

Best Practice Recommendations for the Prevention and Treatment of Pressure Ulcers: Update 2006

BY David H. Keast, MSc, MD, FCFP; Nancy Parslow, RN, ET; Pamela E. Houghton, BScPT, PhD; Linda Norton, OT Reg (Ont); and Chris Fraser, BSc, RD

Abstract

In 2000 the Canadian Association of Wound Care (CAWC) produced and had published in *Ostomy/Wound Management* best practice recommendations for the prevention and treatment of pressure ulcers. These were based on a literature search and a review of a number of clinical practice guidelines available at that time. Since then, the Registered Nurses' Association of Ontario (RNAO) has initiated a rigorous guideline development process.

The CAWC pressure ulcer recommendations were subsequently reviewed and related to the corresponding RNAO guidelines for the prevention and treatment of pressure ulcers. These best practice recommendations are intended to serve as practice enablers

backed by the rigorous evidence review in the RNAO guidelines. The evidence review has produced only minor changes to the original recommendations. Clinical decision-making in the treatment of pressure ulcers can be guided by the algorithm that directs the clinician to identify and treat the underlying causes, to identify and manage patient-centred concerns and to provide for good local wound care, considering adjunctive therapies or biologically active dressings when the edge of the wound is not advancing. Finally, the recommendations advise putting in place those organizational and educational activities that support the translation of the guidelines into practice.

Introduction

As the population ages in North America, the at-risk population for pressure ulcers will increase. A recent review of databases in Canada¹ estimated that one in four patients in acute care and one in three patients in long-term care had a pressure ulcer. The overall prevalence across all institutions was 26 per cent. While the majority (50 per cent) of these were Stage I ulcers, these prevalence data are of concern. Comparison of prevalence data can be somewhat misleading as a result of different methodologies, but studies from other countries suggest lower prevalence. In a six-year review of sequential data from acute-care hospitals in the United States,² prevalence rates ranged from a low of 14 per cent to a high of 17 per cent. Another study compared prevalence in acute-care settings in both Germany and the Netherlands using consistent methodology.³ The prevalence in the Netherlands was 22 per cent as compared to Germany at 12 per cent, but when the prevalence rates were calculated for only those patients at highest risk according to the Braden scores, the prevalence

rates became more equal (33 per cent vs. 28 per cent). With the current trend in Canada to fewer acute-care beds and more outpatient management of medical conditions, the higher prevalence rates in Canadian acute-care settings may relate to the high acuity of hospitalized patients. Long-term-care rates may be more comparable across different countries. One study in the U.S. looked at the incidence of pressure ulcers over a 12-week period in 95 long-term-care facilities.⁴ The incidence was 29 per cent. When one accounts for existing pressure ulcers during the same period, the prevalence data may approach those reported in the Canadian review. Nonetheless, pressure ulcers are costly to treat and create a significant impact on the quality of life for affected individuals. One Irish study⁵ showed that it cost an astonishing € 119,000 to treat one pressure ulcer.

Increasingly, pressure ulcers are being regarded as an indicator of quality of care. Recently, one Canadian province, Saskatchewan, included pressure ulcers in the list of critical incidents. Even when best practices are implemented, however, not all pressure ulcers may

be avoidable. In a 2001 survey of pressure ulcer experts, 62 per cent disagreed with the statement “all pressure ulcers are preventable.”⁶

In 2000 the Canadian Association of Wound Care (CAWC) had published in *Ostomy/Wound Management* best practice recommendations for the prevention and management of pressure ulcers.⁷ These were not intended to be a clinical practice guideline, but rather a distillation of existing guidelines into a succinct practice enabler (a quick reference guide) usable at the bedside but backed up by the existing guidelines that provided more in-depth information. Since that time, the Registered Nurses’ Association of Ontario (RNAO) has obtained stable long-term funding from the Ontario Ministry of Health and Long-Term Care to undertake a rigorous nursing guideline development and maintenance process. The CAWC felt that rather than “reinventing the wheel,” it would work with these guidelines to produce practice enablers that would be based in the evidence of these guidelines but interpreted for the multiple health-care professionals involved in the management of chronic wounds.

This current review of the 2000 CAWC recommendations is based on a literature search of CINAHL, Medline and Cochrane databases as well as the following RNAO guidelines (available free to download at www.rnao.org):

1. Registered Nurses’ Association of Ontario (RNAO). *Nursing Best Practice Guideline: Risk Assessment and Prevention of Pressure Ulcers* (2005).⁸
2. Registered Nurses’ Association of Ontario (RNAO). *Nursing Best*

Practice Guideline: Assessment and Management of Stage I to IV Pressure Ulcers (2002).⁹

3. Registered Nurses’ Association of Ontario (RNAO). *Nursing Best Practice Guideline: Assessment and Management of Pain* (2002).¹⁰
4. Registered Nurses’ Association of Ontario (RNAO). *Nursing Best Practice Guideline: Promoting Continence Using Prompted Voiding* (2005).¹¹

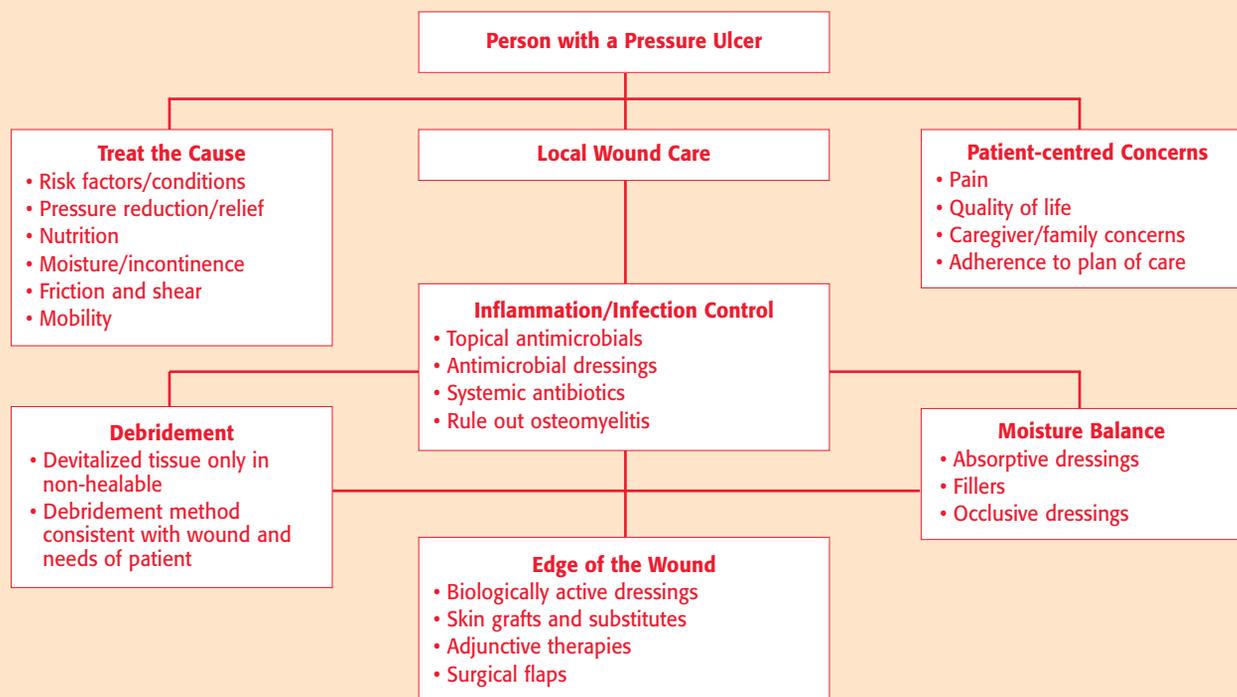
A summary of the updated recommendations is listed in Table 1. Between 2002 and 2005, the RNAO moved to different levels of evidence for their recommendations, and these are compared in Table 2. The recommendations are grouped to correspond to the Pathway to Assessment/Treatment algorithm shown in Figure 1. This algorithm is designed to assist clinical decision-making at the bedside. Finally, a discussion of each recommendation that reviews the relationship to specific RNAO guidelines and newer available evidence follows. It is important to note that the final two recommendations speak to the organizational and educational support required to implement these recommendations.

