MEASURE: A proposed assessment framework for developing best practice recommendations for wound assessment

DAVID H. KEAST, MSc, MD[a]; C. KEITH BOWERING, MD[b]; A. WAYNE EVANS, MD[c]; GERALD L. MACKEAN, MD[d]; CATHERINE BURROWS, RN, BScN[e]; LINCOLN D'SOUZA, RN, BScN[f]

The effective management of nonhealing wounds is based on a complete patient history, a detailed initial assessment of the wound, and an analysis of probable causative factors. This information is used to individualize a management strategy to the underlying pathophysiology preventing healing and to implement appropriate wound interventions. Regular reassessment of progress toward healing and appropriate modification of the intervention are also necessary. Accurate and clinically relevant wound assessment is an important clinical tool, but this process remains a substantial challenge. Wound assessment terminology is nonuniform, many questions surrounding wound assessment remain unanswered, agreement has yet to be reached on the key wound parameters to measure in clinical practice, and the accuracy and reliability of available wound assessment techniques vary. This article, which resulted from a meeting of wound healing experts in June 2003, reviews clinically useful wound measurement approaches, provides an overview of the principles and practice of chronic wound assessment geared to a clinical audience, and introduces a simple mnemonic, MEASURE. MEASURE encapsulates key wound parameters that should be addressed in the assessment and management of chronic wounds: 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), Reevaluate (monitoring of all parameters regularly), and Edge (condition of edge and surrounding skin). This article also provides some preliminary recommendations targeted to developing best practice guidelines for wound assessment. (WOUND REP REG 2004;12:S1–S17)

A strong rationale exists for the routine assessment of chronic wounds. Wound assessment is critical to establish a diagnosis, to monitor the effect of treatment, to

ICC	Intraclass correlation coefficient
PSST	Pressure sore status tool
PWAT	Photographic wound assessment tool
SPG	Stereophotogrammetry
VeV	Verge Videometer

From the Department of Family Medicine[a], University of Western Ontario, London, Ontario; Department of Medicine[b], University of Alberta, Edmonton, Alberta; Department of Anesthesia[c], University of Toronto, Toronto, Ontario; Department of Surgery[d], Dalhousie University, Halifax, Nova Scotia; Queen Elizabeth II Health Sciences Centre[e], Halifax, Nova Scotia; and Department of Surgery[f], McGill University Hospital Center, Montreal, Quebec, Canada.
Reprint requests: Dr. David H. Keast, 201-750 Baseline Road, East London, Ontario, N6C 2R5 Canada. Fax: (519) 433-6087; Email: dkeast@sympatico.ca.

identify the presence of infection, and to predict the outcome of treatment with accuracy.

The principle of routine wound assessment is closely allied with the concept of wound bed preparation, which stresses global assessment, including identifying and addressing the underlying cause of the lack of healing and understanding and dealing with patient-centered concerns, including negotiation of care plans, before evaluating the wound itself (Figure 1).[1] Critical local components of wound bed preparation include debridement of nonviable or deficient tissue; treatment of infection or inflammation; selection of moisture-balancing dressings, and reassessment of the
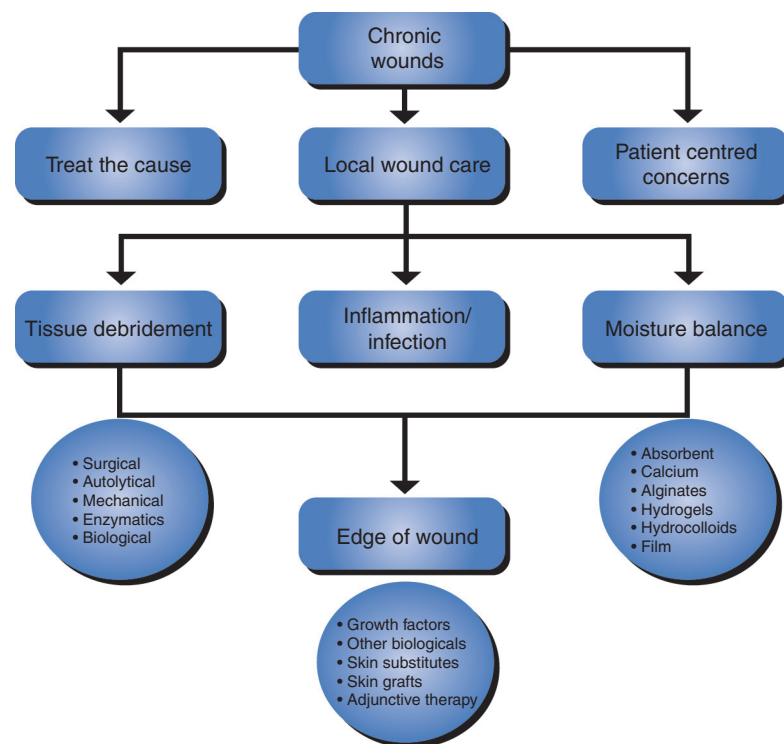
FIGURE 1. Wound bed preparation.

reason for lack of healing if the epidermal margin is not advancing or is undermined. These components are summarized using the acronym TIME: Tissue, Infection, Moisture, and Edge of wound.

