self-management once the patient leaves the care setting.

Effective use of the Wound Prevention and Management Cycle will take all factors into account and will result in a more complete, patient-focused, sustainable process.

This article presents the importance of using the Wound Prevention and Management Cycle in a number of ways:

- in a visual format outlining the five steps (Figure 2)
- as a quick-reference guide (QRG) summarizing the steps and recommendations (Table 1)
- through an in-depth and detailed discussion of the steps and recommendations incorporating the supporting evidence (beginning on page 11)

Figure 2: The Wound Prevention and Management Cycle

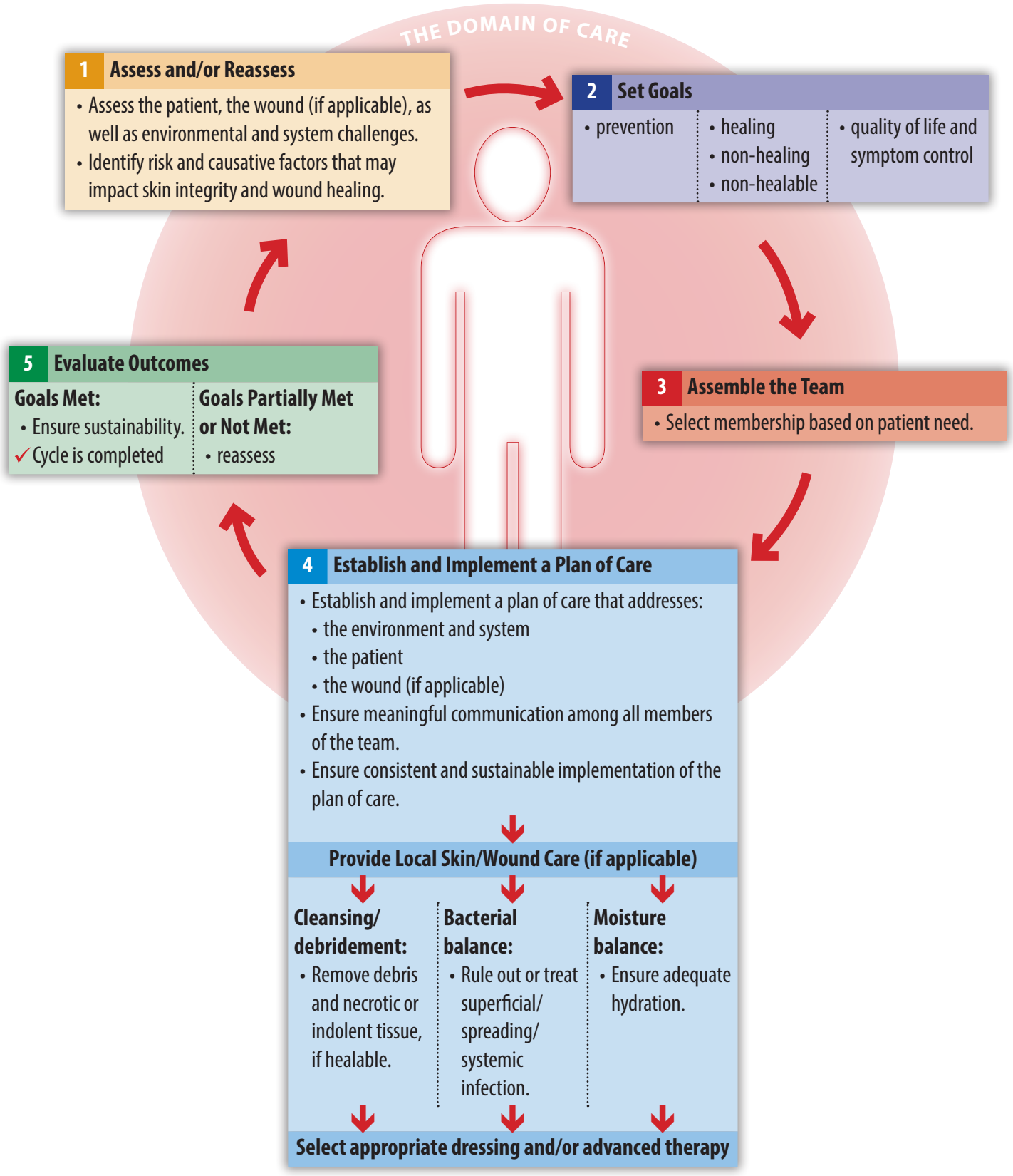


Table 1: Wound Prevention and Management Quick Reference Guide
Recommendations Associated with the Five Steps in the Wound Prevention and Management Cycle

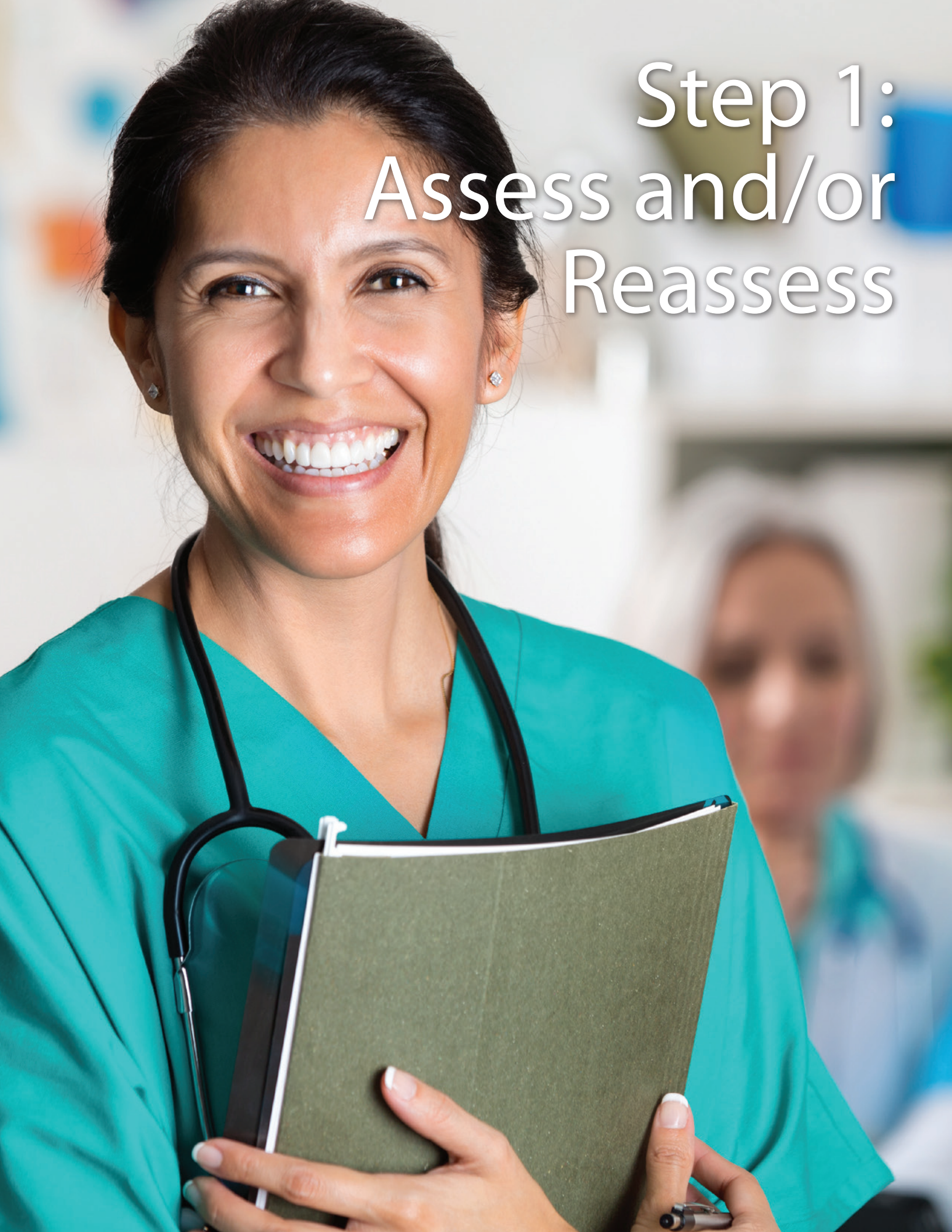
Step		Recommendation	Evidence
1	**Assess and/or Reassess**	1.1 Select and use validated patient assessment tools. 1.2 Identify risk and causative factors that may impact skin integrity and wound healing. 1.2.1 Patient: Physical, emotional and lifestyle 1.2.2 Environmental: Socio-economic, care setting, potential for self-management 1.2.3 Systems: Health-care support and communication 1.3 Complete a wound assessment, if applicable.	Ia – IV Ia – IV Ia – IV
2	**Set Goals**	2.1 Set goals for prevention, healing, non-healing and non-healable wounds. 2.1.1 Identify goals based on prevention or healability of wounds. 2.1.2 Identify quality-of-life and symptom-control goals.	Ia – IV
3	**Assemble the Team**	3.1 Identify appropriate health-care professionals and service providers. 3.2 Enlist the patient and their family and caregivers as part of the team. 3.3 Ensure organizational and system support.	IV IV IV
4	**Establish and Implement a Plan of Care**	4.1 Identify and implement an evidence-informed plan to correct the causes or co-factors that affect skin integrity, including patient needs (physical, emotional and social), the wound (if applicable) and environmental/system challenges. 4.2 Optimize the local wound environment aided through 4.2.1 Cleansing 4.2.2 Debriding 4.2.3 Managing bacterial balance 4.2.4 Managing moisture balance 4.3 Select the appropriate dressings and/or advanced therapy. 4.4 Engage the team to ensure consistent implementation of the plan of care.	IV Ia – IV Ia – IV Ia – IV
5	**Evaluate Outcomes**	5.1 Determine if the outcomes have met the goals of care. 5.2 Reassess patient, wound, environment and system if goals are partially met or unmet. 5.3 Ensure sustainability to support prevention and reduce risk of recurrence.	IV Ib – IV IV

These recommendations are based on the best available evidence and are intended to support the wound-care clinician and team in planning and delivering the best clinical practice. Each recommendation is supported by the level of evidence employed by the Registered Nurses' Association of Ontario (RNAO) guideline development panels (Table 2).

Table 2: Levels of Evidence[2]

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
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

Used with kind permission from the Registered Nurses' Association of Ontario.



Step 1: Assess and/or Reassess

Step 1: Assess and/or Reassess

Assessment occurs, in part, to determine the causes and factors that may impact skin integrity and wound healing. Patient assessment includes history and current health status (physical, emotional and lifestyle); skin status (and wound if applicable); environmental factors such as socio-economic status, culture, care setting, access to services and system factors such as government policies, support and programs. If, after the cycle has been completed and goals of care have not been fully met, reassessment must take place, followed by the rest of the Wound Prevention and Management Cycle steps.

Discussion: Maintenance of healthy skin in health-care settings has become an Accreditation Canada Quality-of-Care Indicator.[3] A standard for early identification of those at risk for skin breakdown to support prevention is now required for most health-care settings. Clinicians must be aware of the risk factors (physical, psychosocial, environmental, cultural and systemic) that can lead to skin breakdown or interfere with healing should breakdown occur.[4,5] Through the use of standardized admission protocols and comprehensive assessment tools, clinicians, patients and their caregivers can develop effective plans for care. Patients need to be encouraged not only to be the object of these assessments but also to become active participants in the assessment process.

Recommendations

1.1 Select and use validated patient assessment tools.

Discussion: Patient assessment tools discriminate between individuals on the basis of parameters that are designed to predict the likelihood or risk of future development of an outcome (such as a pressure injury) or to measure the amount of change that occurs over time (such as wound healing).[6] When choosing assessment tools, decision makers must first decide what the purpose of the tool is. Once the purpose of a tool has been identified, the tool should be reviewed to ensure that the following components have been addressed:

1. Content validity: Assesses the degree to which the assessment tool measures what it was designed or intended to measure.
2. Concurrent validity: Assesses the extent to which the results of the tool correspond to previously measured results.
3. Intra-rater reliability: Assesses the degree to which the assessment tool will give the same user consistent results time after time in different situations.[7]
4. Inter-rater reliability: Assesses the degree to which the assessment tool will provide agreement among different users in their assessment decisions.[8,9]
5. Predictive validity: Assesses how specific and sensitive the tool is. Sensitivity, or the true positive rate, measures the percentage of positives that are correctly identified and the percentage of negatives that are correctly identified. Specificity (true negative rate) measures the proportion of negatives that are correctly identified as such.
6. Responsiveness to change: If the tool is being utilized to evaluate outcomes, an additional component is required: responsiveness to change. This is a domain of validity and indicates whether or not a tool is able to detect meaningful change over

time. A tool that has been deemed valid has not necessarily been investigated for an ability to detect change. Responsiveness needs to be addressed specifically.

Once chosen, the same assessment tools should be used in subsequent assessments for ongoing comparison.

The use of both validated and standardized patient assessment and risk assessment tools is essential for not only identifying risk for altered skin integrity and providing common communication terms but also for providing a template for preventative care or management. In their investigation of 14 wound assessment tools, Greatrex and Moxey stated that even though a tool has benefit(s), it cannot be a substitute for clinical knowledge and expertise.[10]

Examples of tools to identify the risk for skin breakdown:

- Braden Scale for Predicting Pressure Sore Risk has undergone rigorous evaluation and meets the standards outlined above.[6,11]
- Inlow 60-Second Diabetic Foot Screen has undergone rigorous evaluation and meets the standards outlined above.[6,12]
- Waterlow Scale has demonstrated poor inter-rater reliability, high sensitivity and low-specificity levels.[13]

Examples of tools to identify risk for pediatric skin breakdown:

Baharestani et al. reported that 10 risk assessment scales exist for babies and children but only three have been tested for sensitivity and specificity: Braden Q, Glamorgan Scale and Neonatal Skin Risk Assessment Scale (NSRAS).[14]

Table 3: Risk Assessment Tools

	BRADEN	WATERLOW	INLOW	BRADEN Q	GLAMORGAN	NSRAS
Content Validity	+	+	+	+	+	+
Concurrent Validity	0	0	0	0	0	0
Predictive Validity	+++	++	+++	+++	++	++
Intrarater Reliability	++	++	+	++	+	+
Interrater Reliability	++	+	+	++	++	+
Responsiveness	0	0	0	0	0	0

Key: 0 = not available
+ = weak
++ = fair
+++ = strong

Links to Risk Assessment Tools

- Braden Scale: www.bradenscale.com/
- Inlow's 60 Second Diabetic Foot Screen: http://cawc.net/en/index.php/resources/60-second-diabetic-foot-screen/
- Waterlow: www.judy-waterlow.co.uk/the-waterlow-score-card.htm
- Braden Q: www.med.cmu.ac.th/hospital/nis/km/cops/knowledge/2846braden%20scale%20for%20neonates%20and%20infants.pdf
- Glamorgan: www.rch.org.au/uploadedFiles/Main/Content/rchcpg/Revised_Glamorgan_Reference_Guide.pdf
- NSRAS[14]: www.ncbi.nlm.nih.gov/pubmed/9423386

Examples of tools to assess the wound:

- Bates-Jensen Wound Assessment Tool (BWAT)[16] formerly known as the Pressure Sore Status Tool (PSST)
- The Leg Ulcer Measurement Tool (LUMT)[17]
- Pressure Ulcer Scale for Healing (PUSH) tool has been validated for use in all wound types.[18]
- The Photographic Wound Assessment Tool (PWAT) has been found to be very responsive to change and can be used as a bedside tool as well as to assign a score to a photograph of a wound.[19]

Table 4: Wound Assessment Tools

	PUSH	PWAT	LUMT	BWAT/PSST
Content Validity	+	0	+++	+++
Concurrent Validity	++	++	++	++
Predictive Validity	0	0	0	0
Intrarater Reliability	++	+++	++	+++
Interrater Reliability	++	+++	++	+++
Responsiveness	+++	+++	+++	0

Key: 0 = not available
+ = weak
++ = fair
+++ = strong

Links to Wound Assessment Tools

- Bates Jensen Wound Assessment Tool: http://ltctoolkit.rnao.ca/resources/assessment-tools/rnaos-bates-jensen-wound-assessment-tool-bwat
- Leg Ulcer Measurement Tool: http://pda.rnao.ca/sites/pda/files/images/legulcrmesr.pdf
- Pressure Ulcer Scale for Healing: www.npuap.org/wp-content/uploads/2012/02/push3.pdf
- The Photographic Wound Assessment Tool (PWAT): www.southwesthealthline.ca/healthlibrary_docs/B.9.3c.PWATResources.pdf

Examples of tools to assess pain:

- The Visual Analogue Scale (VAS)
- Numeric Rating Scale (NRS)
- Verbal Rating Scale (VRS)
- McGill Pain Questionnaire (PRQ)
- Faces, Legs, Activity, Cry and Consolability (FLACC)
- Faces Pain Scale-Revised (FPS-R)
- NOPPAIN
- Pain diary

Links to Pain Assessment Tools

- Visual Analog Scale (VAS). Systematic Review: www.physio-pedia.com/Visual_Analogue_Scale
- Numeric Rating Scale (NRS): www.rehabmeasures.org/PDF%20Library/Numeric%20Pain%20Rating%20Scale%20Instructions.pdf
- Verbal Rating Scale (VRS): www.jpsmjournal.com/article/S0885-3924(11)00014-5/abstract
- McGill Pain Questionnaire: www.npcrc.org/files/news/mcgill_pain_inventory.pdf
- Face, Legs, Arms, Cry, and Consolability (FLACC) (for newborn to age 3): http://wps.prenhall.com/wps/media/objects/3103/3178396/tools/flacc.pdf
- Non-Communicative Patient's Pain Assessment Instrument (NOPPAIN): http://prc.coh.org/PainNOA/NOPPAIN_Tool.pdf
- Wong-Baker FACES Scale: www.wongbakerfaces.org/public_html/wp-content/uploads/2014/01/Wong-Baker-FACES%C2%AE-Qualities.pdf
- A pain scale tool is available for neonates: https://www.uwhealth.org/health-facts/parenting/7711.pdf

Examples of tools to assess quality of life (QoL) and health-related quality of life (HRQoL):

- The Cardiff Wound Impact Schedule[20] is a validated questionnaire that measures the impact of chronic wounds (leg ulcers and diabetic foot ulcers) on patient HRQoL and identifies areas of patient concern.
- The Wound-QoL is a tool to assess quality of life in those with chronic wounds.[21]
- The Freiburg Life Quality Assessment is a wound module to measure disease-specific, health-related quality-of-life parameters in patients with chronic wounds.[22]

Links to QoL Tools

- Cardiff Wound Impact Schedule: www.ncbi.nlm.nih.gov/pubmed/16722893
- Wound-QoL: www.ncbi.nlm.nih.gov/pubmed/24899053
- Freiburg Life Quality Assessment: www.ncbi.nlm.nih.gov/pubmed/15197001

Nutritional Screening Tool:

- The Canadian Nutrition Screening Tool[23] is a simple two-question screen with good sensitivity and specificity to predict adverse outcomes.