Recommendation 1: (Level of Evidence: Prevention IV, Management C)

Complete a patient history and a targeted physical examination to determine general health and risk factors that may lead to pressure ulcer formation or that may affect healing of existing ulcers.

FIGURE 1

Pathway to Assessment/Treatment of Pressure Ulcers



Adapted from Sibbald RG, Orsted HL, Schultz GS, et al.¹²

TABLE 1

Quick Reference Guide for the Treatment and Prevention of Pressure Ulcers

| Recommendations | RNAO Guidelines | | Overall | |
|---|--|---|---|-----|
| | Prevention ^a | Management ^a | Level of Evidence | |
| Identify and Treat the Cause | | | | |
| 1 | Complete a patient history and a targeted physical examination to determine general health and risk factors that may lead to pressure ulcer formation or that may affect healing of existing ulcers. | 1.1, 1.2(IV) | 1, 12, 21(C) | IV |
| 2 | Assess and modify situations where pressure may be increased. | 3.1(IV), 3.5(la), 3.6(la), 3.7(IV), 3.8(IV) | 11(C), 13(A), 14(B), 15(B), 16(B), 17(C), 18(C) | IV |
| 3 | Maximize nutritional status. | 3.11(IV, lb) | 7(B), 8(C) | IV |
| 4 | Manage moisture and incontinence. | 3.9(IV), 3.10(IV) | 34(B) | IV |
| 5 | Maximize activity and mobility, reducing or eliminating friction and shear. | 1.3(IV), 3.2(IV), 3.7(IV), 3.12(IV) | | IV |
| Address Patient-centred Concerns | | | | |
| 6 | Assess and control pain. | 3.3a(IV), 3.3b(IV), 3.3c(IV) | 9(C), 10(B) | IV |
| 7 | Assess and assist with psychosocial needs. | | 2, 3 | IV |
| Provide Local Wound Care | | | | |
| 8 | Stage, assess and treat the wound. Provide an optimal wound environment consistent with the principles of <i>Preparing the wound bed</i> . | 1.4a(IV), 1.5(IV), 2.1(IV) | 4(C), 5(C), 6(C), 19(C), 20(C), 22(C), 23(C), 24(B), 25(C), 26(B), 27(C), 28(C), 29(B), 30(A), 31(B/C), 32(A), 33(C), 34(B), 37(A), 38(B), 39(C), 40(A), 41(A), 42(C), 43(C), 44(B) | III |
| 9 | Introduce adjunctive modalities or biologically active dressings where appropriate. | | 35(A), 36(A/B/C) | la |
| 10 | Consider surgical intervention for deep non-healing ulcers (Stage III and Stage IV). | | 45 | IV |
| Provide Organizational Support | | | | |
| 11 | Develop an interdisciplinary team specific to the needs of the patient. | | 57 | IV |
| 12 | Educate patients, caregivers, and health-care providers on the prevention and treatment of pressure ulcers. | 5.1(IV), 5.2(III), 6.2(IV) | 48(C), 49(C), 50(C), 519(C), 52(C) | IV |

Discussion

Essentially this recommendation remains unchanged from the previous paper and is consistent across all clinical practice guidelines related to pressure ulcers. The RNAO guidelines (Risk Assessment and Prevention recommendations 1.1 and 1.2,⁸ Assessment and Management 21⁹) recommend a risk assessment that includes a head-to-toe skin assessment at admission to a facility and at a frequency thereafter that depends on the care setting. Expert opinion clearly

supports the use of validated risk assessment tools (e.g., Norton, Braden, Waterlow, Gosnell), but controversy exists over which tool is best suited to a particular care setting. A recent study in Belgium suggested that the use of the Braden and Norton scales leads to 80 per cent of patients receiving unnecessary preventative measures, but that both scales were better at predicting pressure ulcers than the clinical judgement of nurses.¹³ In Iran, a study compared the four previously noted scales and found no sufficient evidence to recom-

TABLE 2

Comparison of RNAO Levels of Evidence

| Previous Levels | New Levels |
|--|---|
| A At least two RCTs* as part of a quality body of evidence | Ia Meta-analysis or systematic review |
| | Ib At least one RCT |
| B Well constructed trials but no RCTs | IIa At least one well-designed controlled study but without randomization |
| | IIb At least one well-designed quasi-experimental study |
| | III Well-designed observational studies |
| C Expert opinion, indicates absence of applicable studies | IV Expert opinion, indicates absence of applicable studies |

*RCT = Randomized controlled trial

mend one tool over another, but did find the Gosnell score was more appropriate for patients with orthopedic or neurologic conditions.¹⁴ In any case, expert opinion recommends the consistent use of a specific validated tool and the development of care plans based on the subscales identified as being at risk. This recommendation was recently supported for the Braden Scale in the acute-care setting by work done in Ottawa, Canada.¹⁵

As well as the extrinsic risk factors that are addressed by the risk assessment tools, the RNAO guidelines also recommend assessing for

intrinsic risk factors that include the physical, psychosocial and medical condition.^{8,9} Factors such as neurological disease, advanced age, hydration status, peripheral vascular disease (Management recommendation 12) and level of consciousness must be taken into account.^{8,9}

Once a person has developed a pressure ulcer, healability will depend upon the ability of the care team to address both the intrinsic and extrinsic factors. Assessment is therefore critical in developing care plans and assisting patients and families in determining the goals of care.

Recommendation 2: (Level of Evidence: Prevention Ia–IV, Management A–C)

Assess and modify situations where pressure may be increased.

Discussion

Multiple recommendations in both the RNAO Risk Assessment and Prevention⁸ and Assessment and Management⁹ guidelines support this recommendation from the original best practice article.⁷ A Cochrane Review¹⁶ supports using higher specification foam mattresses for persons at risk of developing pressure ulcers. The relative merits of using constant low-pressure or alternating pressure surfaces for prevention were less clear.