A variety of etiologic, systemic, and local factors may be involved in the pathogenesis of a nonhealing wound, and these factors must be identified and addressed before healing can take place. For this reason, a global assessment should be undertaken when assessing nonhealing wounds, including a comprehensive patient history and analysis of probable underlying causes. In addition, a plan must be developed for managing each contributing factor potentially preventing wound healing, including poor nutritional status, systemic medications such as corticosteroids, inadequate tissue perfusion, and unrelieved wound pressure. This global approach to the patient and the problem is vital to comprehensive wound assessment and effective management. Local wound assessment, the focus of this article, is a critical part of this overall strategy.

Accurate and comprehensive wound assessment depends on meticulous and consistent clinical observation and on the use of quantitative measurement methods where possible.[2] Regular reassessments, currently the only way of determining treatment effectiveness, quantify and document progress and guide further treatment decisions.

A thorough initial wound assessment provides baseline data about the status of the wound and valuable information that can assist in identifying short-

and long-term goals of care and determining appropriate interventions at each stage. The initial assessment of the patient and the chronic wound should begin with a general wound classification using categories such as cause (surgical or nonsurgical) and depth (superficial, partial thickness, full thickness).[2] Additional clinical classification approaches include variables that may affect healing in patients with specific types of ulcers. For example, initial classification of venous ulcers may include clinical signs, etiology, distribution, and pathophysiology. Similarly, classification of diabetic foot ulcers combines wound characteristics, ischemia, infection, and ischemia plus infection.

The literature on wound care has not simplified wound assessment, which remains a substantial challenge in clinical practice. Terminology describing wound assessment is not standardized, nor has consensus been reached on the most appropriate wound healing parameters to monitor. As several classification and descriptive methods for chronic wounds exist, it is essential that all members of the wound management team use the same approach.[3] In addition, studies of the validity and reliability of wound assessment tend to be conducted from a research rather than a clinical perspective. However, in spite of these issues, wound management experts do agree that, in clinical practice, regular wound assessment using the same technique, whatever its deficiencies, is substantially better than no assessment.

Documentation is an integral part of wound assessment, to meet accepted standards of care, to assess

wound progress toward the treatment goal, and to facilitate communication between members of the wound management team.[3] The requirement to document the status of all wound parameters at each assessment underlines the importance of using objective and accurate wound assessment techniques and standard terminology and of applying a consistent approach during each assessment. Accurate wound measurement is central to the assessment process.

WOUND MEASUREMENT TECHNIQUES

Wounds should be measured at each assessment. A variety of parameters can be measured, including length, width, depth, and circumference.[1] Wound area and volume can be calculated from these measured dimensions, and area and volume can also be estimated using several techniques. During the past decade, research evaluating wound measurement techniques has increased considerably, supporting the evolution of this important aspect of wound assessment from a clinical art into a science.

Clinical importance of wound measurement

The clinical value of measuring wounds has been well established by numerous studies. Sheehan et al. conducted a prospective multicenter trial of 203 diabetic patients with foot ulcers to assess how well the healing rate during the initial 4 weeks predicted total healing within 12 weeks.[4] The authors found that higher 4-week healing rates were significantly correlated with healing at 12 weeks and concluded that assessing healing at 4 weeks is an important clinical indicator for early identification of individuals who are unlikely to heal with standard therapy.

Zimny et al. conducted a prospective study to assess wound size reduction and healing time over at least 10 weeks and to establish equations predicting healing time for neuropathic, neuroischemic, and ischemic diabetic foot ulcers.[5] The authors found that healing rate is determined more by ulcer etiology than by size, although initial area was significantly correlated with time to healing for neuropathic and neuroischemic ulcers. The authors concluded that in patients with neuropathic and neuroischemic ulcers, if initial wound size is known, healing can be predicted using the estimated daily wound radius reduction.