Link to Canadian Nutritional Screening Tool:

- http://nutritioncareincanada.ca/resources/

1.2 Identify risk and causative factors that may impact skin integrity and wound healing.

Discussion: The multi-factorial nature of physical and environmental factors that affect skin integrity and wound healing requires clinicians to become detectives in order to identify various elements that may impact their patients. Ideally, clinicians need to recognize the key risk factors that may either lead to or cause skin breakdown so that prevention strategies become the priority, rather than waiting until skin breakdown has occurred and wound management strategies are required.

1.2.1 Patient: Physical, emotional and lifestyle

Discussion: Assessments begin with a systematic and detailed history of the patient's general health and specific issues related to the skin condition from the patient, caregiver or previous medical records. Patient co-morbidities that increase the risk for skin breakdown, interfere with healing and/or impair immunity should be identified.[24] These include, among others, diabetes mellitus, advanced age, peripheral arterial disease, obesity, collagen vascular diseases (lupus, scleroderma, dermatomyositis), organ transplants, cancer, chemotherapy and therapeutic radiation.[25]

"Listen, look, then touch" (hands-on examination) is a common approach used by health-care professionals to establish a framework for assessment.

Listen

Clinicians must let the patient tell their story to help identify what puts them at risk for wounds or how their wound developed. They can describe how it started, how it evolved, what has made it better and what has made it worse. Clinicians should always listen to the patient's perception of what is happening and how it is affecting their quality of life.

Important information the clinician needs to gather in their assessment includes:

- overall health: changes in height or weight, existing co-morbidities, as well as family history
- information on drug history and known allergies and sensitivities; anticoagulants, chemotherapeutic drugs, immunosuppressive agents and anti-inflammatories/steroids; any other medications or drugs, including over-the-counter medications (OTCs) or natural supplements
- lifestyle choices such as smoking, substance abuse, level of physical activity, high-risk activities, topical medications and skin care products
- level of physical function, including mobility, gait, fatigue, eyesight, hearing, activities of daily living, use of assistive devices
- hydration and nutrition
    - functional capacity: degree to which the patient can access affordable food (activities of daily living), eat food (dentures or mouth sores) and feed themselves (eating support, activity/mobility issues)
    - appetite: related to social factors (such as smells or emotions) or diminished activity level, pain
- psychological factors such as anxiety, stress, depression, "diabetes-distress" and pain, which are all associated with delayed wound healing[26]
- psychosocial factors, including motivation of the patient/family/caregivers; social supports and coping mechanisms; culture and traditions; past adherence to treatment modalities; behavioural conditions affecting ability to participate in self-care and cognitive ability to understand and retain information and instructions

A Special Word on Pain

A systematic approach is required to assess the factors that are causing or exacerbating pain.[27] A standard pain assessment should be considered before and after physical activities and other aspects of patient care, medication or treatment.[28] There are two types of pain: nociceptive (an appropriate physiological response to painful stimuli, either acute or chronic) and neuropathic (an inappropriate response caused by a primary lesion or dysfunction in the nervous system). Pain is often associated with local wound care factors such as dressing changes, debridement, infection and lack of moisture balance. At dressing changes, pain can be caused by the dressing material adhering to the wound base.[29]

Psychosocial factors such as age, sex, culture and traditions, anxiety and depression, as well as environmental factors such as resources and the setting and timing of the procedure can all affect the patient's unique pain experience. Describing pain and monitoring the impact of management strategies for pain control begins by listening to how the patient describes the pain. Pain is consistently reported by patients as one

of the worst aspects of living with chronic wounds, often with a significant impact on their quality of life.

Chronic, persistent pain between dressing changes, even at rest, also occurs. This type of pain can be precipitated by periwound contact-irritant skin damage from enzyme-rich wound exudates.[27]

A number of studies have validated the deleterious impact of pain and related stress on wound healing.[29,30] Time to achieve complete wound closure is significantly prolonged for chronically stressed individuals.[31]

Some older adults live with numerous complicating factors such as sensory deficits and cognitive impairments so when assessing pain in the older adult population, simply worded questions and visual tools that can be easily understood may be the best approach. The use of open-ended questions will provide a clearer understanding of the person's pain experience. Instead of asking "Do you have pain?" a better approach might be "Describe your pain." Subjective tools such as the Visual Analogue Scales (VAS) and the Faces Scale are highly effective for this population and for those with language barriers. Young children benefit from the use of the Faces, Legs, Activity, Cry and Consolability (FLACC) pain scale, which is completed through visual and behavioural assessment by the clinician.

Changes in pain levels may indicate a need to reassess the choice and timing of analgesics and/or other interventions used in pain management.[32]

Pain can also be anticipatory and can lead to anxiety.

A Special Word on Quality of Life

Quality of life, or QoL, refers to all aspects of patients' lives, including where they live, how they live, how they work and how they play. It encompasses life factors such as family circumstances, culture, finances, spiritual care, housing, job and employment opportunities and satisfaction.

Health-related quality of life, or HRQoL, usually refers to aspects of patients' lives that are dominated or significantly influenced by mental or physical wellbeing.[33]

Look

What should a clinician see when looking at a patient? Observation begins as soon as the patient enters the room. An overall impression of a patient can reveal a lot about the individual; body language, affect, style of interaction with family members or caregivers, demeanour and more all contain vital clues about the patient's physical condition, state of mind and social supports. Clothing and footwear or other medical or assistive devices may affect skin integrity, cause pressure or be made out of irritating or non-breathable materials that may impact skin health and wound healing.

Only after looking at the entire person and investigating anything of note should the clinician move on to a full skin assessment. A skin assessment, including appendages, requires observation from head to toe. The clinician should:

- Assess skin and mucous membranes for colour, moisture, temperature, texture, mobility, turgor and the presence of lesions.
  - Dehydrated skin, which feels dry and tight, appears dull with diminished turgor and is often the result of over-cleansing.
  - Maceration causes skin to be soft and it may break down due to prolonged exposure to moisture. Maceration can be caused by the presence of excessive amounts of fluids—such as sweat, saliva, wound drainage, urine or stool—remaining in contact with the skin for extended periods.
- Look for bruising and altered or broken skin, which could indicate bleeding disorders, injury, pressure injuries (areas of pressure) or signs of neglect/abuse.
- Check for red, shiny skin on the lower legs that blanches with elevation, which could indicate insufficient arterial flow and/or perfusion.
- Assess for lower leg edema as it can impair healing; a diagnosis of a venous and/or lymphatic disorder must be based on clinical parameters and rule out systemic conditions such as congestive heart failure.
- Check nails for thickness, splitting, discoloration, breaking and separation from the nail bed.
- Assess hair for distribution and condition and the scalp for lesions and infestation.
- Check for perineal/perianal inflammation, rash, persistent redness, pain and itching that could be indicative of incontinence.
- Inspect all skin folds for moisture, signs of redness and potential yeast infection.
- Assess for signs of pressure, friction and shear that could be damaging to skin integrity. Particular care should be taken in patients with or suspected of impaired sensation related to either central or peripheral nerve function or that induced by medication.

Touch

Not everything can be seen or heard, and contact needs to occur with the patient through strategies that may involve contact or blood work.

- If limbs are cool to touch, pulses are difficult to feel or there is a concern for vascular impairment in the history, an arterial assessment should be scheduled.
- If pitting lower leg edema is present it may be appropriate for a duplex ultrasound to be arranged to assess for venous reflux. If edema of the extremities is extending to fingers and toes, other causes of edema such as congestive heart failure must be investigated.[34]
- Changes in nutritional status can alter skin structure and function, putting it at risk for trauma. It is important for clinicians to screen for nutritional status if there is a suspicion that pre-albumin or serum albumin levels are low; levels below 30 g/L delaying healing and those below 20 g/L often signify any wounds present will be non-healable.[35]

- Anemia with hemoglobin levels below 100g/L can cause delayed wound healing. Levels below 70 to 80g/L may lead to very hard-to-heal or non-healing wounds.[36]

Note: A fear of being touched during a health assessment could indicate anything from the presence of pain to a history of sexual assault, providing the clinician with another clue about the patient's status that can be investigated.

1.2.2 Environmental: Socio-economic, care setting, potential for self-management

Discussion: An environmental assessment is imperative to determine if the patient has socio-economic support to meet any goals of care that will be set.

Socio-economic determinants that should be assessed include:[37]

- income
- employment and working conditions
- food security
- environment and housing
- early childhood development
- education and literacy
- social support and connectedness
- health behaviours
- access to health care

Those with very low total incomes often lack resources and access to nutritious food, adequate housing and safe physical environments such as accessible walking paths and adequate lighting. Any of these factors can negatively impact health. Financial and life stress can have health consequences such as high blood pressure and immune and circulatory complications.

In general, those with adequate income and employment are likely to have better health, particularly if they feel they have control and influence over decision-making in the home, at work and in social settings.

Increased exposure to stress, as well as a lack of resources, coping strategies, skills, social support and connection to the community can contribute to potentially harmful coping skills such as smoking, over-consumption of alcohol and unhealthy eating habits.

1.2.3 Systems: Health care support and communication

Discussion: The collective health of Canadians has a significant impact on economic performance and the health-care system. Systems assessment considers access to funding, availability of services and wound-related products, diagnostic services, service delivery personnel and co-ordination of care, all of which vary considerably from one province/territory to another and also from region to region or even one service delivery site to another (for example, from acute care to home care). Therefore, standards relating to assessment and care need to be based on available regional resources. For example, negative pressure wound therapy might not be available in all regions or all sectors of care.

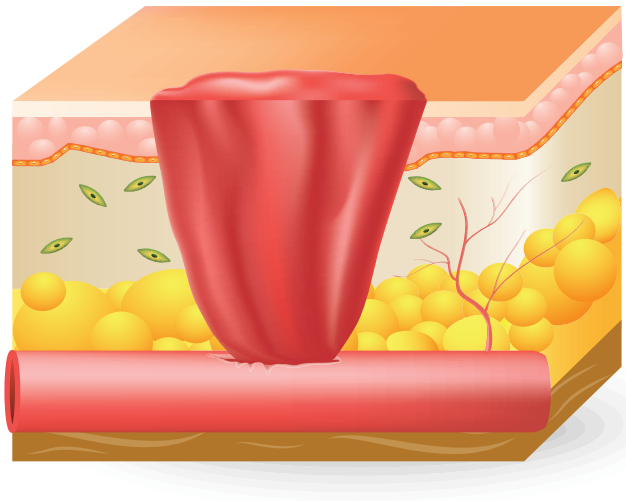
1.3 Complete a wound assessment, if applicable.

Discussion:

Determine the Extent of Injury

Examine the wound if present, including the impact of trauma, depth or degree of injury, presence of any foreign bodies and quality of the wound bed, including presence of necrotic tissue, moisture balance and bacterial burden. The degree of skin trauma or injury is usually described by the thickness of the injury, however, bruising, induration, bogginess and changes to skin turgor can indicate deep tissue damage without a break in the skin (see Figures 3 and 4).

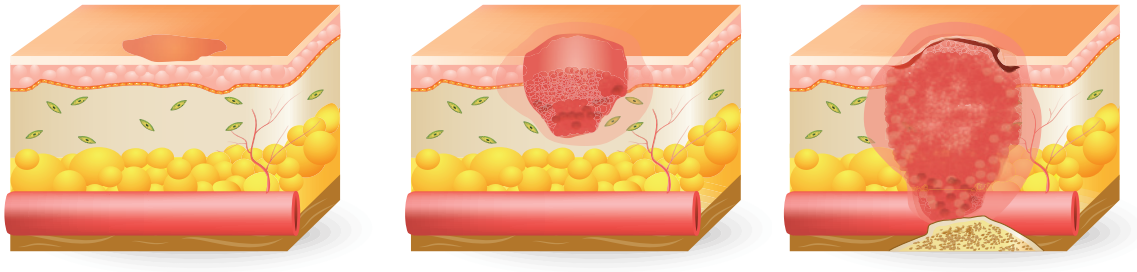
Figure 3: Deep Tissue Damage



Drawing licensed from iStock

Superficial-thickness skin loss involves only the epidermis and may present as an abrasion or blister. Partial-thickness skin loss involves the epidermis or dermis (or both) and may present as a shallow crater. Full-thickness skin loss is the result of extensive destruction, tissue necrosis or damage to underlying structures such as muscle, tendon or bone. It may present as a deep crater and may tunnel into surrounding subcutaneous tissue.[5]

Figure 4: Depth of Injury



Drawing licensed from iStock. Adapted.

Superficial thickness | Partial thickness | Full thickness

Note: Pressure injuries, diabetic foot ulcers, surgical wounds, burns and skin tears employ specific wound staging, categorization or classification systems to describe injury. See the individual best practice recommendation articles for discussions on these systems on the Wounds Canada website.

Enabler

The MEASURE mnemonic (www.sjhc.london.on.ca/sites/default/files/pdf/wound_measure.pdf) provides a memory aide to assist the clinician when completing a wound assessment. It addresses: Measure (length, width, depth, and area), Exudate (quantity and quality), Appearance (wound bed, including tissue type and amount), Suffering (pain type and level), Undermining (presence or absence), Re-evaluate (monitoring of all parameters regularly) and Edge (condition of edge and surrounding skin).[41] The MEASURE mnemonic and others may be useful but it is important to note that not all mnemonics translate well in a multilingual environment.

Determine Wound-healing Status

Determining wound-healing status is different from determining the degree of trauma. A standardized approach to wound assessment and documentation of the wound's progress is essential to determine whether the wound is closing in an orderly and expected sequence of healing based on the patient and their risks.[38–40] The use of a validated assessment tool is crucial, particularly when there are multiple caregivers. Assessment needs to be consistently completed and documented in the patient record and shared with other members of the care team.

There are many components of wound assessment and many validated assessment tools available (see assessment tools in section 1.1). Common assessment parameters include: wound size, depth, edges, undermining, induration, exudate, peripheral edema, periwound skin, odour, wound pain and tissue type: granular, slough, necrotic.

Assessments may be quantified and qualified based on the assessment tool used. It is important to ensure that it is the wound being assessed and not the dressing debris.

Assessing the Wound

Typically, a healing wound has granular tissue that is pale pink to beefy red, is glistening and has a rough surface due to blood vessels and collagen deposits. Often there is yellow tissue in the wound, which can be confusing to the clinician and can impact intervention decisions. Yellow tissue that is stringy and non-adherent to the wound bed may be slough (non-viable tissue), while firmly attached yellow tissue may be fibrinous tissue and a precursor to granular tissue, which indicates normal healing.[5] Eschar is the hardened or soft black crust of necrotic tissue that may form over the wound and may interfere with healing and may be a source for bacterial growth.

Assessing Bacterial Balance

Bacteria are normally found on skin and in a wound. These bacteria may or may not cause problems for the patient, depending on a number of conditions. The International Wound Infection Institute (IWII, www.woundinfection-institute.com), a multidisciplinary organization, provides a global perspective on the latest developments in wound infection. This group of international wound leaders has developed tools that enable clinicians to assess and treat infection in both acute and chronic wounds.

The IWII expresses the levels of bacteria and their activities in a continuum of bacterial invasion from contamination to systemic infection (see Table 5).