Treating the cause of the pressure ulcer is an important part of the treatment plan.¹⁷ One of the primary causes of pressure ulcers is areas of high pressure, which are usually over bony prominences. The positioning checklist in the RNAO Assessment and Management guideline recommends avoiding positioning the patient over his/her pressure ulcer or trochanter and using pillows and wedges to facilitate this positioning.⁹ Pillows and wedges are also used to prevent pressure on the heels and contact between bony prominences, such as

TABLE 3

Factors to Consider When Selecting a Therapeutic Support Surface¹⁹

| Dimension | Considerations |
|--------------------|---|
| Patient Needs | <ul style="list-style-type: none"> • Assess the patient's physical status, number of sores, etc. • Ensure the patient knows their adherence and acceptance are important. • Discuss impact of each type of therapeutic support surface being considered on the patient's activities of daily living (ADLs) and how ADLs can be improved if this surface is selected. <ul style="list-style-type: none"> ◦ For example, some surfaces are less stable than others. A decrease in stability may translate into decreased balance for the patient and a decreased ability to be independent with dressing and other activities. • Evaluate transfer situations and assess ways to decrease transfer shearing forces. |
| Environment | <ul style="list-style-type: none"> • Product must be suitable for patient's living arrangements. Beds or chairs must fit in home/living environment. • Consider effects of beds, seating on others (e.g., significant other). <ul style="list-style-type: none"> ◦ For example, will the noise of the pump for the mattress disrupt the sleep of their significant other? |
| Caregivers | <ul style="list-style-type: none"> • Assess caregivers' role, including maintenance of product, impact on care routine, manageability and ease of use. |
| Product Parameters | <ul style="list-style-type: none"> • Ensure product allows for good alignment, posture and support. • Assess costs (extra features such as power, linen). • Choose durability according to use, and weight limits according to patient size. • Ensure fit with overall patient management plan. <ul style="list-style-type: none"> ◦ For example, if the goal is to decrease pressure and shearing, the therapeutic support surface must not contribute to increased pressure and shearing, not just when the patient is in bed but also during transfers. |

TABLE 4

Support Surface Types and their Impact on the Patient²⁰

| | Category | Clinical Considerations in Addition to Interface Pressure |
|---------|--|--|
| Static | Standard (hospital bed or patient's regular bed at home) | <ul style="list-style-type: none"> • Patient does not have to accommodate to a new surface. |
| | Foam overlay (4-inch egg-crate or convoluted foam) | <ul style="list-style-type: none"> • Requires frequent replacement (who will do this and when?). • Deteriorates when exposed to moisture. • Can be warm. |
| | Foam mattress (replaces the standard hospital mattress) | <ul style="list-style-type: none"> • Can often be adapted with foam or gel in high-risk areas. • Less expensive than dynamic solutions. • Generally does not impact transfers or bed mobility. |
| | Static flotation (air cells, gel, fluid overlays/mattresses) | <ul style="list-style-type: none"> • Generally less expensive than dynamic surfaces. • May require less maintenance (gel, fluid). • Air mattresses/overlays may require some maintenance. |
| Dynamic | Alternating air (large air bolsters alternately over-inflate and under-inflate in sequence) | <ul style="list-style-type: none"> • Noise of the pump and movement of the mattress may be disturbing. • Can decrease bed mobility and make transfers more difficult. |
| | Low air loss (air constantly escapes through the bladders, reducing surface tension) | <ul style="list-style-type: none"> • As above. • Low air loss mattresses may be better able to manage excessive moisture. |
| | Turning/rotation (assists patient position changes) | <ul style="list-style-type: none"> • Motion of the bed can disrupt sleep. • Patient may not be well positioned after the turn related to position on surface, contractures, etc. • Noise, ease of transfers and bed mobility remain issues. |
| | Air fluidized (patient is "floating" on silicone beads) | <ul style="list-style-type: none"> • Patient is unable to transfer/decreased independence with bed mobility. • Care is more difficult. • Usually requires a hospital admission. |

the heels. A repositioning schedule is also recommended. The 30° side-lying position has long been advocated for removing pressure from bony prominences. A recent randomized controlled trial compared this position with the 90° lateral and supine positions.¹⁸ No difference was found in the incidence of non-blanching erythema with the use of the 30° side-lying position, and fully 78 per cent of the subjects experienced difficulty in maintaining the position. This study calls into question this technique for pressure offloading in a predominantly ill population.

Appropriate positioning is recommended, and establishing a repositioning schedule may not be adequate to manage the pressure. Prescription of pressure management devices may become necessary. When choosing a therapeutic support surface, the pressure management properties need to be considered; however, other factors such as patient comfort and impact on functional status may be of equal importance. Table 3 outlines the factors to consider when choosing a therapeutic support surface.

Therapeutic support surfaces have been divided into different categories as outlined in Table 4. The RNAO Management guideline recommends using a static support surface if the patient can assume a variety of positions and does not bottom out the surface.⁹ A dynamic surface is recommended when the patient cannot assume a variety of positions without weight-bearing on a pressure ulcer, if the patient fully compresses the static surface, or the pressure ulcer does not show evidence of healing.

If the wound does not show evidence of healing, the Pathway to Assessment/Treatment Algorithm (Figure 1) should be considered before changing the support surface to ensure all aspects (treating the cause, local wound care, and patient-centred concerns) have been optimized. For example, the underlying issue impeding wound healing could be nutrition. Having the increased expense of changing the support surface does not address the underlying concern and therefore would have little impact on the healing of the ulcer. Caution should also be used when moving down the list of support surfaces in Table 4 as the impact on the patient's function tends to increase. For example, it may be more difficult for the patient to transfer off a dynamic surface, thus increasing the risk of injury or of pressure and shearing.

Pressure also needs to be assessed on all surfaces with which the patient comes in contact, including their wheelchair, commode/toilet seat, couches and car seat. "No one support surface is best for all people . . . the only true test of a support surface is how it works with the patient or client."²¹

Computerized pressure mapping is one way to evaluate a surface. Using this technique, a thin pressure-sensitive mat is placed between the patient and the surface. Interface pressure is then translated into an image on the computer. This system can also be used as a biofeedback technique as the patient has a visual image of the changes in pressure as he/she changes his/her posture. Regardless of whether or not a computerized pressure-mapping system is available, a seating assessment should also be performed to ensure

adequate pressure management on each surface.

Regardless of which surfaces are prescribed, they can be rendered ineffective or be harmful if they are not used appropriately and properly maintained.

Recommendation 3: (Level of Evidence: Prevention Ib–IV, Management B–C)
Maximize nutritional status.