Gorin et al. postulated that measuring percentage change in area overestimates healing in small compared with large wounds, whereas measuring change in area overestimates healing in large compared with small wounds.[6] Methods influenced by initial wound size do not allow accurate comparison of healing rates in clinical trials. The authors therefore evaluated the calculation of average linear healing of the wound

edge toward the center as a means of comparing wound healing across clinical trials. They found that daily linear healing rate was uninfluenced by geometric variables and concluded that this measure is a valid way of comparing healing in wounds of different dimensions in clinical trials.

The prolonged healing time and high prevalence of venous ulcers among chronic wounds make it desirable to predict the likelihood of nonhealing early after instituting a specific therapeutic regimen. Kantor and Margolis compared the use of percentage change in venous leg ulcer area and weekly area healed as prognostic indicators of 24-week healing.[7] The authors found that the percentage change in area from baseline to 4 weeks predicted healing or nonhealing at 24 weeks ($p < 0.05$) and was unaffected by initial wound size or duration. Weekly area healed was not predictive of healing.

Researchers continue to debate which wound healing parameters accurately predict wound healing. Nevertheless, the existence of this debate does not affect the key clinical message for wound care practitioners: a method of measuring wounds should be selected and consistently applied, and results should be meticulously documented to assess the progress of healing.

Tallman et al. compared the ability of baseline-adjusted healing rate (comparing weekly with baseline ulcer size) and mean-adjusted healing rate (measuring mean healing between all visits) to predict wound healing.[8] The authors found that the baseline-adjusted healing rate decreased the ability to predict healing, whereas the mean-adjusted healing rate predicted complete healing as early as 3 weeks after initiating therapy ($p < 0.001$).

Evaluation of wound measurement techniques

A variety of methods are available to measure wound area, including the ruler method; acetate tracing plus manual square counting or mechanical planimetry; digital photography with computerized planimetry using the Verge Videometer (VeV); stereophotogrammetry (SPG), and acetate tracing plus a digitizing tablet.[9,10] The accuracy and reliability of several wound measurement techniques have been evaluated in clinical practice, in the laboratory using models, and in animal studies.

Ruler-based techniques to calculate area are simple but inconsistent and are not very reliable for irregular or large wounds.[10] The accuracy of wound area calculations can be increased by using the average of three length and width measurements. These techniques also carry the risk of wound contamination. Tracing the wound edges onto a transparency and using a metric grid to count the number of square centimeters making up the wound is a commonly used but time-consuming method. In addition, inaccuracy can arise from estimating partial squares.[9] Substituting an electronic or computerized planimetry device for manual counting is also a practical and popular way of measuring wound area.

This method has been shown to have excellent inter-rater and intra-rater reliability, although reliability decreases for small wounds. It is also inexpensive and convenient and requires minimal training.

Digital photography with computerized planimetry is also reliable and accurate, but the potential for inaccuracy as a result of parallax exists. The VeV system consists of a video or digital camera to produce color photographs of the wound and a computer and software system using an accurate perimeter-based algorithm to determine wound measurements and perform a color analysis (Figure 2).[11] The VeV assists in wound monitoring and improves measurement consistency by providing objective and accurate data to track outcomes, analyze treatment, and document healing. This noncontact method eliminates the risk of wound contamination, damage to the wound bed, and the possibility of procedure-related pain.

SPG is a reliable and precise computer-assisted technique using two digital cameras to create a three-dimensional wound image that allows area and volume determinations to be performed.[9] SPG is time consuming and expensive, and it requires special training, making it impractical for routine use in clinical practice.

Langemo et al. assessed the accuracy of four wound measurement techniques using plaster models.[12] The authors compared ruler-based length and width, planimetry, SPG length and width, and SPG area using a sample of 66 raters. The authors found that the most accurate technique, based on standard error and multiple raters, was SPG area, followed in order by ruler length and width, SPG length and width and, lastly, planimetry. The authors also concluded that SPG area was the only technique reliable enough for clinical or research purposes.