Table 5: Categories of Bacterial Burden[42]

Contamination	Wound contamination is the presence of non-proliferating microbes within a wound at a level that does not evoke a host response.[43,44] From the time of wounding, virtually all open wounds are contaminated with microbes. Chronic wounds become contaminated by endogenous secretions (natural flora) and exogenous microbial sources, including poor hand hygiene practised by health-care clinicians and environmental exposure.[45] Unless compromised, the host defences respond swiftly to destroy bacteria through a process called phagocytosis.[46]
Colonization	*Colonization* refers to the presence within the wound of microbial organisms that undergo limited proliferation without evoking a host reaction.[44,47] Microbial growth occurs at a non-critical level and wound healing is not impeded or delayed.[46,48] Sources for micro-organisms may be natural flora, exogenous sources or a result of environmental exposure.
Local Infection	Local infection occurs when bacteria or other microbes move deeper into the wound tissue and proliferate at a rate that invokes a response in the host.[43,47] Local infection is contained in one location, system or structure. Especially in chronic wounds, local wound infection often presents as subtle signs that can be considered covert signs of infection.[47,49] These signs may develop into the classic overt signs of infection. These infections are discussed in more detail below and in Table 6.
Spreading infection	*Spreading infection* describes the invasion of the surrounding tissue by infective organisms that spread from a wound. Micro-organisms proliferate and spread to such a degree that signs and symptoms extend beyond the wound border.[50,51] Spreading infection may involve deep tissue, muscle, fascia, organs or body cavities.
Systemic infection	Spreading infection from a wound that affects the body as a whole,[50] with micro-organisms spreading throughout the body via the vascular or lymphatic systems, constitutes a systemic infection. Systemic inflammatory response, sepsis and organ dysfunction are signs of systemic infection.[51]

Used with kind permission of the International Wound Infection Institute.

The bacterial burden of a wound can be assessed and diagnosis of infection can be made using a variety of methods: clinical observations, laboratory testing (wound culture and susceptibility and/or blood cultures) and occasionally radiological assessment.[52] The classic signs of wound infection are often absent (covert) in chronic wounds, so it is up to the clinician to evaluate other clinical signs (listed in Table 6) along with risk factors specific to the patient to fully evaluate for infection. Wound deterioration or failure to progress toward healing can also be indicators of potential wound infection and should always be considered clear signs that further investigation is warranted.[53]

Table 6: Signs and Symptoms Associated with Bacterial Burden

Contamination[54]	Colonization[54]	Local Infection		Spreading Infection[50,51]	Systemic Infection[50,51]
All wounds may acquire micro-organisms. If suitable nutritive and physical conditions are not available for each microbial species, or if they are not able to successfully evade host defences, they will not multiply or persist; their presence is therefore only transient and wound healing is not delayed.	Microbial species successfully grow and divide, but do not cause damage to the host or initiate wound infection.	Covert (subtle) signs of local infection:[43,55–64] ▪ hypergranulation (excessive 'vascular' tissue) ▪ bleeding friable granulation ▪ epithelial bridging and pocketing in granulation tissue ▪ wound breakdown and enlargement ▪ delayed wound healing beyond expectations ▪ new or increasing pain ▪ increasing malodour	Overt (classic) signs of local infection:[43,55,56,63,64] ▪ erythema ▪ local warmth ▪ swelling ▪ purulent discharge ▪ delayed wound healing beyond expectations ▪ new or increasing pain ▪ increasing malodour	▪ extending induration ± erythema ▪ lymphangitis ▪ crepitus ▪ wound breakdown/dehiscence with or without satellite lesions ▪ malaise/lethargy or non-specific general deterioration ▪ loss of appetite ▪ inflammation, swelling of lymph glands	▪ severe sepsis ▪ septic shock ▪ organ failure ▪ death

Used with kind permission of the International Wound Infection Institute.

The host's resistance to the bacteria is the single most important determinant of a wound moving from the states of contaminated to colonized to infected.

Pain should be assessed regularly in conjunction with infection since an increase in pain can be a warning sign of wound deterioration and may indicate the presence of infection.[65]

Chronic wounds are often polymicrobial, especially in patients with diabetes, making management challenging.[66] The unique health status of each patient is also a factor for infection risk and impact (see Table 7). Patients with serious compromises or multiple factors will be at higher risk for the presence and higher level of infection.

Table 7: Factors Associated with Increased Risk of Wound Infection[42]

Characteristics of the Individual[49,67–81]		
▪ poorly controlled diabetes ▪ prior surgery ▪ radiation therapy or chemotherapy ▪ conditions associated with hypoxia and/or poor tissue perfusion (e.g., anemia, cardiac or respiratory disease, arterial or vascular disease, renal impairment, rheumatoid arthritis, shock) ▪ immune system disorders (e.g., acquired immune deficiency syndrome, malignancy) ▪ inappropriate antibiotic prophylaxis, particularly in acute wounding ▪ protein-energy malnutrition ▪ alcohol, smoking and drug abuse		
Characteristics of the Wound[67,68,74,75]		
Acute wounds: ▪ contaminated or dirty wounds ▪ trauma with delayed treatment ▪ pre-existing infection or sepsis ▪ spillage from gastro-intestinal tract ▪ penetrating wounds over four hours ▪ inappropriate hair removal ▪ operative factors (e.g., long surgical procedure, hypothermia, blood transfusion)	Chronic wounds: ▪ degree of chronicity/duration of wound ▪ large wound area ▪ deep wound ▪ anatomically located near a site of potential contamination (e.g., perineum or sacrum)	Both wound types: ▪ foreign body (e.g., drains, sutures) ▪ hematoma ▪ necrotic wound tissue ▪ impaired tissue perfusion ▪ increased exudate or moisture
Characteristics of the Environment[67–68,81]		
▪ hospitalization (due to increased risk of exposure to antibiotic-resistant organisms) ▪ poor hand hygiene and aseptic technique ▪ unhygienic environment (e.g., dust, unclean surfaces, mould/mildew in bathrooms) ▪ inadequate management of moisture and exudate ▪ inadequate pressure off-loading ▪ repeated trauma (e.g., inappropriate dressing removal technique)		

Used with kind permission of the International Wound Infection Institute.

Clinicians sometimes confuse normal inflammation with infection and it is essential to understand the difference for good clinical decision-making. Inflammation is an important immune response of the body that supports wound healing and removes harmful stimuli, including damaged cells, irritants or pathogens. In cases where there is continued tissue trauma, prolonged inflammation and delayed healing can result. Infection, on the other hand, is the invasion of tissues by disease-causing agents, their multiplication and the reaction of host tissues to these organisms and the toxins they produce. An untreated infection impedes healing.

Persistent inflammation may also indicate the presence of increased levels of metalloproteinases (MMPs), elastase and other inflammatory substances that impair or

delay wound healing. Point-of-care diagnostic testing has been developed to identify increased MMPs. Topical dressings exist to reduce MMPs and can be used in combination with topical antimicrobials or systemic anti-inflammatories/antimicrobials.[81]

Table 8: Differences between Inflammation and Infection[83]

	Signs and Symptoms
Inflammation	Redness, warmth, swelling and pain (the four classical signs of inflammation) and decreased function are seen in injured, infected or irritated tissues. Inflammation is also the first mechanism used as a type of nonspecific immune response.
Infection	Multiplication and invasion of an infectious agent within the body tissues causing signs and symptoms of disease. In wound care the most common are Gram-positive cocci, such as staphylococci, and Gram-negative rods, such as Pseudomonas.

The Levine method is the preferred method of wound culture (see Table 9).

Table 9: Levine Method of Wound Culturing

Step	Action	Further Information
1	Cleanse and debride wound prior to wound culture.	▪ Inform and seek permission from the patient to obtain specimen. ▪ Cleanse wound using warm normal saline. ▪ Debride non-viable tissue as required. ▪ Cleanse wound again.
2	Moisten swab tip.	▪ Moisten tip with sterile normal saline, especially with dry wounds.
3	Obtain specimen.	▪ Obtain specimen from cleanest area of the wound. ▪ Do not obtain (if possible) from slough or necrotic tissue.
4	Apply technique.	▪ Inform the patient that procedure may cause discomfort. ▪ Firmly press swab into wound and rotate. ▪ Using a sterile technique place swab into culture container.
5	Label appropriately.	▪ place patient label on culture container and pathology slip ▪ provide site, time and initials of the person who obtained the specimen ▪ provide as much relevant history as appropriate: ♦ current antibiotic or medication (steroid) ♦ co-morbidity (DM) ♦ specific microbe suspected (Pseudomonas) ♦ provisional diagnosis of wound ♦ duration of wound
6	Apply dressing as appropriate.	▪ use medicated dressings if appropriate ▪ use local wound-care principles to select an appropriate dressing

Used with kind permission of the International Wound Infection Institute.

Tip
While infection can be diagnosed by signs and symptoms, it is the swab that directs treatment.

Biofilms

A biofilm consists of a complex network of bacteria and fungi embedded in a thick, slimy barrier of sugars and proteins that begin to form within minutes to hours of skin breakdown. The biofilm barrier protects the micro-organisms from external threats, making them resistant to standard treatment. Biofilms are present in the majority of chronic wounds (60 to 90%) and have the potential to delay healing. The organisms within the biofilm cannot be detected using a normal wound culture method. The only definitive techniques available to detect biofilm involve advanced microscopy or specialized culture.[84] Table 10 summarizes the key factors that may indicate the presence of biofilms.[84–86]

Table 10: Criteria Indicative of Potential Biofilm

Criteria Indicative of Potential Biofilm
▪ failure of appropriate antibiotic treatment ▪ recalcitrance to appropriate antimicrobial treatment ▪ recurrence of delayed healing on cessation of antibiotic treatment ▪ delayed healing in spite of optimal wound management and health support ▪ increased exudate/moisture ▪ low-level chronic inflammation ▪ low-level erythema ▪ poor granulation/friable hypergranulation ▪ secondary signs of infection

Used with kind permission of the International Wound Infection Institute.

Assessing Moisture Balance

A moist wound environment is necessary for wound healing;[88] however, too much or too little exudate can adversely affect wound healing.[89] Identifying the optimal moisture balance for the wound and periwound skin is a necessary part of wound assessment.

Tip
Only after a thorough assessment has been completed can a working diagnosis be formulated, after which focused lab investigations can confirm and guide treatment if necessary.

Assessing Exudate

The quality of the exudate is also an important aspect of assessment:[90]

- *Serous drainage* is clear, thin and watery plasma and is considered normal during the inflammatory stage of wound healing. Small amounts are considered normal throughout healing. However, a moderate to heavy amount may indicate a high bioburden.
- *Sanguineous exudate* is fresh bleeding. A small amount may be normal early in the injury and during the inflammatory stage. It may indicate trauma to the wound bed.
- *Serosanguineous exudate* is thin, watery and pale red to pink in colour that indicates damage to the capillaries, usually with dressing changes.
- *Seropurulent exudate* is thin, watery, cloudy and yellow to tan in colour. It is considered abnormal and may indicate infection.
- *Purulent exudate* is thick, opaque and tan, yellow, green or brown, is considered abnormal and almost always indicates infection.

Enablers

The NERDS and STONEES mnemonic is a memory aide to assist clinicians in identifying the level of bacterial invasion. NERDS stands for Non-healing, Exudate, Red friable tissue, Debris (discoloration) and Smell. STONEES stands for Size increasing, Temperature elevation, Os (probes to bone), New breakdown, Erythema/Edema, Exudate and Smell.[87] (This mnemonic does not include the symptom of pain).

The Bioburden checklist was developed by Keast and Lindholm to determine the level of bioburden and assist in selecting the correct intervention. It can be found at: www.woundsinternational.com/media/issues/610/files/content_10545.pdf.

Discuss Assessment Findings with Patient

At the end of the assessment it is important to have a summarizing discussion with the patient about the findings of the assessment. The clinician needs to assess how aware the patient is of his/her health status and ensure that there has been a meaningful exchange with the patient during this assessment.

Step 2: Set Goals

Step 2: Set Goals

Discussion: Goals of care need to revolve around the patient. Achieving goals will depend on the interplay of the patients' health status and lifestyle, the availability of resources and the knowledge and ability of caregivers to provide optimal interventions.[33,91] If these factors are not taken into consideration the goals of care may be unrealistic and unrealizable.

Prevention
Even if the patient has a wound, there should always be a plan in place to prevent further skin breakdown in other areas.

Recommendations

2.1 Set goals for prevention, healing, non-healing and non-healable wounds.

Discussion: Goals are not static and can often transition with various conditions over time. Goals must be adjusted accordingly.

2.1.1 Identify goals based on prevention or healability of wounds

Discussion: Determine skin/wound-related goals based on prior assessment and team discussion.

- For intact skin: Preventative plan of care goals should be developed based on risk and implemented to avoid skin breakdown.
- For a healing wound: Plan of care goals should be developed to heal the wound if the patient has the physical capacity to heal, is making choices consistent with optimal wound healing and where the system can support optimal wound healing.
- For a non-healing wound: Plan of care goals should be developed if the patient has the physical capacity to heal, but the patient is making choices inconsistent with optimal wound healing and/or the health-care system cannot support optimal healing at this time.

- For a non-healable wound: Plan of supportive care goals should be developed for the patient who does not have the ability to heal.

2.1.2 Identify quality-of-life and symptom-control goals

Discussion: Goals that impact a patient's daily life, such as the ability to engage in normal activities and maintain an adequate level of emotional well-being, need to be addressed. Regular assessment using validated, responsive and standardized tools allows the clinician to access essential information at a glance and set realistic goals with the team.

These goals may include:[92]

- wound stabilization
- reduced bacterial load
- decreased numbers of dressing changes
- symptom control (such as pain and odour)
- ability to return to a normal routine

Enabler

The team should aim to set goals according to the **SMART** principle:[93]

- **S**pecific – The goals must be specific and clearly state what needs to be accomplished, how, when and where.
- **M**easurable – With specific goals, the results should therefore be able to demonstrate quantifiable results—how much, how many, how often—to help measure progress.
- **A**ttainable – All goals must be realistically achievable.
- **R**ewarding – All members of the team should feel good when a goal is achieved.
- **T**imely – A realistic timeframe should be set for each goal: short-, intermediate- and long-term.

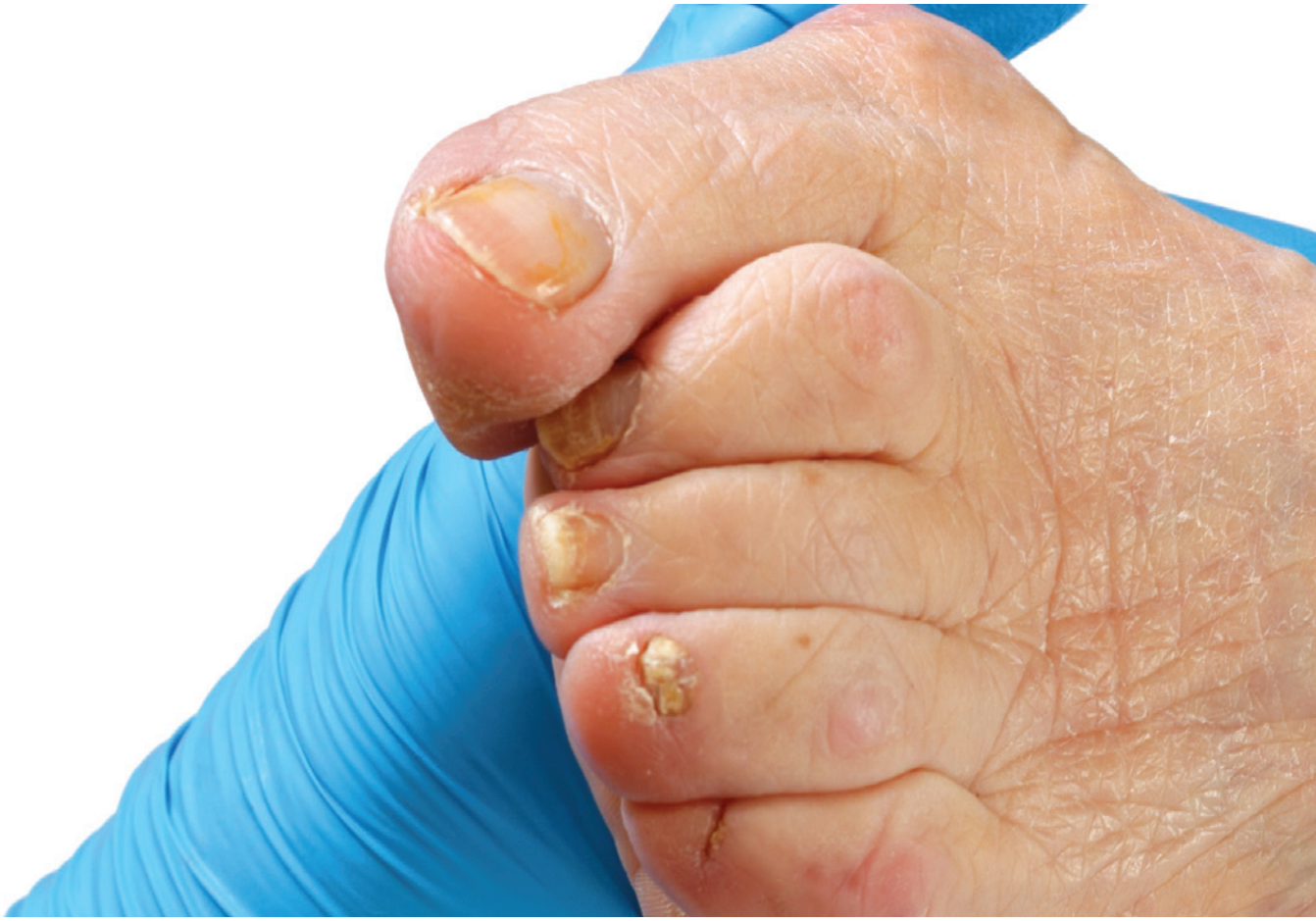
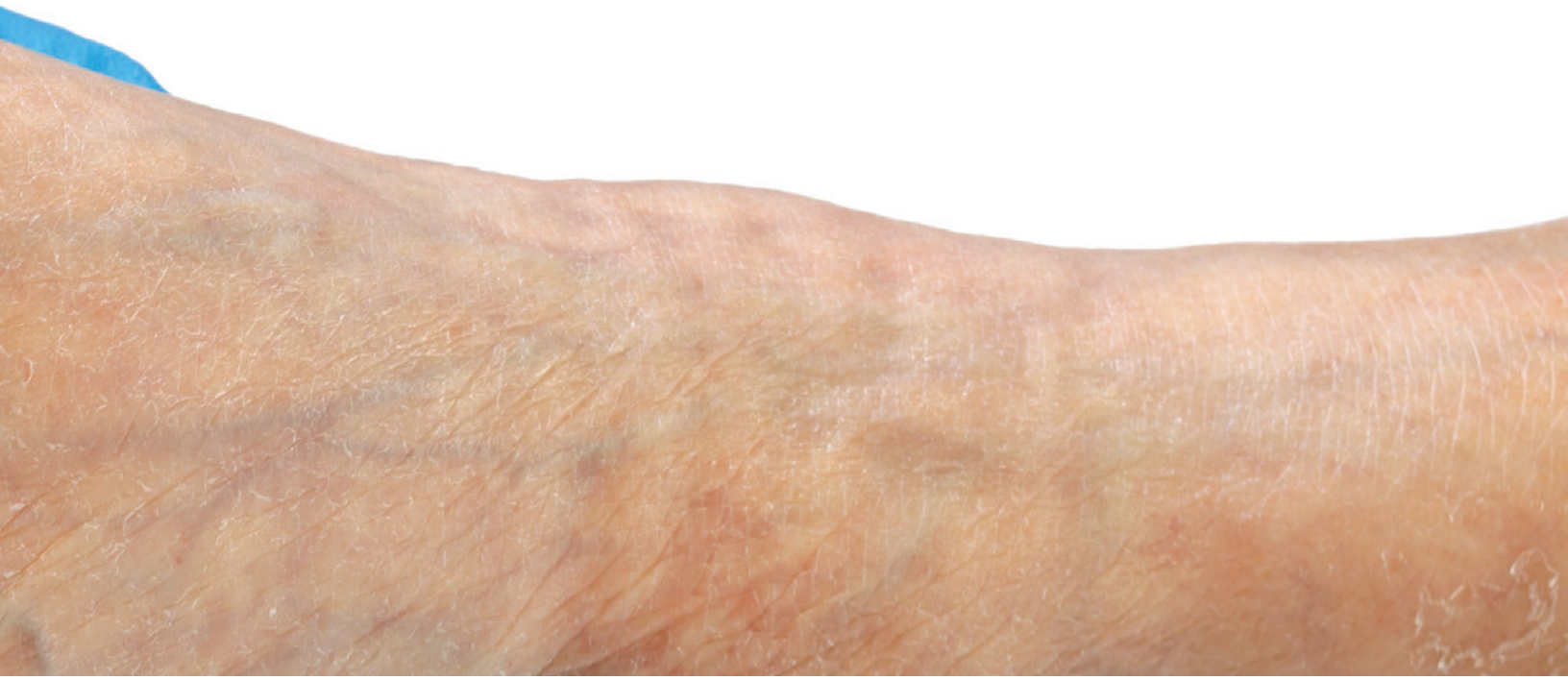