Discussion

Recommendations 3.11 of the Risk Assessment and Prevention guideline⁶ and numbers 7 and 8 of the Assessment and Management guideline⁹ are consistent with the recommendation in the original article.⁷ In that article, vitamin E and individual amino acids are cited as factors associated with wound healing in addition to calories, protein, vitamins A and C, and the mineral zinc. Other literature suggests that the provision of oral vitamin E is not recommended for the nutritional management of pressure ulcers as it may interfere with collagen synthesis, may scavenge oxygen at the wound site, may prolong the inflammatory phase of healing and may interfere with the beneficial effects of vitamin A in wound management.^{22,23} More research is needed before recommendations can be made regarding the indications and safety considerations associated with the supplementation of individual amino acids, such as glutamine, for pressure ulcer management.²⁴

Whenever possible, referral to and intervention by a registered dietitian should take place to thoroughly assess a patient who is at risk for the development of, or who presents with, a pressure ulcer. Nutrition intervention must consider assessed needs, which are elevated in the presence of pressure ulcer(s), adequacy of current nutritional intake, routes and extent of nutrient and fluid losses, existing barriers to achievement of optimal nutrition, considerations related to coexisting clinical conditions/disease states, anthropometric, biochemical and clinical indicators of nutritional status, and the goals/wishes of the patient or his/her substitute decision-maker. Comprehensive assessment provides the data required for the development of a nutrition care plan that will enhance healing potential through foods, supplements and/or enteral nutrition support, if indicated.²⁵

The patient's response to illness, injury or infection or any inflammatory response is an amplification of the "fight or flight" response. A chronic, non-healing pressure ulcer is a perpetual inflammatory state that further impairs the potential to heal.²⁶

While there may be several ways to monitor nutritional status, the monitoring of regular serial patient weights remains the most reliable, valid, inexpensive and non-invasive method to determine whether a patient is in an anabolic, catabolic or stable state. The identification of an undesirable weight trend is an early indicator of risk and allows for proactive intervention before malnutrition and impaired wound healing become severe. Impaired protein status may lead to edema that can mask muscle and fat loss, delaying the identification of wasting that can be detected by regular weight monitoring.²⁷ While estimating daily caloric intake by the portion of

food left on a patient's tray after each meal may be one method of monitoring nutritional status, it should be incorporated with other more objective assessments such as body weight and laboratory measurements of nutritional status.

Hemoglobin less than 100 g/L is associated with impaired wound healing. It is important to ascertain the type of anemia (iron deficiency or anemia of chronic disease) and treat it appropriately. The type of anemia determines the treatment strategy; mismanagement may impair a patient's healing potential and may result in risk to the patient because of iatrogenic hemochromatosis.²⁸ A recent case series suggests that recombinant human erythropoietin may be useful in reversing the anemia of chronic disease that may be associated with chronic pressure ulcers.²⁹

Identification and correction of dehydration is important for optimized healing. Fluid may be lost not only through exuding wounds but also through emesis, frequent loose stools, large urinary outputs (as the result of diuretics or poorly controlled diabetes), fistulae and topical negative pressure therapy. Decreased thirst response and other factors that impact the elderly and other patients at risk for dehydration may result in poor fluid intake and inadequate replacement of fluid losses.

A Cochrane review of nutritional interventions for prevention and treatment of pressure ulcers in 2003 was unable to draw firm conclusions on the effect of parenteral or enteral nutrition in the prevention and management of pressure ulcers.³⁰

Recommendation 4: (Level of Evidence: Prevention IV, Treatment B)
Manage moisture and incontinence.

Discussion

The information presented in Best Practice recommendation 4 has been validated as current by the evidence presented in the RNAO Risk Assessment and Prevention guideline recommendations 3.9 and 3.10⁹ and the Assessment and Management guideline recommendation 34.⁹

Recommendation 3.9 in the Risk Assessment and Prevention guideline provides additional information about skin cleansing, stating that skin should be cleansed gently at time of soiling with a mild pH-balanced, non-sensitizing cleansing agent. Warm water (rather than hot) is recommended to minimize drying and irritation.^{31,32}

Recommendation 3.10 emphasizes that exposure of skin to a variety of moist substances such as urine, feces, perspiration and wound drainage will increase the susceptibility to injury^{33,34} and that wet skin is fragile and more susceptible to friction and tearing injuries, especially during cleansing. Moist skin is also at increased risk for irritation rashes and infections such as *Candida*. The *Guideline for Prevention and Management of Pressure Ulcers* published by Wound Ostomy and Continence Nurses Society (WOCN) in 2003³⁵ confirms that fecal incontinence is a greater risk for skin breakdown than urinary incontinence because of the chemical irritation that results from the enzymes in the stool that are caustic to the skin. In the presence of both urinary and fecal incontinence, fecal enzymes convert urea to ammonia, raising the skin pH. With a more alkaline skin pH, the skin

becomes more permeable to other irritants.³⁶ The clinician should assess bowel/bladder habits to determine the type of incontinence, and develop toileting and management programs to minimize incontinent episodes.

For managing continence, the use of collection devices such as condoms or a pouching system to contain urine or stool should be considered to protect the skin. When urinary incontinence has contributed or may contribute to a pressure ulcer, a urinary catheter may be necessary for a short period of time. A referral to a continence specialist or enterostomal therapist should be considered on an individual basis. The WOCN guideline also recommends consulting the RNAO *Nursing Best Practice Guideline: Promoting Continence Using Prompted Voiding* for further information on continence.¹¹ Absorbent pads or briefs should be changed as they become saturated, and pads and briefs should not interfere with any pressure-redistributing surface an individual may be placed on. The use of cotton linens is recommended to promote evaporation, skin aeration and faster drying for skin that is moist from perspiration. Frequent changes of moist linens are also recommended to maintain dry, intact skin.

Recommendation 34 of the Assessment and Management guideline recommends the use of appropriate dressings to manage wound drainage and protect surrounding skin.⁹ Dressings should not macerate surrounding tissue, as this phenomenon is associated with prolonged healing time. The control of wound exudates, which involves keeping the wound bed moist and the surrounding intact skin dry, is another dressing selection criterion.^{37,38} Ovington³⁹ reports that a literature review from 1993 to 1998 did not reveal any clinical trials or RCTs focusing on ulcer maceration or desiccation caused by inappropriate dressing selection. However, many moisture-retentive dressings prevent lateral wicking and ultimately peri-wound maceration. Dressing replacement is required when the capacity for absorption has been reached. Protective creams, ointments, films and solid barrier sheets such as hydrocolloids may be used to protect peri-wound skin from wound drainage. Pouching may also be a consideration to manage excessive exudates if the wound location permits application.

Recommendation 5: (Level of Evidence: Prevention IV)
Maximize activity and mobility, reducing or eliminating friction and shear.

Discussion

Multiple recommendations in the RNAO Risk Assessment and Prevention guideline deal with the problem of friction and shear.⁸ Recommendations 1.3, 3.2, 3.7 and 3.12 deal with maximizing mobility and reducing the friction and shear associated with positioning and transfers. Shear is a mechanical force that moves the bony structures in a direction opposite to the overlaying skin (tearing force). The effects of pressure are compounded by the addition of shear. Friction is the force of two surfaces moving across one another, creating local heat and often resulting in an abrasion.

Transfers, repositioning on a surface and sliding in bed or in the wheelchair are primary causes of friction and shear. Transfers and positioning should therefore be assessed in all patients with pressure

ulcers. Transfers in particular should be assessed both at the beginning of the day and at the end of the day when fatigue may impact the quality of the transfer.