Lucas et al. evaluated the use of a combined technique to measure wound area using full-scale photography plus transparency tracings to assess pressure ulcers.[13] The authors used two independent observers to assess 30 wounds from 26 subjects over 2 weeks and found that all measurement comparisons were highly reliable, with an intraclass correlation coefficient (ICC) of 0.99. The authors concluded that the combined technique is a simple, practical, inexpensive, and accurate way of monitoring healing in pressure ulcers in clinical practice.
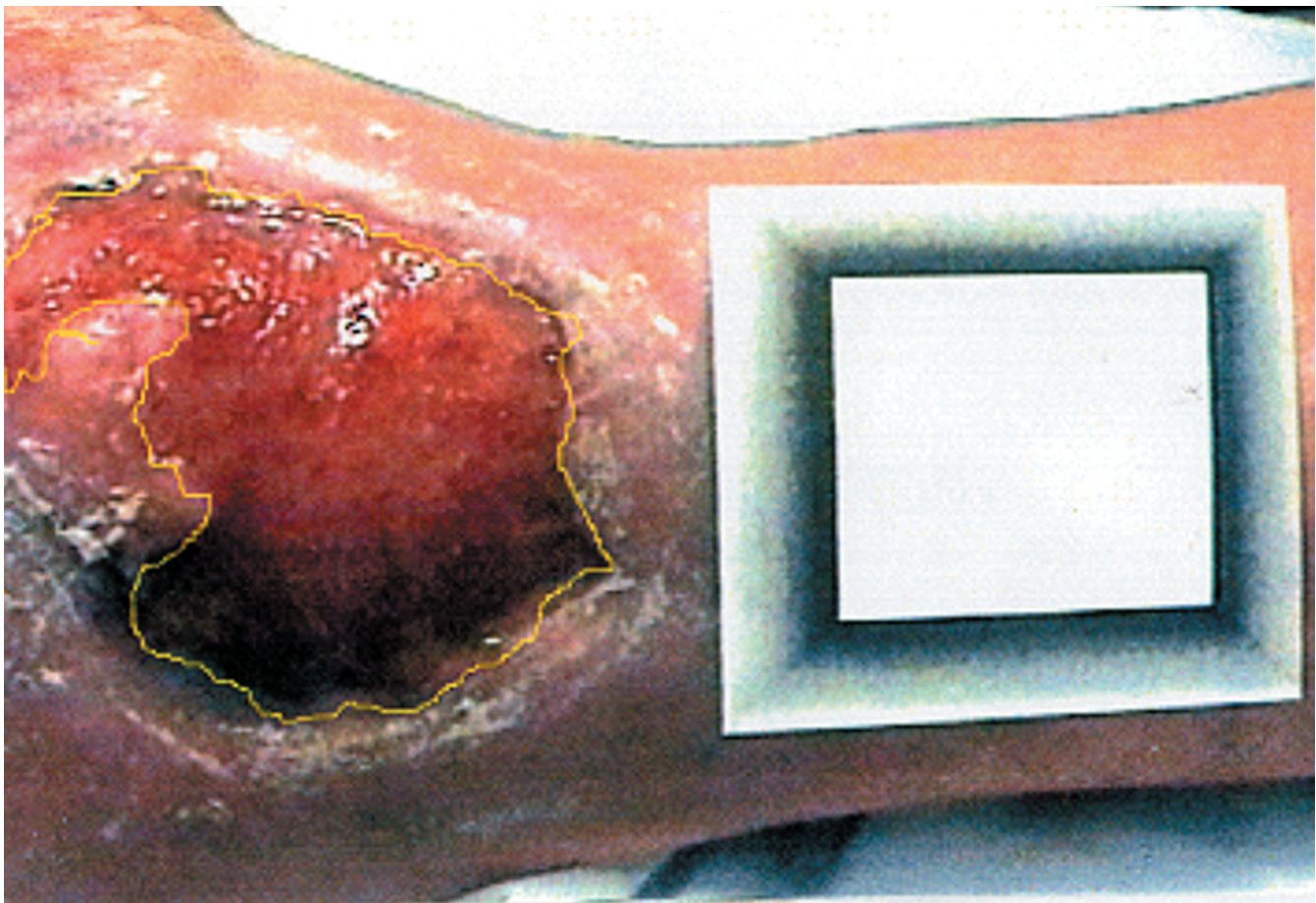
FIGURE 2. Verge Videometer (VeV) system: the target in the picture has a known area, which the computer uses to correct for parallax. The yellow line represents the digital tracing of the wound margin.

Thawer et al. performed a study evaluating the VeV, and comparing it with acetate tracings and mechanical planimetry in measuring 45 chronic human wounds and 38 small surgical animal wounds.[9] The authors found excellent intra-rater and inter-rater reliability for single measurements of human and animal wounds, but greater precision with the computerized technique. Reliability increased when three measurements were taken and the results averaged. Precision also increased when the average of three measurements was used, except for the computerized technique with animal wounds. Excellent concurrent validity between the two techniques for human wounds, but poor concurrent validity for the small animal wounds, was seen. The authors concluded that the computerized technique is as reliable and precise as the manual one for measuring chronic human wounds.