Table 11: Examples of Goals of Care[94]

Status	Example	Goal
At-risk skin.	Neuropathic foot with callus build-up.	Maintain skin integrity.
Healing wound: Causes and co-factors that can interfere with healing have been removed. Wound healing occurs in a predictable fashion. Wound may be acute or chronic.	Pressure injury where pressure and other factors such as incontinence are managed.	Close the wound within three weeks and prevent recurrence.
Non-healing wound: Wound has healing potential, but causes and co-factors that can interfere with healing have not yet been removed.	Neuropathic diabetic foot ulcer where patient is unable to pay for plantar pressure redistributing footwear.	Source funding for offloading footwear within one week, close wound within one month and prevent recurrence.
Non-healable wound: Causes and co-factors that can interfere with healing cannot be removed, e.g., in cases of terminal disease or end-of-life care.	Fungating breast cancer.	Reduce odour by 50% within three days and by 90% within one week. Prevent worsening of existing wounds.



Step 3: Assemble the Team

Step 3: Assemble the Team

A team is necessary to implement, adjust and sustain a plan to meet the goals that have been set. The team should include the relevant health-care professionals and other service providers as required as well as the patient, family and their support system.

Discussion: Whether it is called inter-professional, multidisciplinary or integrated,* a team is essential to maintain and manage skin integrity and to optimize the patient's overall health and well-being. This is especially true in cases relating to chronic wounds for persons at risk for skin breakdown, where interventions by multiple disciplines and of varying levels of care are required. All members must work together to create and implement a sustainable plan of care that can prevent injury, support healing or both.

Remember
The first member of the team is the patient.

Given that the patient and lay caregivers are part of the team and often spend most of their time outside the clinical setting, the "team without walls" approach is often the only way to achieve optimal patient outcomes. This is especially true because only some of the team members work together in a clinical setting. Many times the members of the team work across a variety of service delivery sites. Regardless of the number of settings, the effectiveness of any team depends on having a well-functioning communication strategy in place.

* Because patients, their caregivers and other service providers are part of the team, the term *integrated* is preferred.

Recommendations

3.1 Identify appropriate health-care professionals and service providers.

Discussion: Best practice care for persons at risk for the development of wounds, or for those who have wounds, demands a systematic, team approach from knowledgeable health professionals and service providers with expertise in wound management.

The selection of team members will be based on the patient assessment and needs analysis. All team members must support the patient's goals and plan of care. Members of the team will contribute to patient care in their specific area of expertise.[95]

3.2 Enlist the patient and their family and caregivers as part of the team.

Discussion: The patient, family and any formal or informal caregivers need to be at the core of the team to address individual wants and needs even if their goals differ from the goals of the health-care team.[96] This approach may be a new concept to the patient so the first step is to ensure they recognize their role and responsibilities in their care, as successes in health care can be dependent on early, effective and shared communication between health-care professionals and patients.

Potential Team Members

Health-care professionals on the team may include: nurses, physiotherapists, occupational therapists, orthotists, dietitians, podiatrists/chiropodists, social workers, spiritual care providers, recreational therapists, pharmacists, diabetes educators, nurse practitioners, enterostomal therapists, psychologists and physicians—both generalists and specialists, including dermatologists, plastic surgeons, physiatrists and vascular surgeons, depending on need.

Service providers on the team may include: shoe fitters, meal delivery services, homemakers, garment fitters, medical aid specialists, transportation providers.

Patient communication needs to consider the patient's age, his or her capacity to make decisions (including children < 16 years of age), the cultural appropriateness of shared information, additional needs such as sensory or learning disabilities, literacy level, language ability and preferences regarding health-related information (e.g., written vs. verbal vs. pictorial).[1]

The clinician-patient relationship can be optimized by:[97]

1. Avoiding medical terminology and jargon in communications.
2. Allowing time for questions in patient interaction through frequent pauses and check-ins where the clinician might ask, *"What do you want to know about?"* or *"What worries you the most?"*
3. Using open-ended questions such as *"Describe your pain"* rather than *"Do you have pain?"*
4. Allowing for pauses for reflection, on both sides, between questions.
5. Encouraging engagement and maintaining good non-verbal communication.
6. Avoiding cultural stereotyping while respecting potential differences.

7. Confirming information received from the patient by saying *"In other words what you are telling me is …"*
8. Verifying information given to the patient by having them provide feedback such as *"What you are asking me to do is …"*

3.3 Ensure organizational and system support.

Discussion: Organization and system support is required to ensure that patients receive a co-ordinated transition of care through community and health-care agencies, as well as the development of specialized, knowledgeable, integrated teams. Ongoing knowledge mobilization of the latest evidence through education, policy development and availability of appropriate resources requires system support.[1] Therefore the development and implementation of a successful wound prevention and management program involves collaboration with practice leaders, educators, policy makers and administrators at a local, regional and national level.

Step 4: Establish and Implement a Plan of Care

Step 4: Establish and Implement a Plan of Care

Ensure that care addresses the goals and takes into account patient needs (physical, emotional and lifestyle), factors relating to the skin and wound (if applicable), as well as the environment and the system in which the team is situated.

Discussion: Best-practice-based wound prevention and management is both a science and an art because of the individual challenges each patient brings. Therefore, the plan of care required needs to be guided not only by the evidence, but also through documented clinical decision-making involving patient input regarding preferences, circumstances, values and rights.

Recommendations

4.1 Identify and implement an evidence-informed plan to correct the causes or co-factors that affect skin integrity, including patient needs (physical, emotional and social), the wound (if applicable) and environmental/system challenges.

Discussion: Patients with wounds may also have multiple co-morbidities such as obesity, diabetes, hypertension, hyperlipidemia and arthritis that can interfere with healing and lead to prolonged or stalled healing. Addressing the co-morbid conditions that affect the health of skin and/or its ability to heal is paramount in the development of a plan of care that will effectively meet goals relating to the prevention and management of wounds.

A number of other areas should be considered when implementing a plan of care. These include:

Physical Activity

Appropriate levels and types of exercise have beneficial effects, both physically and mentally. Exercise can improve weight control, cardiorespiratory function, blood pressure, cholesterol levels as well as mood, sleep and mental function.[99] Chronic illnesses have strong links with inactivity. While there is limited evidence linking improved physical fitness to better wound healing, there is strong research associating exercise with a reduction of the effects of chronic diseases. Exercise also positively affects impairments such as pain, stress, circulation, neuropathy, blood glucose levels and well-being, which can be directly linked to issues of skin integrity.[100–105] Given the potential risks of ill effects associated with unsupervised exercise in certain patient populations, it is imperative that high-risk patients be closely supervised by a skilled health professional. With guidance, exercise can be an empowering and safe tool to enable patients to improve their overall well-being.

What is Best Practice?

There is often confusion around what *best practice* means. Best practice comprises the best evidence, individual patient risk factors and preferences, available human resources, equipment and supplies as well as assessment tools and techniques.[98]

Additional Resources

Wounds Canada has created a series of best practice recommendations (BPR) articles for specific wound types that extensively explore wound healing. Please refer to the BPR articles for further guidance at www.woundcarecanada.ca.

Nutrition

Nutritional support plays a vital role in the prevention and management of wounds. Without adequate nutritional intake, the body is unable to maintain tissue integrity, repair damaged tissue or mount an offence against microbial invasion and infection.[106–109]

If a nutritional deficiency is thought to be significant enough to impair wound healing or place skin at risk of breakdown, a nutritionist or dietitian should be consulted[110] to develop an individualized nutrition plan with the goal of optimizing the person's nutritional status. Management of deficiencies may make the difference between a healing and non-healing wound even in the presence of best clinical practice. The nutritional component of the plan of care must take into account the patient's health status, dysphagia, socioeconomic, cultural and psychosocial status as well as other needs and beliefs.

Moisture Control

Intertrigo is a common condition that leads to skin erosions, primarily in skin folds. It is caused by the combined impact of moisture, friction and shear. Sibbald et al. recommend the following prevention and management strategies:[111]

- Implement a skin-fold-hygiene program to keep skin dry and minimize skin-on-skin contact and friction.
- Avoid the use of or contact with any skin irritants.
- Wick moisture away from affected and at-risk skin; consider silver impregnated textiles (not to be confused with silver dressings).
- Control or divert the moisture source.
- Prevent or treat secondary infection.

Incontinence can create a type of irritant contact dermatitis that requires reduction and management of urinary and/or fecal incontinence. According to the Global IAD Expert Panel, two key interventions are critical for the prevention and management of incontinence-associated dermatitis (IAD).[112]

- Management of incontinence requires that the clinician identify and treat reversible causes (e.g., urinary tract infection, constipation, diarrhea, use of diuretics) to reduce or eliminate skin contact with urine and/or feces.
- A structured skin care regimen should be implemented to protect the skin exposed to urine and/or feces and help restore an effective skin barrier function.

Pain Management

The intensity and impact on the patient's quality of life of all assessed pain must be taken into consideration when creating a personalized plan of care.[113,114] Table 12 summarizes some of the causes of pain and strategies for management.

Table 12: Causes and Management of Pain[35]

Causes of Pain	Characteristics	Management Strategies
Background pain	Pain at rest (related to wound etiology, infection, ischemia)	Treat the underlying etiology of the wound and associated pathologies. Provide analgesic and non-analgesic options per WHO Pain Ladder.[115]
Incident pain	Pain during day-to-day activities (coughing, friction, dressing slippage)	
Procedural pain	Pain from routine procedures (dressing removal, application)	Preparation and planning of the procedure are key to preventing pain. Analgesics per WHO Pain Ladder should be administered before a procedure and may be required post procedure. Dressing selection is key to pain management related to dressing removal and application.[115]
Operative pain	Pain associated with an intervention that would require an anesthetic (cutting of tissue or prolonged manipulation)	

Additional Strategies

The plan of care may require referrals to programs relating to mental health, social support, smoking cessation, weight management and stress management, among others, to optimize patient health in order to support wound healing or prevent skin breakdown. Table 13 outlines several examples.

Table 13: Examples of Lifestyle Strategies for Optimizing Patient Health

Strategy	Impact and Benefits
Smoking cessation programs	Smoking cessation benefits a patient's long-term health by reducing the risk of disease development. There is also evidence that quitting smoking may reduce wound complications, such as infection, and increase rates of bone healing.[116]
Weight management programs	Obesity and associated co-morbidities increase the likelihood of impaired skin integrity and slow-to-heal wounds due to poor blood supply to adipose tissue. Some obese patients may have protein malnutrition, which further impedes the healing.[117] Effective weight management can decrease a patient's risk of developing pressure injuries, irritant dermatitis due to urinary and/or fecal incontinence, candidal intertrigo, cellulitis or more serious skin infections such as necrotizing fasciitis, venous ulcers, diabetic foot ulcerations and surgical site infections.
Stress management programs	Stress can have a negative impact on wound healing. The most prominent impact is on cellular immunity. Stress management programs have demonstrated reduced distress and improved quality of life.[118]
Mental health and other programs	Programs that support the management of anxiety, addiction, chronic illness, pain, palliative care, healthy living and sleep disorders can improve skin integrity, wound healing and quality of life.[119]

4.2 Optimize the local wound environment.

Discussion: Local wound management strategies should be part of the plan of care and fit within the context of the overall goals of care that address the cause(s) of the wound and determine the extent to which the body has the ability to heal the wound. The wound environment needs to be optimized. This involves four basic components: cleansing, debridement of necrotic or indolent tissue, managing bacterial balance and controlling moisture.

4.2.1. Wound Cleansing

Discussion: Wound cleansing solutions vary and should be used at body temperature. Cleansing solutions should be nontoxic, hypoallergenic, readily available, cost-effective and easy to use. Wound cleansing solutions commonly used in wound management include: sterile normal saline, sterile water, potable tap water and liquid antiseptics (see Table 14). A therapeutic irrigation with a force of 4–15 psi has been demonstrated to be effective and generally safe.[120]

When wound infection is suspected, a solution with a surfactant, antiseptic or antimicrobial agent is recommended. Some commonly used antiseptic solutions are polyhexanide (PHMB), betaine/PHMB (a surfactant), povidone-iodine and octenidine with ethylhexyl glycerine (a surfactant). Clinicians should be aware of the cytotoxicity of each solution, appropriate concentrations and the individual wound requirements when choosing the most appropriate solution.[85]

Wound cleansing is likely to cause pain during dressing change. The routine practice of using abrasive materials and gauze to scrub the wound surface is discouraged.

Table 14: Cleansing Solutions[42]

Solution	Type	Cytotoxicity	Effect on biofilm	Comments
Sterile normal saline	Isotonic[121]	• none	• none	• sterile, non-antiseptic solution[125]
Sterile water	Hypotonic	• none	• none	• sterile, non-antiseptic solution[125]
Potable tap water	Varies in content	• unknown/ variable	• none	• not sterile[125]
Polyhexamethylene biguanide (PHMB)	Surfactant anti-microbial	• low to none[52]	• surfactant qualities disrupt biofilm attachments[52]	• lowers liquid surface tension, allowing greater spread and facilitating separation of non-viable tissue[52] • does not promote bacterial resistance[52]
Octenidine dihydrochloride (OCT)	Surfactant anti-microbial	• *in-vitro* tests show high toxicity[122] • lack of absorption suggests no systemic effects[122] • not shown to disrupt healing	• prevents formation of new biofilm for at least 3 hours[124] • inhibits planktonic and bacterial biofilm growth for up to 72 hours[124]	• comes in a gel and irrigation preparation that can be used together or separately[123] • lowers liquid surface tension, allowing greater spread and facilitating separation of non-viable tissue[125]
Super oxidized with hypochlorous acid (HOCl) and sodium hypochlorite (NaOCl)	Antiseptic	• may vary depending on concentrations	• penetrates biofilm rapidly, killing formations from within[125] • does not promote resistant bacteria strains[125]	• purported to provide de-sloughing and antimicrobial activity • comes in a gel and irrigation preparation that can be used together or separately
Povidone-iodine	Antiseptic	• varies depending on concentration[123]	• inhibits development of new biofilm[126] • eradicates young biofilm colonies[126] • significantly reduces mature biofilm colonies[126]	• modulates redox potentials and enhances angiogenesis, thereby promoting healing[127] • may inhibit excess protease levels in chronic wounds[127]

Used with kind permission of the International Wound Infection Institute.