The RNAO recommends “that a patient who has a pressure ulcer on a seating surface should avoid sitting. If pressure on the ulcer can be relieved, limited sitting may be allowed.”⁸ Unfortunately, the alternative to sitting in the chair is often bed rest. Bed rest has known complications such as anorexia, decreased executive functioning and pulmonary emboli. However, there are no randomized controlled trials that indicate that bed rest is effective in the treatment of pressure ulcers.¹⁷ Managing pressure, friction and shear throughout the patient’s activities of daily life likely results in an improved quality of life for the patient, and avoids the known complications of bed rest.

Recommendation 6: (Level of Evidence: Prevention IV, Management B–C)

Assess and control pain.

Discussion

The importance of the information found in Best Practice recommendation 6 has been validated by the evidence presented by recommendations found in the RNAO Risk Assessment and Prevention guideline recommendations 3.3a and 3.3b (Level of Evidence: IV)⁸ and the Assessment and Management guideline recommendations 9 (Level of Evidence: C) and 10 (Level of Evidence: B).⁹ In addition, wound-care providers are referred to the RNAO Assessment and Management of Pain¹⁰ guideline recommendations 1, 2, 3, 4, 5 and 6 (Level of Evidence: C).

Recommendation 3.3a in the Risk Assessment and Prevention guideline identifies the need to consider the impact of pain on decreased mobility and activity as a factor increasing the risk for pressure ulcer development.⁸ Pain control measures may include effective medication, therapeutic positioning, support surfaces and other non-pharmaceutical interventions.

Recommendation 3.3b in the Risk Assessment and Prevention guideline discusses the risk for skin breakdown related to loss of protective sensation, or the ability to perceive pain and respond effectively.⁸ Analgesia and sedatives may depress the central nervous system, resulting in reduced mental alertness, activity and mobility, thereby altering the individual’s ability to respond to ischemic pain.⁴⁰ Consideration should also be given to the impact of pain on decreased local tissue perfusion and the increased risk for pressure ulcer development or delayed healing. More research is needed in the area of pain and its impact as a risk factor for pressure ulcer development.

Recommendation 9 of the Assessment and Management guideline states that all patients should be assessed for pain related to the pressure ulcer or its treatment.⁹ Review of the evidence reports that pain should be assessed routinely and regularly using the same validated tool each time.⁴¹ Assessment tools should be appropriate for the cognitive ability of the patient and should be easy to use. There is no validated tool for use specifically with patients experiencing pressure ulcer pain. The development panel suggested the use of a validated tool that had

been tested for validity and reliability in adults. Tools with established validity are described in recommendation 4 of the RNAO Assessment and Management of Pain guideline.¹⁰ A recent study by Nemeth et al. 2003 compared pain assessment tools for use in leg ulcer populations⁴² and found that current evidence was insufficient to recommend any one pain assessment tool. However, they did suggest that a two-step pain assessment process might be useful. Initially the assessment should include a self-report related to the presence and level of pain, and in situations where pain is present, a more comprehensive assessment about the quality of the pain should be conducted. Recommendation 5 in the Pain guideline recommends that pain assessment also include physiological and behavioural indicators of pain, and should be included in populations such as infants, children, the cognitively impaired and in persons with acute pain.¹⁰

Recommendation 10 of the Assessment and Management guideline describes the features of a pain assessment.⁹ Additional features of a comprehensive pain assessment are described in detail in recommendations 3 and 6 of the Pain guideline.¹⁰ The RNAO guideline supports the AHCPR recommendation that the management of pressure ulcer pain should include eliminating or controlling the source of pain (e.g., covering wounds, adjusting support surfaces, and repositioning) as well as providing analgesia to treat procedure-related and wound pain.³¹ Successful management of pain requires an interdisciplinary effort to manage the complexities of pain and develop a multifaceted treatment plan. Accurate assessment and diagnosis of the type of pain, its intensity, and its effect on the person are necessary to plan appropriate interventions or treatments and are an integral part of overall clinical assessment.

Recommendation 7: (Level of Evidence: Management C)

Assess and assist with psychosocial needs.

Discussion

Recommendations 2 and 3 from the RNAO Assessment and Management guideline provide validation for recommendation 7.⁹ A psychosocial assessment, including assessment of quality of life, should be conducted to determine the patient's ability and motivation to comprehend and adhere to the treatment plan. A psychosocial assessment is necessary to collect information to develop a plan of care with the patient that is consistent with individual and family preferences, goals and resources, especially when the understanding, co-operation and initiative of patients and their caregivers are required. The treatment plan should include interventions to address identified psychosocial needs and goals. Follow-up should be planned in co-operation with the individual and caregiver, in consultation with appropriate interdisciplinary team members.

Recommendation 8: (Level of Evidence: Prevention IV, Management A–C)

Stage, assess and treat the wound. Provide an optimal wound environment consistent with the principles of *Preparing the wound bed*.

Discussion

Multiple recommendations in both the Risk Assessment and Prevention and Assessment and Management guidelines relate to local wound care.^{8,9} A more thorough discussion of local wound care can be found in the original *Preparing the wound bed* article, the subsequent review in 2003¹² and the companion article in this issue (page 15). Pressure ulcers should continue to be staged according to the National Pressure Ulcer Advisory Panel (NPUAP) staging system (Level of Evidence: IV), which can be accessed at www.npuap.org or in Appendix E of the Risk Assessment and Prevention guideline.⁸ Controversy about reverse staging exists. Computer-based systems such as the Minimum Data Set, commonly used in long-term-care settings, require reverse staging as an ulcer closes, but expert opinion recommends against this on the basis that it is clinically difficult to do so accurately, and that even though the ulcer is healing, the depth of tissue damage remains as per the original ulcer.

Progress toward closure is best assessed using a valid and reliable assessment tool that detects change over time. In 1999, Woodbury et al.⁴³ critically appraised the existing tools at the time. The PSST, Sessing and PWAT tools showed the best evidence for their use. Since that time, further work on validation of the PUSH tool⁴⁴ has been done, and it can be recommended for use. The tool used must be appropriate for the setting and the users. The MEASURE⁴⁵ mnemonic, reported in the *Preparing the wound bed* article in this issue (see page 21), captures the key parameters that should be addressed as part of a pressure ulcer assessment (Level of Evidence: IV).

Local wound care involves debridement of non-viable tissue, assessment and management of bacterial burden and management of exudate through appropriate dressing selection. In non-healable pressure ulcers, the debridement of non-viable tissue to reduce bacterial burden and control exudate and odour is warranted, but debridement to bleeding tissue is contraindicated. In healable ulcers more aggressive debridement is indicated. Depending on the patient, the setting, and the skills of the clinician, all forms of debridement may be employed. There is growing evidence that larval debridement⁴⁶ therapy is useful in pressure ulcers, but patient acceptance in Canada remains low.