Keast and Cranney conducted a retrospective analysis of a large wound database using the VeV.[14] They compared the relation between calculated rectangular area (length×width), calculated elliptical area (length×width×$\Pi/4$) and true wound area using information from 12,181 observations of 2131 patients with 2768 wounds. True area was obtained from VeV measurements in the database. Rectangular area and elliptical area were calculated from length and width measurements (Figure 3). Wounds of all etiologies, such as pressure, venous, and diabetic ulcers, were included in the analysis. The absolute and percentage differences between rectangular area and true area and between elliptical area and true area were calculated.

The calculated rectangular area overestimated true area by 44 percent ($p < 0.001$) and the calculated elliptical area overestimated true area by 13 percent ($p < 0.001$) (Table 1). Bland-Altman plots showed these results (Figures 4 and 5). With these plots, the horizontal lines represent ± 2 standard deviations, and calculated area represents true area if most points fall between the lines.

Consistent with previous studies, the data also show that agreement between calculated rectangular area and true area becomes progressively worse as ulcer size increases, even for smaller ulcers. This retrospective analysis clearly shows that calculated elliptical area provides a better approximation of true area but still overestimates true size considerably. It therefore seems reasonable to use an ellipse, rather than a rectangle, as a model for calculating wound area. It is important to remember, however, that calculating wound area from length and width measurements provides only an approximation of wound size. As a result, in situations where serial wound area measurements are being used prognostically, or where accuracy is important for other reasons, a more accurate method of determining wound area may be appropriate.

Measurement of wound volume can be useful in some clinical situations, for example, to assess the progress of granulation in deep wounds.[15] In this situation, area measurements miss early healing, as such wounds initially heal from the base.

Schubert and Zander compared the reliability of pressure ulcer size measurements using volume, area, perimeter, and depth.[16] The authors found that volume and area were more reliable than perimeter and depth, and that area measurement was most suitable for relatively broad and irregularly shaped ulcers, whereas volume measurement was most appropriate for deep ulcers.

Langemo et al. compared the inter-rater and intra-rater accuracy of wound volume measurements performed using either a Kundin device or an SPG technique and found the less biased and more accurate technique to be SPG.[17]

Plassmann et al. compared three methods of measuring wound volume: filling the defect with saline, making an impression with alginate, and using image processing based on a structured light technique.[15] The structured light technique creates a three-dimensional image of the wound and calculates volume using operator-provided wound data. The authors found the saline method to be least precise and the computer imaging method to be most precise and reliable.

New technology for wound measurement

The Visitrak[TM] (Smith & Nephew) is a novel bedside wound measurement system currently undergoing clinical evaluation (Figure 6). The system consists of a transparent tracing grid, a depth indicator, and a digital tablet. The tracing grid consists of a three-layer transparent film. The film is sterile, comfortable, and easy to draw on, and the multilayer structure minimizes the risk of contamination. The top film layer, which is

Rectangular:
Area = l x w

Elliptical:
Area = l x w x $\Pi/4$
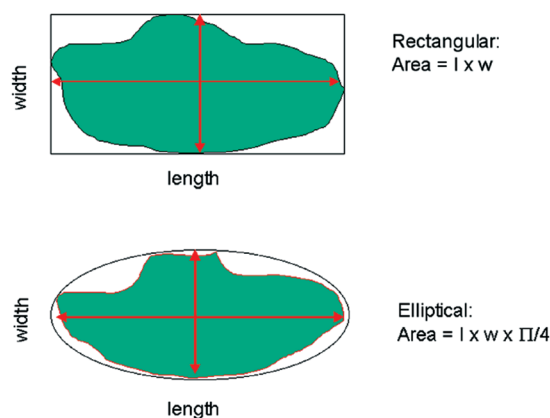
‡Verge Camera System, Vista Medical

FIGURE 3. Wound area approximations using rectangular and elliptical models. From Keast et al. 2003[14] with permission.

Table 1. Rectangular and elliptical wound area compared with true area

Relation between calculated and true area	Rectangular area	Elliptical area
Total observations	12,181	12,181
Calculated area > true area	12,102	10,916
Calculated area = true area	4	280
Calculated area < true area	75	985
Mean percent difference	44% ($p < 0.001$)	13% ($p < 0.001$)

Adapted from Keast et al. 2003.[14]

used to record wound measurements, is clean and can be stored in patient records. The depth indicator is a sterile, single-use, foam-tipped probe. The battery-operated digital tablet is a portable lightweight tool that can be disinfected. It accurately (to $0.1\,cm^2$) and reproducibly measures area, length, and width. Measurements are recorded using a special stylus. The Visitrak[TM] system rapidly calculates percentage reduction in wound area from previous measurements, measures wounds larger than one film, and subtracts traced areas of epithelialization from overall wound size. In addition, the clinician can select additional wound factors to track, such as undermining, epithelialization, or the percentage of different tissue types, including nonviable tissue.