4.2.2 Debriding

Discussion: The European Wound Management Association defines debridement as the "act of removing necrotic material, eschar, devitalized tissue, serocrusts, infected tissue, hyperkeratosis, slough, pus, hematomas, foreign bodies, debris, bone fragments, or any other type of bioburden from a wound with the objective to promote wound healing."[128]

In some wounds debridement is required to eliminate moist necrotic tissue, which provides a medium for bacterial growth, initiates an inflammatory response, places a

phagocytic demand on the wound and retards wound healing. The ensuing infection and biofilm formation limit the effectiveness of topical and systemic antibiotics.

It is important to note that debridement of a wound that does not have adequate vascular supply is not recommended. Therefore, a thorough assessment of vascular supply to the wounded area is imperative prior to debriding.

Types of Debridement

Debridement may be selective (removing only non-viable tissue) or non-selective (potentially harmful to healthy tissue). Selective debridement methods fall into several categories: biological (biosurgical), mechanical, hydrosurgical, chemical, autolytic, enzymatic, surgical and conservative sharp.

Biological Debridement (Biosurgical)

Maggots possess potent enzymes that can liquefy necrotic tissue and secrete substances that destroy bacteria.[129] Maggot debridement (or larval) therapy (MDT) was first described by Pare in the 1500s. During World War I, Baer documented the successful treatment of leg ulcers and osteomyelitis using larval therapy. This led the way for further use of larval therapy, but the development of antibiotics and improvements in surgical techniques reduced larval therapy to a treatment of last resort.

With the emergence of MRSA (methicillin-resistant *Staph. aureus*), there has been a renewed interest in larval therapy, which has shown to be not only beneficial to the patient but also cost-effective. There is substantial literature available on larval thera-

py; however, large-scale clinical trials supporting the evidence are lacking. The largest deterrent to the use of larval therapy appears to be the "yuck" factor.[128,130]

Mechanical Debridement

Mechanical debridement involves the use of mechanical forces to remove bacteria and non-viable tissue from the wound bed. It remains the most common form of debridement and is usually performed by applying moistened gauze and periodically removing it (the "wet-to-dry dressing") along with adherent debris. This method causes unnecessary trauma to healthy tissue and added pain, so its use is strongly discouraged. One common method of mechanical debridement is the use of spray wound cleansers or non-traumatic irrigation systems that deliver irrigation pressure with a force of 4 – 15 pounds per square inch (psi), which has been demonstrated to be effective and safe at the wound surface to dislodge bacteria and debris.[120] It is generally accepted that pressure greater than 15 psi must be used with great care. In the case of fragile elderly or newborn skin, a psi of 8 or less is recommended.[131] The use of a syringe (30 – 35 cc) and needle (18 – 19 gauge) can also be used for wound irrigation.[132]

Although polyacrylic microfibre pads have recently been employed to promote debridement,[133] most wound professionals today prefer more selective methods of debridement.[128]

Another option is low-frequency ultrasound, a noncontact mechanical debridement method using sound waves transmitted through a constant flow of saline that re-

moves necrotic tissue, fibrosis, exudate and bacteria with minimum bleeding and pain. It is performed at a distance between 5 mm and 15 mm from the wound surface.[134]

Hydrosurgical Debridement

Hydrosurgical debridement involves the use of a specialized, powered surgical tool that enables a surgeon to precisely select, excise and evacuate nonviable tissue, bacteria and contaminants from wounds, burns and soft tissue injuries using pulsed lavage irrigation.[135]

Chemical Debridement

Chemical debridement involves the use of a chemical agent, such as sodium hypochlorite, to remove necrotic tissue. This treatment is non-selective and can be harmful to healthy cells and granulating tissue. Selective debridement methods are preferred.[136]

Autolytic Debridement

Autolytic debridement involves allowing natural physiologic processes to occur where the body uses neutrophils aided by macrophages and enzymes (serum proteases and collagenase) to rid wounds of dead tissue. Autolysis refers to self-digestion by the enzymes naturally present in wound fluids and the process of liquefaction of eschars. If the wound is covered with a dry eschar, scoring or crosshatching of the eschar with a scalpel is necessary to assist in the autolytic process. Dressings that promote autolytic debridement also support the rehydration and softening of the devitalized tissue.[137] Care must be taken to adequately cleanse the wound of any loosened devitalized tissue. Autolytic debridement must be used with care in wounds that are actively infected.

Enzymatic Debridement

Enzymatic debridement involves the topical application of proteolytic substances (enzymes such as collagenase) to break down devitalized tissue. The enzymatic debriding agent can be used to remove necrotic tissue from the wound through its ability to digest the collagen fibres that anchor necrotic tissue to the base of the wound. In the process, necrotic tissue is separated from the wound, leaving behind a clean base to support an increased rate of healing. The activity level of enzymatic agents decreases in a dry environment; therefore, dry eschar should be scored and kept moist. Enzymatic debridement can be used alone or in combination with sharp debridement and autolytic debridement when combined with a foam dressing topper.[138,139]

Note: Collagenase-based products are available only in Canada.

Surgical Debridement

Surgical debridement is the fastest way to remove devitalized, contaminated or infected tissue. It may also be used to convert a chronic, non-healing wound environment into an acute wound environment. Surgical debridement must be performed by a properly trained health professional (e.g., a surgeon), usually in the controlled conditions of an operating room or properly equipped clinic (i.e., with sterilized equipment and coagulation equipment). This method can be costly because it requires an operating room or specialized clinic. Surgical debridement may be contraindicated for individuals who are medically unfit or who have uncontrolled blood clotting disorders. Delays in wound healing can arise when wait times for operating rooms are long.

Conservative Sharp Wound Debridement

Conservative sharp wound debridement involves the removal of only devitalized tissue, usually with a scalpel or scissors. Health-care professionals who have the proven knowledge, skill and supervised hands-on experience relating to conservative sharp debridement and who have obtained institutional and physician permission to perform the procedure may perform it at the bedside or in a clinical setting. Clinicians must verify within their health-care institution or agency that sharp debridement is within their scope of practice and whether there is a policy indicating who may perform conservative sharp debridement.[137–140]

Table 15 reviews key factors in determining which type of debridement would be best suited to which patient situation and whether the type of debridement is selective or non-selective. For clinicians not skilled in sharp debridement, autolytic or enzymatic debridement may be the preferred option. In all cases, the method used needs to suit the clinical situation based on patient and wound assessment.[141]

Table 15: Key Factors in Deciding Method of Debridement[35]

	Surgical/ sharp	Enzymatic	Autolytic	Biologic	Mechanical
Speed	1	3	5	2	4
Tissue selectivity	3	1	4	2	5
Painful wound	5	2	1	3	4
Exudate	1	4	3	5	2
Infection	1	4	5	2	3
Cost	5	2	1	3	4

1 is most desirable and 5 is least desirable

4.2.3 Managing Bacterial Balance

Discussion: Bacterial balance is essential for wound healing. Management needs to address the interaction between the individual and the infecting pathogen by:

- optimizing the host response
- reducing the number or virulence of micro-organisms in the wound
- optimizing the wound environment[42]

Terminology related to bacterial management can be confusing. For clarification:

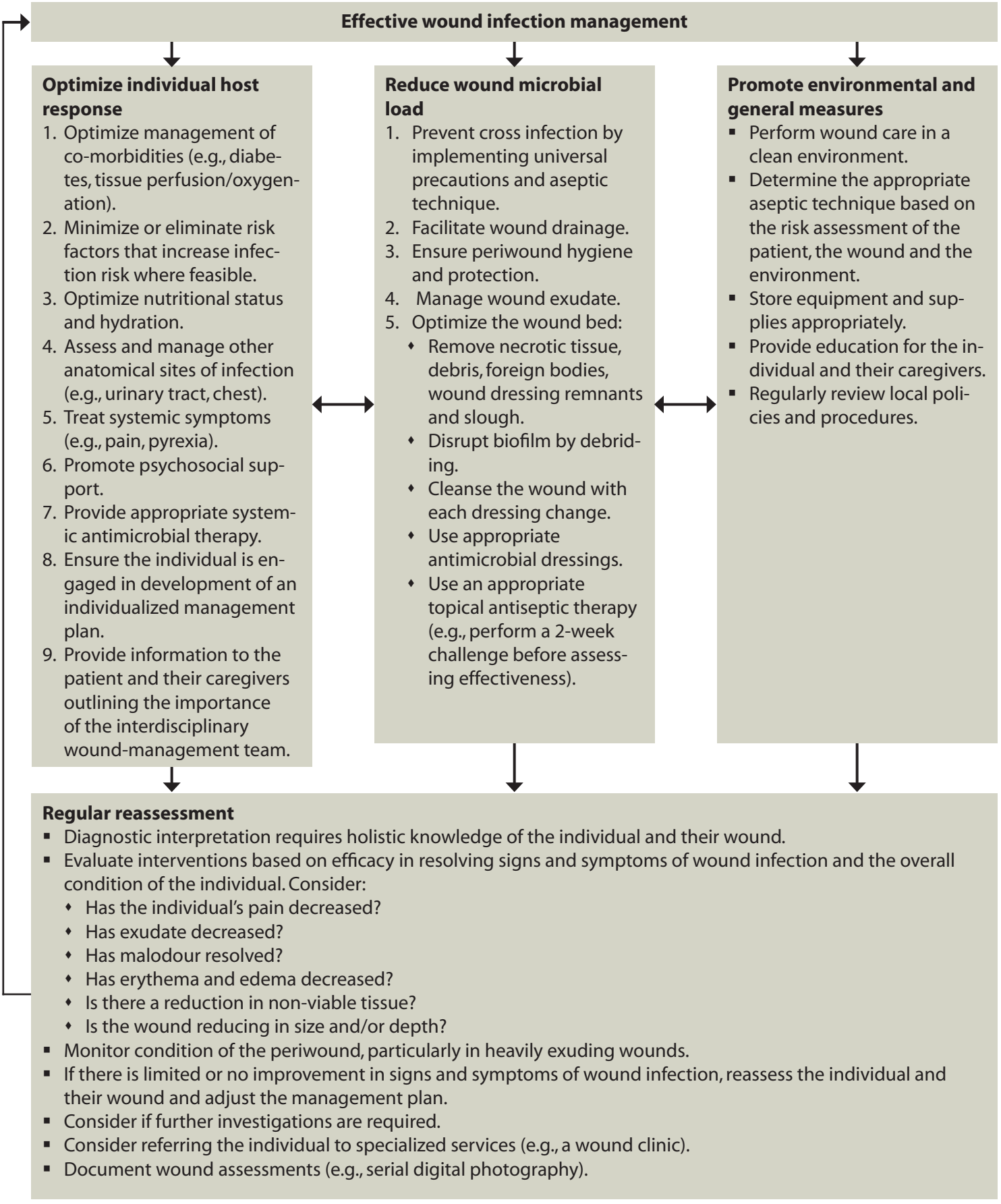
- Antibiotics are agents that kill selectively and require metabolic activity for action. Antibiotics can be bacteriostatic or bactericidal.
- Antiseptics are non-selective agents that do not require metabolic action for efficacy. Antiseptics are always bactericidal and usually act on the surface.
- *Antimicrobial* is an umbrella term often used to group antibiotics and antiseptics.

Tip

To prevent the development of resistance it is important when selecting topical antimicrobials to avoid those that may be used systemically.[42]

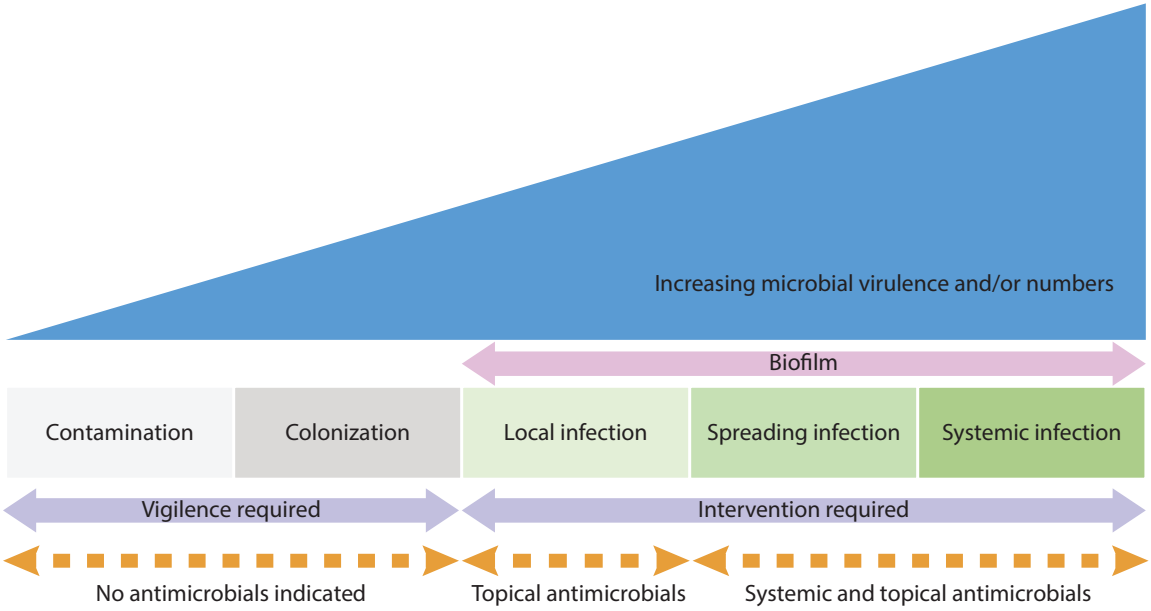
The International Wound Infection Institute has created several enablers for optimal infection management that can be a useful tool for clinicians (see Figures 4 and 5, and Table 16).

Figure 4: Managing Wound Infection



Used with kind permission of the International Wound Infection Institute.

Figure 5: Common Topical Antimicrobials — Indications and Contraindications



Used with kind permission of the International Wound Infection Institute.

Note that the characteristics of topical antimicrobials will change depending on the use and type of dressing used. Dressings that absorb wound exudate and wick infectious material away from the wound bed can provide additional benefit due to the reduced number of endotoxins that often impede healing. Drainage absorption by dressings may have synergistic effects by disrupting the bacteria's ability to attach and form a biofilm.[142]

Table 16: Topical Antimicrobial Therapies

Antimicrobial agents	Usage Considerations
Classifications: • Gentian violet/ methylene blue • Honey • Iodine (povidone and cadexomer) • Polyhexamethylene biguanide (PHMB) • Silver • Hydrophobic	• Indicated to reduce bacterial burden and/or to disrupt biofilms in locally infected wounds and in wounds with spreading or systemic infection (in conjunction with systemic antibiotics) • May be used prophylactically in non-healing or non-healable wounds to prevent wound infection • Iodine-based dressings are contraindicated before/after use of radio-iodine, in pregnant and breastfeeding women and in those with renal disorders • Iodine-based dressings should be used with caution in those with thyroid disorders, deep ulcerative wounds, burns or large injuries and in infants under six months of age • Leptospermum species honey (medical grade) dressings are more effective than other types of honey dressings
Forms: • Calcium alginate • Foam • Gauze • Gel • Gelling fibre • Hydrocolloid • Non-adherent synthetic contact layer • Paste • Powder	• Honey must be medical grade • Silver dressings come in either a salt or metallic form • May be anti-inflammatory, pro-inflammatory or neutral • Antimicrobial dressing MUST come into direct contact with the wound bed to be effective • Use a topical antimicrobial dressings for two weeks before reaching conclusions about its effectiveness (two-week challenge) • Topical antibiotics should be used only under the advice of specialized clinicians for specific purposes, e.g., topical metronidazole gel for the treatment of malodour in fungating wounds. Avoid the use of topical antibiotics that can be used systemically to avoid resistance

For a current list of Canadian products see the series of Wounds Canada Product Pickers: www.woundscanada.ca/Product-Pickers.

For a list of international products visit the International Wound Infection Institute website[42]: www.woundinfection-institute.com/.