Assessment of pressure ulcers for infection remains a clinical challenge as most pressure ulcers are colonized. Surface swabs will only reveal the colonizing organism and may not reflect deeper tissue infection. In one study, superficial swabs were positive for 96 per cent of ulcers tested, whereas the deep tissue aspirates were positive in only 43 per cent and deep tissue biopsies in 63 per cent of the same ulcers tested.⁴⁷ In a retrospective study of surgical samples in infected pressure ulcers, the predominant organisms were *Enterobacter* (29 per cent), *Staphylococci* (28 per cent), and *Enterococcus faecalis* (16 per cent).⁴⁸ Many pressure ulcers occur in institutionalized patients where antibiotic resistant organisms may be prevalent. All of these factors should be taken into account when developing treatment plans. Osteomyelitis in pressure ulcers has been reported in up to 32 per cent of patients.⁴⁹ Diagnostic investigations may include plain film X-rays, elevated white counts, elevated ESR,

bone scans, and MRI, depending on the clinical situation. The RNAO Assessment and Management guideline recommendations 37 through 44 deal with colonization and infection.⁹

Dressing selection is well covered by Assessment and Management guideline recommendations 30 to 34.⁹ A few general principles are worth noting. Ulcers in areas at risk of contamination from urine or feces should be covered with occlusive dressings to reduce the risk of contamination. Many pressure ulcers have undermining or sinuses. Visible areas of undermining and dead space should be gently filled with absorbent materials such as alginates or Hydrofibers to wick the exudate into the secondary dressing. Over-packing with non-deformable gauze may actually lead to increased tissue pressures and further breakdown. In areas of high risk for contamination, the use of antimicrobial dressings may be useful in reducing the risk of infection.

Recommendation 9: (Level of Evidence: Management A–C)

Introduce adjunctive modalities or biologically active dressings where appropriate.

Discussion

The RNAO Assessment and Management guideline indicates that there are multiple levels of evidence depending on the modality.⁹ The literature was further reviewed for randomized controlled trials, multi-centre trials and meta-analyses that examined effectiveness of the modality on the healing (wound closure) of chronic pressure ulcers. Clinical trials examining the benefit of these modalities on other types of chronic wound or on ulcers of mixed etiology were not considered in this review. A systematic review of literature using peer-reviewed articles published in journals cited on Index Medicus and found on established medical databases was completed.

Based on this review, the following recommendations are made that clarify the RNAO guideline:

1. Use of electrical stimulation therapy (EST) is recommended for treatment of chronic pressure ulcers (Level of Evidence: A).

There are 12 randomized controlled studies involving the study of a total of 404 subjects. Ten of the 12 studies report that EST accelerated wound healing compared with subjects in the control group. The results of these clinical trials are to be combined in a meta-analysis.⁵⁰ Preliminary findings reported recently showed a significant ($P < 0.0001$) increase in closure rates of pressure ulcers of EST ($n = 253$) compared with controls ($n = 151$).⁵¹

2. Consider platelet-derived growth factor (PDGF-BB), electromagnetic fields (EMFs), therapeutic ultrasound, normothermia, ultraviolet Light C, and larval debridement therapy for stimulating closure of chronic non-healing pressure ulcers (Level of Evidence: B).

One large multi-centre trial ($n = 124$) reported a significant increase in healing of chronic pressure ulcers treated with recombinant PDGF-BB.⁵² A smaller randomized trial also reported an improvement in healing rates of chronic pressure ulcers treated with PDGF-BB; however, these differences were not statistically significant ($p = 0.056$).

The effect of EMFs and ultrasound on healing of chronic pressure

ulcers has been investigated in more than one randomized controlled trial; however, the results are not consistent. Normothermia, ultraviolet Light C, and larval therapy have been shown to produce beneficial results when administered to pressure ulcers in at least one RCT.

3. There is limited evidence to support the use of topical negative pressure (TNP) therapy, laser, oxidized regenerated cellulose/collagen, skin equivalents and hyperbaric oxygen in the treatment of chronic non-healing pressure ulcers (Level of Evidence: C).

There are two controlled clinical trials that report the effects of TNP therapy on chronic pressure ulcers. An interim report⁵³ on 35 persons with chronic pressure ulcers concluded that TNP therapy decreased wound size; however, the reported differences were not statistically significant ($p = 0.46$). A second small clinical trial ($n = 22$) reported that TNP and saline-soaked gauze dressing produced similar reduction in wound volume in persons with pressure ulcers due to spinal cord injuries. Joseph et al.⁵⁴ in a controlled clinical trial reported TNP therapy improved wound size over saline gauze-treated wounds. This study was not included in this review since it had serious methodological flaws (chronic ulcers of mixed etiology, multiple wounds per subject were included in analysis, and no description of methods to obtain primary study outcome of wound depth).

A meta-analysis performed by Evans and Land of the Cochrane Collaboration in 2005⁵⁵ reported there was weak evidence suggesting that negative pressure may be superior to saline gauze dressings. However, due to total number of subjects in two studies ($n = 34$) they concluded that there was no reliable evidence that TNP therapy increases chronic wound healing. There is no meta-analysis published to date that has examined the effects of negative topical pressure therapy on pressure ulcers specifically. There is one controlled clinical trial that investigated the ability of laser therapy to stimulate closure of pressure ulcers, and this report did not indicate a statistically significant difference. The literature search did not find a single controlled trial that has been published to examine the effect of oxidized regenerated cellulose/collagen, skin equivalents or hyperbaric oxygen on healing of chronic pressure ulcers.

Recommendation 10: (Level of Evidence: Management C)

Consider surgical intervention for deep non-healing ulcers (Stage III and Stage IV).

Discussion

Recommendation 45 of the RNAO Assessment and Management guideline⁹ is consistent with recommendations in the original best practice article.⁷ A review by Brown and Smith⁵⁶ in 1999 found that no significant changes in clinical management were warranted. A retrospective review of 20 years of experience in surgical reconstruction of pressure ulcers⁵⁷ confirmed the very high failure rates of such procedures. The study looked at 598 ulcers in 168 patients. Suture line dehiscence occurred in 31 per cent of surgical procedures, and 11 per cent required reconstruction. In 54 per cent of the patients the ulcers reoccurred after flap or graft closure. These results are

consistent with those cited in the original article. High failure rates were associated with unemployment, low level of education, and drug or alcohol abuse. Success rates as cited in the original article are higher when patients with pressure ulcers are involved in a rehabilitation program both before and after surgery.⁷ Surgical closure in younger patients where quality of life is a significant issue remains a viable alternative in carefully selected individuals.

Recommendation 11: (Level of Evidence: Management C)

Develop an interdisciplinary team specific to the needs of the patient.

Discussion

Recommendation 57 of the Assessment and Management guideline advocates the formation of interprofessional teams to deal with the complex issue of the treatment of pressure ulcers.⁹ It is interesting that few other pressure-ulcer-treatment clinical-practice guidelines comment on the desirability of multiple health-care professionals working together in the management of pressure ulcers, and yet the discussion of the need for teams in the original best practice article remains valid today.

Recommendation 12: (Level of Evidence: Prevention III–IV, Management C)

Educate patients, caregivers, and health-care providers on the prevention and treatment of pressure ulcers.