The Visitrak[TM] has undergone internal reliability testing by the developer, Smith & Nephew. Testing involved 25 volunteers who made 10 traces of each of five different wound templates, using four different time limits (short, medium, long, and natural time). True area was determined by a computerized technique. Area accuracy equaled or exceeded 98.3 percent for all tests and was highest for the shortest time (98.7%).

## MEASURE: A PROPOSED FRAMEWORK FOR WOUND ASSESSMENT

A clinically oriented overview of the principles and practice of chronic wound assessment accompanies the discussion of the simple mnemonic, MEASURE and

the underlying concept.[10] MEASURE encapsulates the following basic wound parameters, which should be addressed in the routine assessment and management of chronic wounds: 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), Reevaluate (monitoring of all parameters regularly), and Edge (condition of edge and surrounding skin). Preliminary recommendations to encourage standardization of terminology and definitions and consistency in the approach to clinical wound assessment using the MEASURE framework are proposed. MEASURE can also be used as the basis for developing a consistent approach to documenting wound status at each assessment and for creating institution-specific assessment flow sheets (Table 2).[10]

M – Measure

As a wound heals, growth of granulation tissue decreases wound depth and volume, and proliferation and migration of new epithelium decrease wound area.[18] Measures of wound size are therefore important indicators of healing. Dimensional wound parameters that can be measured, estimated, or calculated include length, width, depth, circumference, area, and volume.

Numerous tools and techniques have been developed to measure wounds, including the ruler method to measure length and width and calculate rectangular or elliptical area; acetate wound tracings from which area
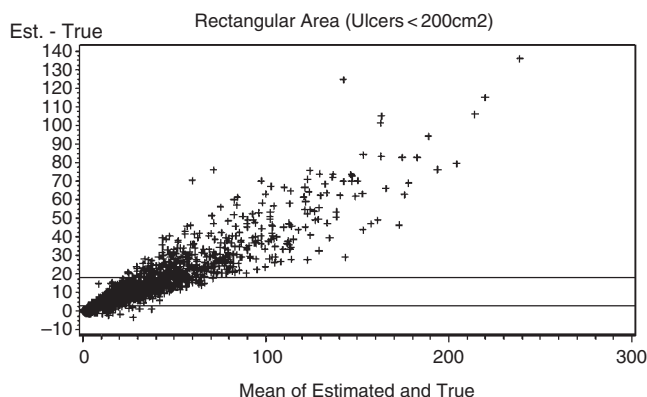
FIGURE 4. Wound area approximation using rectangular area (ulcers < 200 cm²). From Keast et al. 2003[14] with permission.
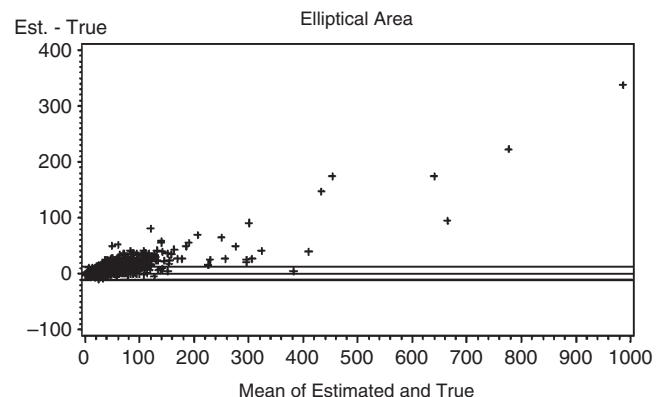
FIGURE 5. Wound area approximations using elliptical area. From Keast et al. 2003[14] with permission.
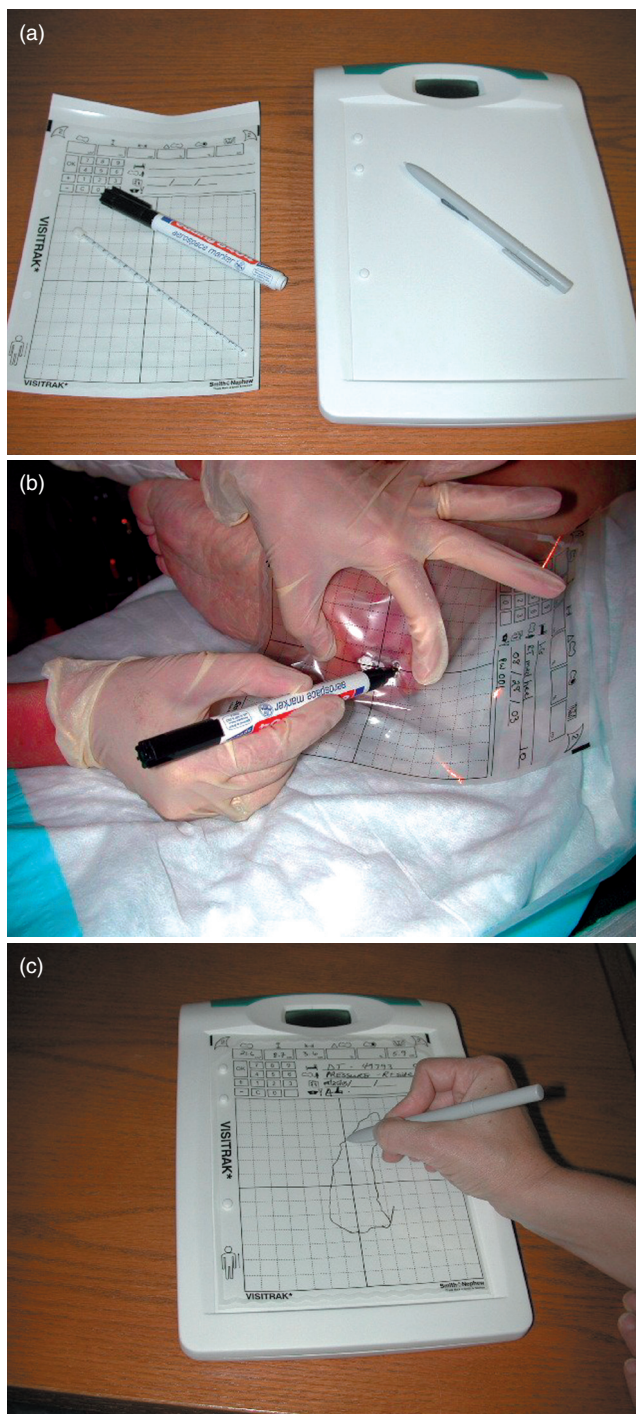
FIGURE 6. Visitrak™ system. (a) The Visitrak™ system consists of a multilayer acetate tracing, a sterile depth probe, and a digitizing tablet. (b) The wound is traced onto the acetate sheet and the backing layer removed and discarded. (c) The wound outline is traced onto the digitizing tablet and the wound area is calculated.