In addition to topical antimicrobials and commercially available topical antimicrobial/ antibiotic dressings, which are discussed in Table 16, the management of wound and skin infections may also require oral and systemic antibiotics. The choice of antibiotic will depend on various factors:

- patient factors such as allergies, hepatic and renal function, patient goals (e.g., whether it is a healable or non-healable wound) and co-morbidities; in women, pregnancy and breastfeeding status are also considerations
- infection factors such as severity of the infection, involvement of bone, risk for drug-resistant bacteria (e.g., MRSA) and recent antibiotic use
- drug factors such as drug interactions, cost, safety profile and frequency of dosing
- system factors such as drug coverage, available route of administration (e.g., PO versus IV) and available resources required for IV administration

Figure 6: Empiric Management of Cellulitis Infections[156]

Cutaneous Infections		Cellulitis Infections		
Uncomplicated	**Complicated (moderate to severe)**	**Uncomplicated (mild)**	**Uncomplicated (severe, non-facial)**	**Invasive Group A Strep: Necrotizing Fasciitis**
Folliculitis and Faruncle (Boil)	TMP / SMX OR Ciprofloxacin	Cephalexin	Cefazolin IV	Clindamycin IV
Hot compresses and antiseptic cleanser	± ONE of: Metronidazole Clindamycin	Cloxacillin OR Clindamycin	± Clindamycin PO	PLUS ONE of the following: Cefazolin IV Penicillin G IV
Mupirocin 2% ung/ cream OR Fusidic acid 2% ung/cream	Amoxycillin/ Clavulante OR Ceftriaxone IM/IV	Erythromycin (for adults) Erythromycin estolate (for children) OR Clarithromycin OR Azithromycin	Clindamycin IC OR Ceftriaxone IV/IM	Vancomycin IV
Carbuncles (moderate to severe)	± ONE of: Metronidazole Clindamycin		Levofloxacin PO Moxifloxacin PO	
Cephalexin	CefazolinIV			
Cloxacillin OR Clindamycin	PLUS ONE of: Metroindazole IV/ PO Clindamycin IV/PO			
Erythromycin OR Clarithromycin OR Azithromycin	PLUS ONE of: Gentramicin IV Tobramycin IV Amikacin IV			

Legend:

- First-line therapy
- Second-line therapy
- Third-line therapy

TMP / SMX = Sulfamethoxazole / Trimethoprim

4.2.4 Managing Moisture Balance

Discussion: The seminal work by Winter in 1962 first described the advantages of moist wound healing that are now recognized in clinical practice.[88] Dressings should retain enough moisture to stimulate good healing yet not cause maceration or irritation to the surrounding tissues.[89] Some advantages of moist wound healing include:

- Decreased dehydration and cell death. Wound repair requires the activity of a host of cells, from neutrophils and macrophages to fibroblasts and pericytes. These cells cannot function in a dry environment.
- Increased angiogenesis. The cells required for angiogenesis require a moist environment. As well, angiogenesis occurs toward regions of low oxygen tension, meaning that occlusive dressings may act as a stimulus in the process.[88]
- Enhanced autolytic debridement. In a moist environment, neutrophil cell life is enhanced and proteolytic enzymes are carried to the wound bed, allowing for painless debridement.[157] The resulting fibrin degradation products are a factor in stimulating macrophages to release growth factors into the wound bed.
- Increased re-epithelialization. In larger, deeper wounds, epidermal cells must spread over the wound surface from the edges and have a supply of blood and nutrients. Dry, crusted wounds reduce this supply and provide a barrier to migration, slowing epithelialization.[158]
- Decreased pain. A moist wound bed insulates and protects the nerve endings, reducing pain.

The use of occlusive dressings, or ones that isolate the wound from the outside environment, is one of the most effective ways to maintain moisture in a wound. The potential results are:

- Improved bacterial barrier and decreased infection rates. Occlusive dressings with good edge seals can provide a barrier to the migration of micro-organisms into the wound. It has been demonstrated that bacteria can pass through 64 layers of moist gauze.[159] Wounds covered with occlusive dressings have been shown to have lower rates of infection than those with conventional gauze dressings.[159]
- Decreased pain. Occlusive dressings often require fewer dressing changes, which may be uncomfortable for patients.
- Decreased costs. While occlusive dressings have a higher per-unit cost than conventional gauze, increased healing rates and the reduced frequency of dressing changes and related costs of nursing care may be cost-effective in the long term.

Table 17: Moisture Management in the Wound

Too Little	Just Right	Too Much
Use a hydrating dressing such as a gel.	Use a moisture-retentive dressing such as a wafer.	Use an absorber such as a hydrocolloid fibre or foam.

Caution: Too much moisture may indicate unrecognized trauma that needs to be addressed.

4.3 Select the appropriate dressings and/or advanced therapy.

Discussion: Over the past 40 years an ever-expanding list of dressing products has come onto the market. There remains, however, no magic "one-size-fits-all" dressing. The selection of the most appropriate dressing takes into consideration:[35,161]

- the goal of treatment (based on whether the wound is healing, non-healing or non-healable)
- wound characteristics (including infection)
- indications and contraindications for the different classes of dressings and advanced therapies
- phase of healing
- the needs (and risk factors) of the patient, patient choice, lifestyle and comfort (during change and with use) and cost-effectiveness
- product availability and the availability and skill of the caregiver
- safety and effectiveness, ease of use and cost-effectiveness of the dressing available

FYI

Health Canada states that wound dressings and surgical barriers containing an antimicrobial agent and wound dressings whose primary purpose is to act as a barrier to pathogens are considered devices. Wound dressings whose primary purpose is to deliver a drug are considered drugs.[160]

Studies have consistently shown that appropriate dressing selection can improve patient outcomes, decrease pain with dressing changes and demonstrate cost-effectiveness when both the dressing product and human resource costs are factored into the equation.[35,39,162,163]

The patient's response to the dressing requires documented monitoring within a reasonable trial to determine effectiveness before changing to another product.[40,164]

Dressing selection can be challenging even for the most seasoned clinicians and cannot be made in isolation of the clinical situation. At times, dressings may be used in combination with other products or topical preparations to adequately address patient needs. Care needs to be taken to ensure that products do not interact with, interfere with or counteract one another. The Canadian Association of Wound Care (Wounds Canada) has created a series of Product Pickers that address, among other things, (1) product categories, characteristics and contraindications and (2) the clinical situation, local wound care and other care considerations. This enabler for clinicians can be posted in the clinical area to assist with decision-making at the point of care.

To access the Product Picker series visit www.woundscanada.ca/Product-Pickers.

Dressing Tips

Remember to:

- Change dressing based on patient, wound and dressing assessment, not on standardized routines.
- Practice with dressing materials to learn their performance parameters and related tricks.
- Check the product information/manufacturer's recommended usage documentation before using any dressing or advanced therapy.

Advanced Therapies

Some wounds may require advanced therapies such as negative pressure wound therapy, electrical stimulation, ultrasound, electromagnetic therapy, ultraviolet light C, hyperbaric oxygen therapy (HBOT), topical oxygen therapy, warming therapy and biologically active dressings. Though each of these modalities has evidence to support their use in limited situations, cost or the lack of good therapeutic evidence in some may limit their usefulness. Not all advanced therapies are available in every region. Consultation with local experts familiar with these therapies should be sought before using one as a therapeutic course of action.[163] Table 18 provides an overview of some of the most common advanced wound therapies.

Table 18: Overview of Common Advanced Wound Therapies

Category	Description	Considerations/Indications/ Contraindications
Negative pressure wound therapy (NPWT)	Applies controlled subatmospheric pressure to mechanically stress the tissues to remove exudate and reduce periwound edema, increase local microvascular blood flow/ test vascularity, promote formation of granulation tissue, reduce complexity/ size of the wound, optimize the wound bed prior to and following surgery and reduce complexity and length of surgical wound closure procedures.	Debridement, including bone if osteomyelitis is present, is necessary prior to the application of NPWT. The wound must be free of active, untreated infection (e.g., cellulitis). The wound bed should not involve fistulas to internal organs or body cavities over a blood vessel. Caution in patients receiving anticoagulants. Contraindicated with the presence of intracutaneous fistulae, necrotic tissue, untreated osteomyelitis and malignancy.

cont'd.

Category	Description	Considerations/Indications/ Contraindications
Electrical stimulation (ES)	Delivery of a low-voltage electrical current to the wound bed to stimulate healing. Provides benefits in three of the four phases of wound healing.[165] Inflammatory: increases circulation affecting phagocytosis and tissue oxygenation, reduces microvascular leakage, stimulates fibroblasts and epithelial cells, stimulates DNA synthesis and may have bactericidal effects. Proliferative: stimulates fibroblasts and epithelial cells, stimulates DNA and protein synthesis, increases ATP generation and membrane transport, improves the organization of the collagen matrix and stimulates wound contraction. Epithelialization: stimulates epidermal cell reproduction/migration.[165] Electrical stimulation may also address other impairments such as inactive muscles, impaired perfusion, edema and pain to enhance conditions necessary for wound healing.	ES should not be applied to areas where it could cause malfunction of electronic devices including cardiac pacemakers, low back or abdomen of pregnant women, acupuncture points of pregnant women, regions of known or suspected malignancy, active DVT or thrombophlebitis, untreated infection or osteomyelitis, recently radiated tissues, to the chest of persons with cardiac disease, arrhythmias or active heart failure, the neck or head region of persons known to have seizures, transcranially without specialized training, areas near reproductive organs or genitalia without specialized training, areas near or over eyes, anterior neck or carotid sinus.[176]
Electromagnetic therapy (EMT)	Does not involve the use of a current, as electrical stimulation therapy does. EMT works with generators that create an electromagnetic field to stimulate wound healing.[166]	Similar indications and contraindications to ES.

cont'd.

Category	Description	Considerations/Indications/ Contraindications
Ultrasound (US)	Delivers high-frequency mechanical vibration to facilitate healing at a cellular level in all phases of healing. Inflammatory: facilitates the release of histamine to attract fibroblasts and endothelial cells and accelerates this phase. Proliferative: stimulates fibroblast migration and proliferation, promotes angiogenesis. Epithelialization: releases growth factors. Remodeling: improves tensile strength of healing tissue.[5]	US should not be applied over eyes, genital areas, exposed neural tissue; avoid in thromboembolic diseases.[176] Should be distinguished from low-frequency ultrasound debridement.
Ultraviolet light C	There are three forms of ultraviolet light: UVA, UVB and UVC. UVC is the most frequently used for chronic wounds and its bactericidal effect has been demonstrated.[167]	Can be used for a short period when traditional therapies have failed. Contraindications include active cancer in the area.

cont'd.

Category	Description	Considerations/Indications/ Contraindications
Hyperbaric oxygen therapy (HBOT)	In HBOT the patient breathes 100% oxygen intermittently while the pressure in the chamber is increased to greater than one atmosphere absolute (atm abs). Reverses hypoxia by increasing the oxygen diffusion in blood plasma and local tissues.[168,169] The benefits include angiogenesis, collagen synthesis, osteoclastic activity and the release of vascular endothelial growth factor.[9,170] Current information indicates that pressurization should be at least 1.4 atm abs. This may occur in a monoplace (single-person) or multiplace (two or more people) chamber.[171]	Indications for use include "air or gas embolism, carbon monoxide/cyanide poisoning, clostridial myositis and myonecrosis, crush injury, compartment syndrome and other acute traumatic ischemias, decompression sickness, enhancement of healing in selected problem wounds, exceptional blood loss, intracranial abscess, necrotizing soft tissue injuries, refractory osteomyelitis, soft tissue/ bone radiation necrosis, compromised skin grafts and flaps and thermal burns."[171,177] Should be closely managed by certified hyperbaric physicians/clinicians. Considerations include patient selection, monitoring of wounds, contraindications and risks of HBOT use and indications for discontinuation.
Topical pressurized oxygen therapy	Differs from HBOT in that topical pressurized oxygen therapy delivers a regulated, pressurized oxygen flow directly to a specific wound area using a portable device (e.g., a soft plastic sleeve or hard plastic chamber) that can be secured to a body surface or around an extremity to create an airtight seal.[172]	Controversy exists as to the therapeutic value of topical pressurized oxygen delivery to local tissues/wounds.

cont'd.

Category	Description	Considerations/Indications/ Contraindications
Warming therapy	Application of a heating element in the dressing that increases heat in the wound bed, inducing vasodilatation of the regional blood vessels.	Contraindications: ▪ very large areas or at sufficient intensity to raise core temperature in pregnant women, persons with severe cardiac disease or cardiac failure ▪ regions of known or suspected malignancy ▪ infected tissues or persons with TB ▪ persons with active DVT or thrombophlebitis (in the area) ▪ areas of impaired sensation that prevent the patient from giving accurate and timely feedback ▪ areas of active bleeding or persons with untreated hemorrhagic disorders ▪ recently radiated tissues ▪ persons with cognition or communication impairments that prevent the patient from giving accurate and timely feedback ▪ areas with significantly impaired circulation ▪ tissues inflamed as a result of recent injury or exacerbation of chronic inflammatory condition ▪ areas affected by heat-sensitive skin diseases (e.g., eczema) ▪ areas of severe edema ▪ reproductive organs (e.g., testes) Precautions: ▪ areas near or over eyes ▪ anterior neck and carotid sinus ▪ pregnant women ▪ people with cardiac failures ▪ areas of skin breakdown or damage that produce uneven heat conduction across the skin[178]

cont'd.

Category	Description	Considerations/Indications/ Contraindications
Biologically active dressings	Developed to find adjunctive exogenous factors to induce and stimulate healing or to produce a skin substitute for use in acute and chronic wounds.[173] Living skin equivalents (LSE), or tissue-engineered skin is a bilaminar structure of epithelium cultured on a dermal equivalent. It has characteristics that closely resemble a skin graft and is used in that capacity.[174] (This is not currently available in Canada.) Protease modulating dressings: Rebalance high protease activity levels in a stalled, healable wound. Isolated growth factors: Platelet-derived growth factor (PDGF), available as recombinant human PDGF-BB, reduces healing time and improves the incidence of complete wound healing in stage 3 and 4 pressure injuries.[136,175]	Used alone, these dressings will not effectively produce results if proper wound bed preparation does not first occur. Contraindications: ▪ wounds with infection, sinus tracts or excessive exudate ▪ patients known to have hypersensitivity to any of the product components Cultural issues related to the source of the biologically active dressing may be of concern to some patients.

4.4 Engage the team to ensure consistent implementation of the plan of care.

Discussion: Ensure that all team members have well-defined roles, are making contributions and are actively connected to and communicating with the larger team. The team needs to show continuous progress toward the goal(s) of the plan of care and provide regular feedback to all team members.

To ensure optimum care, health-care professionals need to recognize the need for their own continuing education to keep abreast of change. Researchers and industry partners are key ancillary team members that support clinicians in providing innovations for wound management. Because of ongoing developments in the areas of treatment and medication, all professional members of the team have a responsibility to remain up-to-date and share information on the latest evidence, practice and self-management strategies.[179,180]

Step 5: Evaluate Outcomes

Step 5: Evaluate Outcomes

Evaluation of the plan of care should be routine and ongoing to identify whether the plan is effective in meeting the goal(s).

Discussion: Routine reassessment and potential modifications need to be built into the plan to ensure it continues to meet the patient's needs and is sustainable. Since wound healing is only one outcome parameter and wound closure is not always realistic, other outcomes such as symptom control should also be routinely measured with standardized tools.

Recommendations

5.1 Determine if the outcomes have met the goals of care.

Discussion: The use of validated and responsive tools as well as patient feedback can assist in determining if the goals of care have been met. These tools provide benchmark assessments to determine the improvement or deterioration of a condition or wound and are best used when outcomes are of interest.[9] If goals of care have been met, discharge planning may proceed and must include a discussion of self-management strategies (See 5.3).

Documentation determines whether goals of the plan of care have been met because it verifies progress from assessment to discharge. Documentation must address the patient's needs, track clinical performance and support a defence in the event of a lawsuit. Therefore, chart entries need to be thorough, accurate, factual, objective, and follow agency policy and procedures.[181]

5.2 Reassess patient, wound, environment and system if goals are partially met or unmet.

Discussion: When goals of care are not being met, go back to Step 1 of the Wound Prevention and Management Cycle. Reassessment needs to consider the level of adherence to the plan of care by anyone involved in either the planning or implementation of care. Careful exploration may reveal modifiable factors that can be addressed. Unless these issues are discussed in a non-confrontational and sensitive manner, the patient or health-care colleague may not be able to support progress to the desired outcome.

Key documentation areas to address include the following:[182]

- completed assessment tools
- properly followed protocols
- all communication with the patient and caregivers
- all communication with health-care professionals and service providers
- patient response to care
- changes in the delivery of care

5.3 Ensure sustainability to support prevention and reduce risk of recurrence.

Discussion: Discharge planning begins at admission and should be straightforward, cost-effective and time-efficient. Discharge information for patients and caregivers should be written in plain language and, in some areas, made available in all relevant languages. Pamphlets or discharge instructions should not be simply handed to

patients as they leave; instructions should be reviewed with them and they should be given an opportunity to ask questions and provide feedback to ensure that the instructions have been understood. Patients on discharge from service should also receive clear instructions about whom to call should complications arise.

The plan of care needs to be revisited at discharge to ensure that self-management strategies are in place to support the patient to sustain the outcomes achieved after discharge. Strategies need to increase awareness, support positive behaviour choices and promote motivation. The patient-provider relationship strongly influences outcomes and may continue after discharge to ensure sustainability.

To ensure this sustainability, consideration needs to be given to patient comfort and cosmetic appearance, patient preference, product availability and the presence and ability of the caregiver to provide care and/or the patient to provide self-care.

Summary

Best practice does not occur innately; it requires substantial work as well as a framework for implementation. Sustainable best practice requires even more work and involves the patient at every step. Collaboration is required not only in the short and intermediate terms with all members of the team, but also in the longer term with stakeholders such as researchers, educators, practitioners and policymakers at individual, organizational and systems levels.

By using the framework provided in this paper the integrated team will have a systematic process to follow to effectively prevent or manage wounds. This framework has built on the three guiding principles and will provide all members of the team with a process to enable care that is individualized while still following best practice.