Discussion

The information presented in Best Practice recommendation 12 has been validated as current by the evidence presented in the RNAO Risk Assessment and Prevention guideline recommendations 5.1 and 5.2, and by the Assessment and Management guideline recommendations 48, 49, 50, 51 and 52.^{8,9}

Recommendation 5.1 supports that individuals at risk for pressure ulcers should be informed and educated about risk assessment and prevention strategies, and that this education should be directed at all levels of health-care providers, including the patient and family or other caregivers.^{58,59} In addition, information is provided regarding the content of patient and caregiver programs, indicating that they should be individualized and provide information regarding personal risk factors for pressure ulcer development; sites that are of the greatest risk for ulcer development; how to inspect the skin for damage and recognize changes in the skin; how to care for the skin, including methods for pressure relief/reduction; where and when to obtain assistance when required and when to seek immediate assessment by a health-care professional should signs of deterioration be noted. In addition to the information discussed in recommendation 12 of the Best Practice article of 2000,⁷ RNAO Risk Assessment and Prevention guideline recommendation 5.1 states that educational programs for the prevention of pressure ulcers should be structured, organized, and comprehensive and should be updated on a regular basis to incorporate new evidence and technologies.⁸

Recommendation 5.2 states that educational programs should be

based on the principles of adult learning, addressing the level of information and mode of delivery to the level of the audience.⁸ It is also recommended that education programs be monitored for outcomes to ensure that they are effective, for example, by the reduction of prevalence and incidence of ulcers.

Recommendations 48 through 51 of the Assessment and Management guideline address the structure and content of educational activities.⁹ These recommendations suggest including discussions on quality of life and pain management in patient/caregiver education. The content of educational programs as described in the original Best Practice article recommendation 12 was confirmed by Royal College of Nursing 2000 guideline,³⁴ with the addition of education about the selection, use and maintenance of pressure redistributing equipment. This same guideline also recommends defining the roles and responsibilities of the interdisciplinary team in relation to pressure ulcer risk assessment and prevention. It is also suggested that education programs include a focus on the limitations and applications of risk assessment tools. A systematic review by McGough (as cited in RCN, 2000)³⁴ supports the concept that education programs may reduce the incidence and prevalence of pressure ulcer development.

Conclusions

The estimated overall prevalence of pressure ulcers in institutionalized patients in Canada is 26 per cent. While about half of these are Stage I, the number remains unacceptably high. Pressure ulcer experts believe that not all pressure ulcers are preventable, but it is hoped that, by implementing best practices across all care settings, the prevalence can be reduced.

The production and maintenance of clinical practice guidelines is a labour-intensive and expensive process. The RNAO has both the financial and human resources to undertake the rigorous processes of regular systematic literature review and guideline production. These guidelines are, however, often large, with multiple recommendations and may not be practical to assist clinicians at the bedside. They are also targeted at nurses and, regrettably, may be ignored by other disciplines. Translation of evidence into practice requires strong leadership and ongoing organizational and institutional support across all care settings. Clinicians require multiple supports such as education, policy support and practice enablers to move the evidence base into everyday practice.

The original best practice recommendations for the prevention and treatment of pressure ulcers published in 2000,⁷ while based on a thorough literature review, were primarily expert opinion. By reviewing and revising these recommendations and linking them to the RNAO guidelines, it is hoped that these practice enablers are now grounded soundly in the evidence. ☺

References

1. Woodbury MG, Houghton PE. Prevalence of pressure ulcers in Canadian healthcare settings. *Ostomy/Wound Management*. 2004;50(10):22-38.
2. Whittington KT, Briones R. National prevalence and incidence study: 6-year sequential acute care data. *Adv Skin Wound Care*. 2004;17(9):490-4.