can be estimated using a manual square count, mechanical or computerized planimetry, or a digitizing tablet; digital photography with or without computerized planimetry; and volumetric calculations, measures, or

modeling techniques.[10,19] These methods have varying degrees of reliability, validity, clinical practicality, and responsiveness to changing wound status.

Area measurement is a crucial part of wound assessment and an important tool in articulating the goals of care, developing a care plan, and predicting healing time.[2] Initial wound area affects healing time, and regular reevaluation of wound size can quantify healing or identify a lack of healing. The percentage decrease in wound area during the first 2–4 weeks of treatment has been found to be predictive of healing at 12–24 weeks.[14] As a result, accurate measurements of wound area are vital to the clinician in making treatment decisions.

A literature review conducted by Flanagan critically evaluated the effectiveness of wound measurement techniques with the dual objective of providing an evidence-based rationale for accurate wound measurement and of identifying measurement parameters correlated with healing.[18] Most wound measurement methods used in clinical trials to evaluate healing assess the change either in wound area or in wound depth. The accuracy of these techniques relies both on the inherent precision of the technique and on the clinician's ability to see the new epithelium at the margin of the wound.[2] Area calculations based on the commonly used ruler-based wound size measurements have been found to be reliable.[14] However, as these techniques commonly overestimate wound size, determining the best way to measure irregular wounds can be difficult, and measurements are less reliable for larger wounds. For example, researchers have noted that the accuracy of area calculations based on greatest length and width measurements varies with how closely the wound conforms to a regular geometric shape.[2] In addition, the accuracy of this approach decreases with increasing wound size. Finally, research indicates that measuring the greatest length and the greatest width, perpendicular to the greatest length, is more valid and reliable than other ruler-based methods.