References

References

1. Orsted H, Keast D, McConnell H, Ratcliff C. Best Practice Guidelines, algorithms, and standards: tools to make the right thing easier to do. In: Krasner D (ed.). Chronic Wound Care. Malvern PA: HMP Communications. 2014. p. 319–330.
2. Registered Nurses' Association of Ontario (RNAO). Clinical Best Practice Guidelines: Assessment and Management of Foot Ulcers for People with Diabetes (2nd Edition). 2013.
3. Accreditation Canada. Required Organizational Practices: Handbook 2016. Available from: https://accreditation.ca/sites/default/files/rop-handbook-2016-en.pdf.
4. Erwin-Toth P, Stenger B. Teaching wound care to patients, families and healthcare providers. In: Krasner DL, Rodeheaver GT, Sibbald RG (eds.). Chronic Wound Care: A Clinical Source Book for Healthcare Professionals (4th Edition). Wayne, PA: HMP Communications. 2007. p. 45–50.
5. Sussman C, Bates-Jensen B. Wound care: A Collaborative Practice Manual for Health Professionals (4th Edition). 2012. Available from: www.rhc.ac.ir/Files/Download/pdf/nursingbooks/Wound%20Care%20A%20Collaborative%20Practice%20Manual%20for%20Health%20Professionals.2012%20-%20CD.pdf.
6. Woodbury MG. The BWAT pictorial guide and the 60-second diabetic foot screen: A commentary on developing and validating clinical materials. Wound Care Canada. 2009;7(2);44–46.
7. Streiner DL, Norman GR. Pretty Darn Quick Epidemiology. Hamilton, Ontario: B.C. Decker. 1998.
8. Flahr D, Woodbury MG, Grégoire D. Clinimetrics and wound science. Wound Care Canada. 2005;3(2):18–19.
9. Phillips J. Understanding hyperbaric oxygen therapy and its use in the treatment of compromised skin grafts and flaps. Plastic Surgical Nursing. 2005;25(2):72–80.
10. Greatrex-White S, Moxey H. Wound assessment tools and nurses' needs: An evaluation study. IWJ. 2015;12(3):293–301.
11. Kring DL. Reliability and validity of the Braden Scale for predicting pressure ulcer risk. J Wound Ostomy Continence Nurs. 2007;34(4):399–406.
12. Murphy CA, Laforet K, Da Rosa P, Da Rosa P, Tabama F, Woodbury MG. Reliability and predictive validity of Inlow's 60-Second Diabetic Foot Screen Tool. Adv Skin Wound Care. 2012;25(6):261–6.
13. Walsh B, Dempsey L. Investigating the reliability and validity of the Waterlow Risk Assessment Scale: A literature review clinical nursing research. Clinical Nursing Research. 2011;20(2):197–208.
14. Baharestani MM, Ratliff CR. Pressure ulcers in neonates and children: An NPUAP white paper. Adv Skin Wound Care. 2007;20(4).
15. Huffines B, Logsden MC. The Neonatal Skin Risk Assessment Scale for predicting skin breakdown in neonates. Issues Compr Pediatr Nurs. 1997;20(2):103–14.
16. Bates-Jensen, BM, Vredevoe DL, Brecht ML. Validity and reliability of the Pressure Sore Status Tool. Decubitus. 1992;5(6):20–28.
17. Woodbury MG, Houghton PE, Campbell KE, Keast DH. Development, validity, reliability and responsiveness of a new leg ulcer measurement tool. Adv Skin Wound Care. 2004;17:187–196.

18. Hon J, Lagden K, McLaren AM, O'Sullivan D, Orr L, Houghton PE, Woodbury MG. A prospective, multicenter study to validate use of the PUSH in patients with diabetic, venous, and pressure ulcers. Ostomy/Wound Management. 2010;56(2):26–36.

19. Houghton PE, Kincaid CB, Campbell KE, Woodbury MG, Keast DH. Photographic assessment of the appearance of chronic pressure and leg ulcers. Ostomy/Wound Management. 2000;46(4):20–26,28–30.

20. Price P, Harding K. Cardiff Wound Impact Schedule: The development of a condition-specific questionnaire to assess health-related quality of life in patients with chronic wounds of the lower limb. Int Wound J. 2004;1(1):10–17.

21 Blome C, Baade K, Debus ES, Price P, Augustin M. The "Wound-QoL": A short questionnaire measuring quality of life in patients with chronic wounds based on three established disease-specific instruments. Wound Repair Regen. 2014;22(4):504–14.

22. Augustin M, Herberger K, Rustenbach SJ, Schafer I, Zschocke I, Blome C. Quality of life evaluation in wounds: Validation of the Freiburg Life Quality Assessment wound module, a disease-specific instrument. IWJ. 2010;7(6): 493–501.

23. Laporte M, Keller HH, Payette H, Allard JP, Duerksen DR, Bernier P, et al. Validity and reliability of the new Canadian Nutrition Screening Tool in the 'real-world' hospital setting. European Journal of Clinical Nutrition. 2015;69:558–564.

24. Valderas JM, Starfield B, Sibbald B, Salisbury C, Roland M. Defining co-morbidity: Implications for understanding health and health services. Annals of Family Medicine. 2009;7(4):357–363.

25. Vowden P. Hard to heal wounds made easy. Wounds International. 2011;2(4):1–6. Available from: www.woundsinternational.com/media/issues/514/files/content_10140.pdf.

26. Moffatt C, Vowden K, Price P, Vowden P. Position Document: Hard-to-heal wounds: A holistic approach. European Wound Management Association (EWMA). London: MEP Ltd. 2008.

27. Sibbald RG, Goodman L, Woo KY, Krasner DL, Smart H, Tariq G, et al. Special considerations in wound bed preparation 2011: An update – PART ONE. Wound Care Canada. 2012;10(2):20–35.

28. Woo K, Sibbald G, Fogh K, Glynn C, Krasner D, Leaper D, et al. Assessment and management of persistent (chronic) and total wound pain. Int Wound J. 2008;5(2):205–215.

29. Upton D, Solowiej K, Hender C, Woodyatt KY. Stress and pain associated with dressing change in patients with chronic wounds. J Wound Care. 2010;21(2):53–61.

30. Woo K. Exploring the effects of pain and stress on wound healing. Adv Skin Wound Care. 2012;25(1):38–44.

31. Woo KY, Sibbald RG. The improvement of wound-associated pain and healing trajectory with a comprehensive foot and leg ulcer care model. J Wound Ostomy Continence Nurs. 2009;36(2):184–193.

32. Registered Nurses' Association of Ontario (RNAO). Nursing Best Practice Guideline: Assessment and Management of Venous Leg Ulcers. Toronto: RNAO. 2004. Available from: www.rnao.org/bestpractices/.

33. The American College of Wound Healing & Tissue Repair and The Angiogenesis Foundation. Patient-centered Outcomes in Wound Care. 2013. Available from: https://www.angio.org/wpcontent/uploads/2013/10/Wound_Care_White_Paper.pdf.

34. Kalawat TC, Chittoria RK, Reddy PK, Suneetha B, Narayan R, Ravi P. Role of lymphoscintigraphy in diagnosis and management of patients with leg swelling of unclear etiology. Indian J Nucl Med. 2012 Oct;27(4):226–230.

35. Sibbald RG, Orsted H, Coutts P, Keast D. Best practice recommendations for preparing the wound bed update 2006. Advances In Skin and Wound Care, 2006;20(7):390–405.

36. Keast DH, Fraser C. Treatment of chronic skin ulcers in individuals with anemia of chronic disease using human recombinant erythropoietin: A review of four cases. Ostomy/Wound Management. 2004;50(10):64–70.

37. Public Health Agency of Canada. The chief public health officer's report on the state of public health in Canada 2008. Available from: www.phac-aspc.gc.ca/cphorsphc-respcacsp/2008/fr-rc/cphorsphc-respcacsp07a-eng.php.

38. Flanagan, M. Improving accuracy of wound measurement in clinical practice. Ostomy/Wound Management. 2003;49(10):28–40.

39. Okan D, Woo K, Ayello EA, Sibbald G. The role of moisture balance in wound healing. Advances in Skin and Wound Care. 2007;20(1):39–53.

40. van Rijswijk L, Eisenberg M. Wound assessment and documentation. In: Krasner D (ed.). Chronic Wound Care: The Essentials. Malvern PA: HMP Communications. 2014. p. 29–45.

41. Keast DH, Bowering CK, Evans AW, Mackean GL, Burrows C, D'Souza L. MEASURE: A proposed assessment framework for developing best practice recommendations for wound assessment. Wound Repair Regen. 2004;12:SS17.

42. Swanson T, Sussman G, Angel D, Cooper R, et al. Wound infection in Clinical Practice: A 2016 International Consensus Update. International Wound Infection Institute. 2016.

43. Collier M. Recognition and management of wound infections. World Wide Wounds. 2004.

44. Eberlein T. Critical colonisation and local infection – current therapy by use of polihexanide. 2006:15–17. Available from: www.activahealthcare.co.uk/casestudies-files/SXP010-T-Eberlein-Critical-colonisation-and-local-infect.pdf.

45. Sibbald RG, Orsted H, Schultz G, Coutts P, Keast D. Preparing the wound bed 2003: Focus on infection and inflammation. Ostomy/Wound Management. 2003;49(11):24–51.

46. Enoch S and Harding K. Wound bed preparation: The science behind the removal of barriers to healing. Wounds. 2003;15(7):213–229.

47. Siddiqui AR, Bernstein JM. Chronic wound infection: Facts and controversies. Clin Dermatol. 2010;28(5):519–526.

48. Dow G, Browne A, Sibbald G, Infection in chronic wounds: Controversies in diagnosis and treatment. Ostomy/Wound Management. 1999;45(8):23–40.

49. Schultz GS, Sibbald RG, Falanga V, Ayello EA, Dowsett C, Harding K, et al. Wound bed preparation: A systematic approach to wound management. Wound Repair Regen. 2003;11(Supp 1):S1–28.

50. World Union of Wound Healing Societies (WUWHS). Principles of Best Practice: Wound Infection in Clinical Practice. An International Consensus. 2008. MEP Ltd: London.

51. Leaper DJ, Schultz G, Carville K, Fletcher J, Swanson T, Drake R. Extending the TIME concept: What have we learned in the past 10 years? Int Wound J. 2012;9(Suppl 2):1–19.

52. Miller CN, Carville K, Newall N, Kapp S, Lewin G, Larimi L, et al. Assessing bacterial burden in wounds: Comparing clinical observation and wound swabs. IWJ. 2011;8(1):45–55.

53. Vowden P, Cooper RA. An integrated approach to managing wound infection. In: European Wound Management Association (EWMA) Position Document: Management of Wound Infection. London, MEP Ltd; 2006:2–6.

54. Cooper R. Understanding wound infection. In: Cutting K, Gilchrist B, Gottrup F (eds.). Identifying Criteria for Wound Infection. European Wound Management Association Position Document. 2005. MEP Ltd: London.

55. Gardner SE, Frantz RA. Wound bioburden and infection-related complications in diabetic foot ulcers. Biol Res Nurs. 2008;10(1):44–53.

56. Gardner SE, Franz RA, Doebbeling BN. The validity of the clinical signs and symptoms used to identify localized chronic wound infection. Wound Repair Regen. 2001;9(3):178–186.

57. Gardner SE, Frantz RA, Park H, Scherubel M. The inter-rater reliability of the clinical signs and symptoms checklist in diabetic foot ulcers. Ostomy/Wound Management. 2007;53(1): 46–51.

58. Kingsley AR. The wound infection continuum and its application to clinical practice. Ostomy/Wound Management. 2003;47(Suppl A):S1–S.

59. Cutting KF, White RJ, Maloney P, Harding KD. Clinical identification of wound infection: A Delphi approach. In: Calne S (ed.). European Wound Management Association Position Document: Identifying Criteria for Wound Infection. MEP Ltd.: London. 2005.

60. Joseph WS, Lipsky BA. Medical therapy of diabetic foot infections. J Am Podiatr Med Assoc. 2010;100(5):395–400.

61. Cutting KF, Harding KG. Criteria for identifying wound infection. J Wound Care. 1994;3(4):198–20.

62. White RJ, Cutting KF, Kingsley A. Critical colonisation: Clinical reality or myth? Wounds UK. 2005;1(1):94–95.

63. Stotts NA, Hunt TK. Managing bacterial colonization and infection. Clin Geriatr Med. 1997;13:565–573.

64. Galpin JE, Chow AW, Bayer AS, Guze LB. Sepsis associated with decubitus ulcers. Am J Med. 1976;61:346–50.

65. Reddy, M, Gill SS, Wu W, Kalkar SR, Rochon PA. Does this patient have an infection of a chronic wound? JAMA. 2012;307(6).

66. Citron DM, Goldstein EJC, Vreni Mirriam C, Lipsky BA, Abramson MA. Bacteriology of moderate-to-severe diabetic foot infections and in vitro activity of antimicrobial agents. Journal Of Clinical Microbiology. 2007;45(9):2819–2828.

67. Swanson T, Keast DH, Cooper R, Black J, Shultz G, Carville K, et al. Ten top tips: Identification of wound infection in a chronic wound. Wounds Middle East. 2015;2(1):20–25.

68. Schultz GS, Sibbald RG, Falanga V, Ayello EA, Dowsett C, Harding K. Wound bed preparation: A systematic approach to wound management. Wound Repair Regen. 2003;11(Suppl 1):S1–28.

69. Ata A, Lee J, Bestle SL, Desemone J, Stain SC. Postoperative hyperglycemia and surgical site infection in general surgery patients. Arch Surg. 2010;145(9):858–64.

70. Lecube A, Pachón G, Petriz J, Hernández C, Simo R. Phagocytic activity is impaired in type 2 diabetes mellitus and increases after metabolic improvement. PLoS One. 2011;6(8):e23366.

71. Cheadle WG. Risk factors for surgical site infection. Surg Infect (Larchmt). 2006;7(Suppl 1):S7–11.

72. Reichman D, Greenberg JA. Reducing surgical site infections: A review. Rev Obstet Gynecol. 2009;2(4):212–21.

73. Haubner F, Ohmann E, Pohl F, Strutz J, Gassner HG. Wound healing after radiation therapy: Review of the literature. Radiat Oncol. 2012;7:162.

74. Gottrup F, Melling A, Hollander DA. An overview of surgical site infections: Aetiology, incidence and risk factors. World Wide Wounds. 2005. Available from: www.worldwidewounds.com/2005/september/Gottrup/Surgical-Site-Infections-Overview.html.

75. Korol E, Johnston K, Waser N, Sifakis F, Jafri HS, Lo M, et al. A systematic review of risk factors associated with surgical site infections among surgical patients. PLoS One. 2013;8(12).

76. Sen CK. Wound healing essentials: Let there be oxygen. Wound Repair Regen. 2009;17(1):1–18.

77. Stechmiller JK. Understanding the role of nutrition and wound healing. Nutr Clin Pract. 2010;25(1).

78. Gouina JP, Kiecolt-Glaser J. The impact of psychological stress on wound healing: Methods and mechanisms. Immunol Allergy Clin North Am. 2011;31(1):81–93.

79. Curtis B, Hlavin S, Brubaker A, Kovacs ER, Radek KA. Episodic binge ethanol exposure impairs murine macrophage infiltration and delays would closure by promoting defects in early innate immune responses. Alcohol Clin and Exper Res. 2014;38(5):1347–1355.

80. Sørensen LT. Wound healing and infection in surgery: The pathophysiological impact of smoking, smoking cessation, and nicotine replacement therapy: A systematic review. Ann Surg. 2012;255(6):1069–1079.

80. Torpy JM, Burke A, Glass RM. Wound infections. JAMA. 2005;294(16):2122.

82. Gibson D, Cullen B, Legerstee R, Harding KG, Schultz G. MMPs made easy. Wounds International. 2009;1(1).

83. International Wound Infection Institute (IWII). Glossary of Terms in Wound Infection. October 2009. Available from: www.woundinfection-institute.com/wp-content/uploads/2014/04/iwii_glossary_2009.doc.

84. Pieper C, Rotard W. Investigation on the removal of natural and synthetic estrogens using biofilms in continuous flow biofilm reactors and batch experiments analysed by gas chromatography/mass spectrometry. Water Res. 2011;45(3):1105–14.

85. Keast D, Swanson T, Carville K, Fletcher J, Schultz G, Black J. Top ten tips: Understanding and managing wound biofilm. Wounds International. 2014;5(2):20–24.

86. Thomson CH. Biofilms: Do they affect wound healing? IWJ. 2011;8(1):63–67.

87. Woo KY, Sibbald RG. A cross-sectional validation study of using NERDS and STONEES to assess bacterial burden. Ostomy/Wound Management. 2009;55(8):40–48.

88. Winter GD. Formation of scab and rate of epithelialization of superficial wounds in the skin of the young domestic pig. Nature. 1962;193:293–294.

89. Romanelli M, Vowden K, Weir D. Exudate management made easy. Wounds International. 2010;1(2). Available from: www.woundsinternational.com.

90. Morgan N. Wound exudate types. Wound Care Advisor. Available from: http://woundcareadvisor.com/wound-exudate-types/.

91. Stewart M, Brown JB, Weston WW, McWhinney IR, McWilliam CL, Freeman TR. Patient-centered Medicine: Transforming the Clinical Method (3rd Edition). Oxford UK: Radcliffe Publishing Ltd. 2014.

92. Enoch S, Price P. Should alternative endpoints be considered to evaluate outcomes in chronic recalcitrant wounds? 2004. Available from: www.worldwidewounds.com/2004/october/Enoch-Part2/Alternative-Enpoints-To-Healing.html.

93. Nutrition Services, Alberta Heath Services. Setting SMART Goals. Available from: https://myhealth.alberta.ca/Alberta/Pages/Setting-smart-goals.aspx.

94. Despatis M, Shapera L, Parslow N, Woo K. Complex wounds. Wound Care Canada. 2008;8(2):24–25. Available from: http://cawc.net/images/uploads/wcc/CW.pdf.

95. Moore Z, Butcher G, Corbett LQ, McGuiness W, Snyder RJ, van Acker K. Exploring the concept of a team approach to wound care: Managing wounds as a team. 2014. http://aawconline.org/wp-content/uploads/2014/11/AAWC_AWMA_EWMA_ManagingWoundAsATeam.pdf.