3. Tannen A, Dassen T, Bours G, Halfens R. A comparison of pressure ulcer prevalence: Concerted data collection in the Netherlands and Germany. *Int J Nurs Stud.* 2004; 14(6):607-612.
4. Horn SD, Bender SA, Ferguson ML, et al. The national pressure ulcer long-term care study: Pressure ulcer development in long-term care residents. *J Am Geriatr Soc.* 2004; 52(3):359-67.
5. Gethin G, Jordan-O'Brien J, Moore Z. Estimating costs of pressure area management based on a survey of ulcer care in one Irish hospital. *Journal of Wound Care.* 2005; 14(4):162-5.
6. Brandeis GH, Berlowitz DR, Katz P. Are pressure ulcers preventable? A survey of experts. *Adv Skin Wound Care.* 2001;14:244.
7. Dolynchuk K, Keast DH, Campbell KE, et al. Best practices for the prevention and treatment of pressure ulcers. *Ostomy/Wound Management.* 2000;46(11):38-51.
8. Registered Nurses' Association of Ontario (RNAO). *Nursing Best Practice Guideline: Risk Assessment and Prevention of Pressure Ulcers.* Toronto: RNAO. 2005. Available online at www.mao.org/bestpractices/.
9. ——. *Nursing Best Practice Guideline: Assessment and Management of Stage I to IV Pressure Ulcers.* Toronto: RNAO. 2002. Available online at www.mao.org/bestpractices/.
10. ——. *Nursing Best Practice Guideline: Assessment and Management of Pain.* Toronto: RNAO. 2002. Available online at www.mao.org/bestpractices/.
11. ——. *Nursing Best Practice Guideline: Promoting Continence Using Prompted Voiding.* Toronto: RNAO. 2005. Available online at www.mao.org/bestpractices/.
12. Sibbald RG, Orsted HL, Schultz GS, et al. Preparing the wound bed 2003: Focus on infection and inflammation. *Ostomy/Wound Management.* 2003;49(11):24-51.
13. Defloor T, Grypdonck MF. Pressure ulcers: Validation of two risk assessment scales. *J Clin Nurs.* 2005;14(3):373-82.
14. Jalali R, Rezaie M. Predicting pressure ulcer risk: Comparing the predictive validity of 4 scales. *Adv Skin Wound Care.* 2005;18(2):92-97.
15. Fisher AR, Wells G, Harrison MB. Factors associated with pressure ulcers in acute care hospitals. *Holist Nurs Pract.* 2004;18(5):242-53.
16. Cullum N, McInnes E, Bell-Syer SEM, Legood R. Support surfaces for pressure ulcer prevention. *The Cochrane Database of Systematic Reviews* [Internet database]. 2004;3:Art. No. CD001735. Accessible online at www.thecochranelibrary.com.
17. Sibbald RG, Williamson D, Orsted HL, et al. Preparing the wound bed: Debridement, bacterial balance and moisture balance. *Ostomy/Wound Management.* 2000; 46(11):14-35.
18. Young T. The 30 degree tilt position vs. the 90 degree lateral or supine positions in reducing the incidence of non-blanching erythema in a hospital inpatient population: A randomized controlled trial. *J Tissue Viability.* 2004;14(3):88, 90, 92-96.
19. Norton L, Sibbald RG. Is bed rest an effective treatment for pressure ulcers? *Ostomy/Wound Management.* 2004;50(10):40-52.
20. Sibbald RG, Norton L. Wound care text [German]. In press 2006.
21. Sprigle S. Prescribing pressure ulcer treatment. *Rehab Management.* 2000;June/July. Available online at www.rehabpub.com/trehab/672000/5.asp.
22. Albina JE. Nutrition and wound healing. *J Parenter Enter Nutr.* 1994;84(9):367-76.
23. Ross V. Micronutrient recommendations for wound healing. *Support Line.* 2002; 24(4):3-9.
24. Langkamp-Henken B, Herrlinger-Garcia KA, et al. Arginine supplementation is well tolerated but does not enhance mitogen-induced lymphocyte proliferation in elderly nursing home residents with pressure ulcers. *J Parenter Enter Nutr.* 2000; 24(5):280-7.
25. Harris C, Fraser C. Malnutrition in the institutionalized elderly: The effects on wound healing. *Ostomy/Wound Management.* 2004;50(10):54-63.
26. Mast B, Schultz G. Interaction of cytokines, growth factors and proteases in acute and chronic wounds. *Wound Repair Regen.* 1996;4:411-20.
27. Walaszek P, et al. Involuntary weight loss: Treatment issues in long-term care. *The Consultant Pharmacist.* 2002;17(SA):511-21.
28. Spivak JL. Iron and anemia of chronic disease. *Oncology.* 2002;9(suppl 10):25-33.
29. 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.
30. Langer G, Schloemer G, Kner A, et al. Nutritional interventions for preventing and treating pressure ulcers. *The Cochrane Database of Systematic Reviews* [Internet database]. 2003;4:Art. No. CD003216. Accessible online at www.thecochrane library.com.
31. Agency for Health Care Policy and Research. *Pressure Ulcers in Adults: Prediction and Prevention.* 1992. Available online at www.guidelines.gov.
32. Consortium for Spinal Cord Medicine. *Pressure Ulcer Prevention and Treatment Following Spinal Cord Injury: A Clinical Practice Guideline for Health-care Professionals.* United States Government: Paralyzed Veterans of America. 2000.
33. Braden BJ. Risk assessment in pressure ulcer prevention. In Krasner DL, Rodeheaver GT, Sibbald RG, (eds.). *Chronic Wound Care: A Clinical Source Book For Healthcare Professionals*, Third Edition. Wayne, PA: HMP Communications. 2001:641-651.
34. Royal College of Nursing. *Pressure Ulcer Risk Assessment and Prevention.* London: Royal College of Nursing. 2000.
35. Wound Ostomy and Continence Nurses Society. *Guideline for Prevention and Management of Pressure Ulcers.* 2003:15.
36. Ratliff CR, Rodeheaver GT. Pressure ulcer assessment and management. *Lippincott's Primary Care Practice.* 1999;3:242-258.
37. Agency for Health Care Policy and Research. *Treatment of Pressure Ulcers.* 1994. Available online at www.guidelines.gov.
38. Compliance Network Physicians/Health Force Initiative. *Guidelines for Outpatient Treatment of Chronic Wounds and Burns.* Berlin, Vienna: Blackwell Wissenschafts-Verlag. 1999.
39. Ovington L. Dressings and adjunctive therapies: AHCPR guidelines revisited. *Ostomy/Wound Management.* 1999;45(Suppl.1A):94S-106S.
40. Lindquist LA, Feinglass J, Martin GJ. How sedative medication in older people affects patient risk factors for developing pressure ulcers. *Journal of Wound Care.* 2003;12(7):272-275.
41. McCaffery M, Pasero C. *Pain: Clinical Manual.* St. Louis: Mosby. 1999.
42. Nemeth K, Graham I, Harrison M. The measurement of leg ulcer pain: Identification and appraisal of pain assessment tools. *Advances in Skin & Wound Care.* 2003;16(5):260-267.
43. Woodbury MG, Houghton PE, Campbell KE, Keast DH. Pressure ulcer assessment instruments: A critical appraisal. *Ostomy/Wound Management.* 1999;45(5):42-55.
44. Gardner SE, Frantz RA, Berquist S, Shin CD. A prospective study of the pressure ulcer scale for healing (PUSH). *J Gerontol A Biol Sci Med Sci.* 2005;60(1):93-97.
45. Keast DH, Bowering K, Evans W, et al. Measure: A proposed assessment framework for developing best recommendations for wound assessment. *Wound Repair Regen.* 2004;12:S1-S17.
46. Sherman RA. Maggot versus conservative debridement therapy for the treatment of pressure ulcers. *Wound Repair Regen.* 2002;10(4):208-14.
47. Rudensky B, Lipschits M, Isaacsohn M, Sonnenblick M. Infected pressure sores: Comparison of methods of bacterial identification. *South Med J.* 1992;85:901.
48. Heym B, Rimariex F, Lortat-Jacob A, Nicolas-Chanoine MH. Bacteriological investigation of infected pressure ulcers in spinal cord-injured patients and impact on antibiotic therapy. *Spinal Cord.* 2004;42:230.
49. Darouiche RO, Landon GC, Klima M, et al. Osteomyelitis associated with pressure sores. *Arch Intern Med.* 1994;154:753.
50. Fernandez-Chimeno M, Houghton P, Holey L. Electrical stimulation for chronic wounds (Protocol). *The Cochrane Database of Systematic Reviews* [Internet database]. 2004;1:Art. No. CD004550. Accessible online at www.thecochranelibrary.com.
51. Houghton PE. Proceedings of the 10th Annual Conference of the Canadian Association of Wound Care; November 2004. Calgary, AB.
52. Rees RS, Robson MC, Smiell JM, et al. Becaplermin gel in the treatment of pressure ulcers: A phase II, randomized, double-blind, placebo-controlled study. *Wound Repair Regen.* 1999;7(3):141-147.
53. Ford C, Reinhard E, Yeh D, et al. Interim analysis of a prospective randomized trial of vacuum-assisted closure vs. the Healthpoint system in the management of pressure ulcers. *Annals of Plastic Surgery.* 2002;9(1):55-61.
54. Joseph E, Hamori CA, Bergman S, et al. A prospective randomized trial of vacuum-assisted closure vs. standard therapy of chronic non-healing wounds. *Wounds.* 2000;12:60.
55. Evans D, Land L. Topical negative pressure for treating chronic wounds. *The Cochrane Database of Systematic Reviews* [Internet database]. 2001;1: Art. No. CD CD001898. Accessible online at www.thecochranelibrary.com.
56. Brown DL, Smith DJ. Bacterial colonization/infection and surgical management of pressure ulcers. *Ostomy/Wound Management.* 1999;45(1A Suppl):109S-20S.
57. Schryvers OI, Stranc MF, Nance PW. Surgical treatment of pressure ulcers: 20 years experience. *Arch Phys Med Rehabil.* 2000;81(12):1556-62.
58. National Institute for Clinical Excellence. Pressure ulcer risk assessment and prevention. 2001. Available online at www.nice.org.uk.
59. Wiechula R. Best practice: Evidence-based practice information sheets for health professionals. [Pamphlet]. 1997.