96. Krasner DL, Rodeheaver GT, Sibbald RG, (eds.). Chronic Wound Care: A Clinical Source Book for Healthcare Professionals (4th Edition). Wayne, PA: HMP Communications. 2007.

97. Hess C. Performing a skin assessment. Nursing. 2010;40(7):66. Available from: http://journals.lww.com/nursing/Fulltext/2010/07000/Performing_a_skin_assessment.20.aspx.

98. Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS. Evidence based medicine: What it is and what it isn't. BMJ. 1996;312(7023):71–2. Available from: www.dcscience.net/sackett-BMJ-1996.pdf.

99. Vina J, Sanchis-Gomar F, Martinez-Bello V, Gomez-Cabrera MC. Exercise acts as a drug; The pharmacological benefits of exercise. Br J Pharmacol. 2012;167(1):1–12.

100. Balducci S, et al. Exercise training can modify the natural history of diabetic peripheral neuropathy. Journal of Diabetes and Its Complications. 2006;20:216–223.

101. Castro-Sanchez AE and Avila-Ortiz MN. Changing dietary habits in persons living with type 2 diabetes. J Nutr Educ Behav. 2013;45(6):761–766.

102. Li L, Manor B. Long term Tai Chi exercise improves physical performance among people with peripheral neuropathy. Am J Chin Med. 2010;38:449–459.

103. Pieber K, Herceg M, and Paternostro-Sluga T. Electrotherapy for the treatment of painful diabetic peripheral neuropathy: A review. Journal of Rehabilitation Medicine. 2010;42(4):289–295.

104. Snowling NJ, Hopkins WG. Effects of different modes of exercise training on glucose control and risk factors for complications in type 2 diabetic patients: A meta-analysis. Diabetes Care. 2006;29(11):2518–2527.

105. Treat-Jacobson D, Bronas U, Leon A. Efficacy of armergometry verses treadmill exercise training to improve walking distance in patients with claudication. Vascular Medicine. 2009;14:203–213.

106. Ayello EA. Preventing pressure ulcers and skin tears. Available from: www.guideline.gov/summary/summary.aspx?ss=15&doc_ id=3511&nbr=2737 [Accessed 30th April 2007].

107. Kane DP. Chronic wound healing and chronic wound management. In: Krasner DL, Rodeheaver GT, Sibbald RG, (eds.). Chronic Wound Care: A Clinical Source Book for Healthcare Professionals (4th Edition). Wayne, PA: HMP Communications. 2007. p. 11–24

108. Posthauer ME. The role of nutrition in wound care. Skin & Wound Care. 2012;25(2):62–63. Available from: http://journals.lww.com/aswcjournal/Fulltext/2012/02000/The_Role_of_Nutrition_in_Wound_Care.5.aspx.

109. Zagoren AJ, Johnson DR, Amick N. Nutritional assessment and intervention in the adult with a chronic wound. In: Krasner DL, Rodeheaver GT, Sibbald RG, (eds.). Chronic Wound Care: A Clinical Source Book for Healthcare Professionals (4th Edition). Wayne, PA: HMP Communications. 2007.

110. Collins N, Schnitzer A. How dietary protein intake promotes wound healing. Wound Care Advisor. 2013. Available from: http://woundcareadvisor.com/wp-content/uploads/2013/11/Protein_N-D13.pdf.

111. Sibbald RG, Kelley J, Kennedy-Evans KL, Labreque C, Waters N. A practical approach to the prevention and management of intertrigo, or moisture-associated skin damage, due to perspiration: Expert consensus on best practice. Wound Care Canada. 2013;11(2 – supplement):1–22. Available from: www.woundcarecanada.ca/wp-content/uploads/WCCv11n2SUPPLEMENT-Intertrigonc.pdf.

112. Beeckman D, et al. Proceeding of the Global Expert Panel. Incontinence associated dermatitis: Moving prevention forward. A Consensus Document. Wounds International 2015. Available from: www.woundsinternational.com.

113. Keast D, Parslow N, Houghton P, Norton L, Fraser C. Best practice recommendations for the prevention and treatment of pressure ulcers: Update 2006. Wound Care Canada. 2006;4(1):19–29.

114. Krasner DL, Papen J, Sibbald RG. Helping patients out of the SWAMP: Skin and wound assessment and management of pain. In: Krasner DL, Rodeheaver GT, Sibbald RG, (eds.). Chronic Wound Care: A Clinical Source Book for Healthcare Professionals (4th Edition). Wayne, PA: HMP Communications. 2007.

115. World Health Organization (WHO). WHO's cancer pain ladder for adults. Available from: www.who.int/cancer/palliative/painladder/en/.

116. National Health Service (NHS). The Clinical Case for Smoking Cessation for WOUND CARE. Available from: www.ncsct.co.uk/usr/pub/interventions-in-secondary-care-june-10-wound-care-factsheet.pdf.

117. Hess CT. Checklist for nutrients necessary for wound healing. Advances in Skin and Wound Care. 2011;24(5): 240.

118. Upton D, Upton P. Psychology of Wounds and Wound Care in Clinical Practice. Springer International Publishing. 2015: chapter 3.

119. Canadian Psychology Association. Psychology Works Fact Sheets. 2016. Available from: www.cpa.ca/psychologyfactsheets/.

120. National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel. Pressure ulcer TREATMENT recommendations. In: Prevention and Treatment of Pressure Ulcers: Clinical Practice Guideline. NGC-8204. 2009.

121. Reddi BAJ. Why is saline so acidic (and does it really matter?). Int J Med Sci. 2013;10(6):747–750.

122. Braun M, McGrath A, and Downie F. Octenilin® range made easy. Wounds UK. 2013;9(4).

123. Drosou A, Falabella A, and Kirsner RS. Antiseptics on wounds: An area of controversy. Wounds. 2003;15(5): 149–166.

124. Cutting K, Westgate S. The use of cleansing solutions in chronic wounds. Wounds UK. 2012;8(4):130–133.

125. Edwards-Jones V, Flanagan M, and Wolcott R. Technological advancements in the fight against antimicrobial resistance. Wounds International. 2015;6(2):47–51.

126. Wound Healing and Management Group. Evidence summary: Wound infection: Iodophors and biofilms. Wound Practice and Research. 2013;21(2):86–87.

127. Leaper DJ, Durani P. Topical antimicrobial therapy of chronic wounds healing by secondary intention using iodine products. Int Wound J. 2008;5(2):361–368.

128. European Wound Management Association (EWMA). Debridement: An updated overview and clarification of the principle role of debridement. 2013. Available from: http://ewma.org/fileadmin/user_upload/EWMA/pdf/EWMA_Projects/Debridement/EWMA_Debridement_Document_JWCfinal.pdf.

129. Margolin L, Gialanella P. Assessment of the antimicrobial properties of maggots. IWJ. 2010;7(3)202–204.

130. Parnés A, Lagan KM. Larval therapy in wound management: A review. Int J Clin Pract. 2007;61(3):488–93.

131. LeBlanc K, Woo K, Christensen D, Forest-Lalande L, O'Dea J, Varga M, McSwiggan J, van Ineveld C. Best practice recommendations for the prevention and management of skin tears. A supplement of Wound Care Canada. 2017.

132. Rodeheaver GT, Ratliff CR. Wound cleansing, wound irrigation, wound disinfection. In: Rodeheaver GT, Krasnder DI, Sibbald RG (eds.). Chronic Wound Care: A Clinical Source Book for Healthcare Professionals. Malvern PA: HMP Communications. 2007.

133. Dam W, Winther C, Masmussen GS. Methods for cleaning and debridement of wounds – experiences with Debrisoft. 2011;19:182–184. Available from: http://ewma.org/fileadmin/user_upload/EWMA/pdf/journals/EWMA_Journal_1_2013_WEB.pdf.

134. Michailidis L, Williams CM, Bergin SM, Haines TP. Comparison of healing rate in diabetes-related foot ulcers with low frequency ultrasonic debridement versus non-surgical sharps debridement: A randomised trial protocol. Journal of Foot and Ankle Research. 2014;7(1).

135. National Institute for Health and Clinical Excellence (NICE). The Versajet II Hydrosurgery System for Surgical Debridement of Acute and Chronic Wounds and Burns. 2014. Available from: https://www.nice.org.uk/advice/mib1.

136. Gabriel, A. Wound Irrigation. 2015. Available from: http://emedicine.medscape.com/article/1895071-overview.

137. Broadus C. Debridement options: BEAMS made easy. Wound Care Advisor. 2013;2(2):15–18. Available from: http://woundcareadvisor.com/wp-content/uploads/2013/03/BP_BEAMS_M-A13.pdf.

138. Ramudo J, Gray M. Enzymatic wound debridement. Journal of Wound Ostomy Continence Nursing. 2008;35(3):273–280.

139. Salcido R. Enzymatic debridement: A tried and tested method. Adv Skin Wound Care. 2000;13:92.

140. Rodd-Nielsen E, Brown J, Brooke J, Fatum H, Hill M, Morin J, St-Cyr L, in association with the Canadian Association for Enterostomal Therapy (CAET). Evidence-Based Recommendations for Conservative Sharp Wound Debridement. 2011. Available from: www.caet.ca/wp-content/uploads/2015/02/caet-ebr-cswd-2013-04.pdf.

141. Woo KY, Keast D, Parsons N, Sibbald RG, Mittmann N. The cost of wound debridement: A Canadian perspective. Int Wound J. 2015;12(4):402–407.

142. Edwards, K. New twist on an old favorite: Gentian violet and methylene blue antibacterial foams. Adv Wound Care (New Rochelle). 2016;5(1):11–18.

143. Ammons MC, Copie V. Mini-review: Lactoferrin: A bioinspired, anti-biofilm therapeutic. Biofouling. 2013;29(4):443–455.

144. Cooper RA. Inhibition of biofilms by glucose oxidase, lactoperoxidase and guaiacol: The active antibacterial component in an enzyme alginogel. Int Wound J. 2013;10(6):630–637.

145. Cooper RA, Bjarnsholt T, Alhede M. Biofilms in wounds: A review of present knowledge. J Wound Care. 2014;23(11):570–580.

146. Suman E, Madhavi R, Shashidhar Kotian M. Role of bacterial biofilms in chronic non-healing ulcers and effect of subinhibitory concentrations of betadine and hydrogen peroxide on biofilms. J Hosp Infect. 2009;73:87–89.

147. Hill KE, Malic S, McKee R, Rennison T, Harding KG, Williams DW, et al. An *in vitro* model of chronic wound biofilms to test wound dressings and assess antimicrobial susceptibilities. *J Antimicrob Chemother.* 2010;65:1195–1206.

148. Cooper R, Jenkins L, Hooper S. Inhibition of biofilms of *Pseudomonas aeruginosa* by Medihoney *in vitro*. *J Wound Care*. 2014;23(3):93–104.

149. Roberts A, Maddocks SE, Cooper RA. Manuka honey is bactericidal against *Pseudomonas aeruginosa* and results in differential expression of oprF and algD. *Microbial Pathogenicity*. 2012;158:3005–3013.

150. Majtan J, Bohova J, Horniackova M, Klaudiny J, Majtan V. Anti-biofilm effects of honey against wound pathogens *Proteus mirabilis* and *Enterobacter cloacae*. *Phytother Res*. 2014;28(1):69–75.

151. Lu J, Turnbull L, Burke CM, Liu M, et al. Manuka-type honeys can eradicate biofilms produced by *Staphylococcus aureus* strains with different biofilm-forming abilities. *PeerJ*. 2014;2:e326.

152. Wang R, Starkey M, Hazan R, Rahme LG, Honey's ability to counter bacterial infections arises from both bactericidal compounds and QS inhibition. Front Microbiol. 2012;3:144.

153. Haesler E for Wound Healing and Management Group. Evidence summary: Wound infection: Silver products and biofilm. Wound Practice and Research. 2013;21(3):126–127.

154. Cutting K, McGuire J. Safe bioburden management: A clinical review of DACC technology. J Wound Care. 2015;24(5):S1–30.

155. Cooper R, Okhiria O. Biofilms, wound infection and the issue of control. Wounds UK. 2006;2(3):48–57.

156. Anti-infective Review Panel. Anti-infective Guidelines for Community-acquired Infections. 2013 Edition. Mums Health.

157. Knighton DR, Silver JA, Hunt TK. Regulation of wound-healing angiogenesis: Effect of oxygen gradients and inspired oxygen concentration. Surgery. 1981;90:262–270.

158. Hamiowitz JE, Margolis DJ. Moist wound healing. In: Krasner D, Jane D (eds.). Chronic Wound Care: A Clinical Source Book for Healthcare Professionals. Wayne PA: Health Management Publications. 1997. p. 49–55.

159. Hutchinson JJ, McGuckin M. Occlusive dressings: A microbiologic and clinical review. Am J Infect Control. 1990;18:257–268.

160. Health Canada. Policy on Drug/Medical Device Combination Products – Decisions. 2014. Available from: www.hc-sc.gc.ca/dhp-mps/prodpharma/applic-demande/pol/combo_mixte_dec_pol-eng.php.

161. Krasner D. Dressing decisions for the twenty-first century: On the cusp of a paradigm shift. In: Krasner D, Jane D (eds.). Chronic Wound Care: A Clinical Source Book for Healthcare Professionals (2nd edition). Wayne PA: Health Management Publications. 1997. p. 139–151.

162. Jones V, Harding K. Moist Wound Healing: Optimizing the wound environment. In: Krasner D, Rodeheaver GT, Sibbald RG (eds.). Chronic Wound Care: A Clinical Source Book for Healthcare Professionals (4th edition). Malvern PA: HMP Communications. 2007. p. 199–204.

163. Queen D, Orsted H, Sanada H, Sussman G. A dressing history. International Wound Journal. 2004;1(1):59–77.

164. Cockbill SME, Turner TD. The development of wound management products. In: Krasner D (ed.). Chronic Wound Care: The Essentials. Malvern PA: HMP Communications. 2014. p. 145–163.

165. Myer A. The role of physical therapy in chronic wound care. In: Krasner DL, Rodeheaver GT, Sibbald RG (eds.). Chronic Wound Care: A Clinical Source Book for Healthcare Professionals (3rd edition). Wayne PA: HMP Communications. 2001. p. 421–434.

166. Aziz Z, Flemming K, Cullum N, Olyaee Manesh A. Electromagnetic therapy for treating pressure ulcers (Review). Cochrane Database Syst Rev. Hoboken, NJ: John Wiley & Sons. 2010;11:1–27.

167. Nussbaum EL, Biemann I, Mustard B. Comparison of ultrasound/ultraviolet-C and laser for treatment of pressure ulcers in patients with spinal cord injury. Phys Ther. 1994;74(9):812–825.

168. Albert M. The role of hyperbaric oxygen therapy in wound healing. Wound Care Canada. 2008;6(1):60–62.

169. Gray M, Ratliff CR. Is hyperbaric oxygen therapy effective for the management of chronic wounds? J Wound Ostomy Continence Nurs. 2006;33(1):21–25.

170. Wright, J. Hyperbaric oxygen therapy for wound healing. World Wide Wounds. 2001. Available from: www.worldwidewounds.com/2001/april/wright/HyperbaricOxygen.html.

171. Undersea & Hyperbaric Medical Society. Indications for Hyperbaric Oxygen Therapy. 2016. Available from: www.uhms.org/resources/hbo-indications.html.

172. Rund, C, Sussman, G. Nontraditional or alternative topical therapies for wound care. In: Krasner DL, Rodeheaver GT, Sibbald RG (eds.). Chronic Wound Care: A Clinical Source Book for Healthcare Professionals (4th edition). Malvern PA: HMP Communications. 2007.

173. Ehrenreich M, Ruszczak Z. Update on tissue-engineered biological dressings. Tissue Eng. 2006;12(9):2407–2424.

174. Mooney EK, Lippitt C, Reynolds R. Alternate applications of living skin equivalent. Wounds. 2002;14(7):257–265.

175. Gabriel A. Wound Healing and Growth Factors. Medscape. 2015. Available from: http://emedicine.medscape.com/article/1298196-overview#a3.

176. Houghton PE, Karen KE, Fraser CH, Harris C, Keast DH, Potter PJ, et al. Electrical stimulation therapy increases rate of healing of pressure ulcers in community-dwelling people with spinal cord injury. Arch Phys Med Rehabil . 2010;91(5):669–678.

177. Broussard CL. Hyperbaric oxygenation and wound healing. J Wound Ostomy Continence Nurs. 2003;30(4):210–216.

178. Rennie S. Electrophysical agents: Contraindications and precautions: An evidence-based approach to clinical decision making in physical therapy. Physiother Can. 2010;62(5):1–80.

179. Registered Nurses' Association of Ontario (RNAO). Complications for People with Diabetes. Toronto, ON: RNAO, 2007.

180. Registered Nurses' Association of Ontario (RNAO). Nursing Best Practice Guideline: Assessment and Management of Foot Ulcers for People with Diabetes. Toronto, ON: RNAO, 2005.

181. Knowlton SP and Brown G. Legal aspects of wound care. In: Baranoski S, Ayello EA (eds.). Wound Care Essentials: Practice Principles (2nd Edition). Philadelphia, PA: Lippincott Williams & Wilkins. 2007. p. 38.

182. Tippett A. Wound Documentation Standards to Follow to Help Avoid Legal Issues. Available from: www.woundsource.com/blog/wound-documentation-standards-follow-help-avoid-legal-issues.