Wound depth is an important measure for deep wounds, as it is correlated with the degree of tissue damage. A variety of staging systems, such as the pressure ulcer staging system, based on the work of Shea, the International Association of Enterostomal Therapy and the National Pressure Ulcer Advisory Panel, and the University of Texas diabetic wound classification system can be used to categorize wound depth.[2] The use of staging systems in wound assessment is valuable, as these systems standardize terminology. However, they rely on clinical depth measurement, which may be complicated by several factors.

No technique to measure wound depth is accurate if the wound bed contains debris, particulate matter, or bits of dressing. Therefore, the first step in measuring wound depth is cleansing. Similarly, if eschar covers a

Table 2. Documentation of wound assessment using MEASURE

Parameter	Clinical observation	Indicator
Measure	Wound size: length, width, area, depth, volume	Decrease or increase in wound surface area and/or depth
Exudate	Quality and quantity	Decreased or increased purulence*
		Decreased or increased quantity
Appearance	Wound bed appearance	Decreased or increased percentage granulation tissue
(wound bed)	Tissue type and amount	Decreased or increased percentage necrotic tissue
		Friability of granulation tissue*
		Presence or absence of deep tissue structures (tendon, bone, joint)
Suffering	Patient pain level using validated pain scale	Improving or worsening wound-related pain
Undermining	Presence or absence	Decreased or increased amount
Reevaluate	All parameters monitored regularly (1–4 weeks)	Planned monitoring and reassessment frequency
Edge	Condition of wound edge and surrounding skin	Presence or absence of attached edge with advancing border of epithelium
		Presence or absence of erythema and/or induration
		Presence or absence of maceration

*May indicate infection.
Adapted from Keast et al. 2003.[10]

wound, depth measurement cannot be performed until the wound has been debrided. Accurate measurement of the depth of a wound with sinus tracts or tunnels is not possible. In this situation, however, recording the amount of wound product needed to fill the defect provides an indication of the depth of the tunnel. The depth of wounds that contain areas of partial-thickness and full-thickness damage must be estimated, but the greatest depth is usually recorded as the wound depth. Wound depth is typically measured by inserting a sterile swab into the deepest part of the wound, placing a gloved forefinger at the level of the surrounding skin, and measuring the length of swab within the wound against a ruler or other calibrated guide.

Volumetric wound measurements have several inherent practical problems including the following: the subjective nature of defining wound boundaries; the impact of positioning or movement on reproducibility of measurements; wound volume changes resulting solely from positioning differences and the impact of the normal curvature of the body on the accuracy of optical measuring techniques. In addition, a residual defect may remain in spite of complete healing of wounds in anatomical areas with thick subcutaneous tissues, such as the abdomen.[15]

In summary, research indicates that measuring wound area provides clinically useful and valid information about wound healing, whereas the clinical benefit of measuring wound volume has not yet been definitely established. Evidence for the accuracy and validity of different wound measurement techniques is reviewed in the section on wound measurement techniques.

Recommendations

Area – Repeated assessment of wound area can effectively both monitor and predict healing. Tracing the wound margin onto acetate and calculating area using mechanical planimetry is currently an accepted standard for measuring wound area. Calculating wound area from length and width measurements may be acceptable for some clinical settings, and accuracy may be improved by having a single individual perform the measurements and by taking the average of three measurements. A validated and reliable wound surface area measurement technique should be used in clinical research.

Depth – Simple depth measures may be useful in the assessment of full-thickness wounds to monitor healing. Depth should be measured in a standard way, preferably using a sterile swab inserted into the deepest part of the wound.

Volume – No simple, valid, and reliable technique for measuring wound volume is available to clinicians today. As a result, the routine measurement of wound volume cannot be recommended.

New technologies and techniques – New measurement techniques and technologies should be validated against accepted standards, such as the use of acetate tracings and mechanical planimetry for the measurement of area, before being recommended for routine clinical use.

E – Exudate

Experience with acute wounds has shown that acute wound fluid contributes to the healing process, as it contains growth factors, which stimulate tissue regeneration and promote cellular migration; proteases, which degrade necrotic tissue; and inhibitors of bacterial growth.[20,21] The composition of wound fluid may vary between individuals and at different stages of healing, although the amount of exudate gradually decreases as healing progresses.[21] In fact, recent data confirm that the quantity of wound exudate is a reliable and sensitive indicator of healing.[22]

The situation with chronic wound exudate is more complex. Chronic wound exudate differs biochemically from acute wound exudate.[20] Studies have shown that chronic wound fluid contains a variety of factors that inhibit or prevent cellular proliferation; decreased levels of growth factors compared with acute wound

fluid; high levels of proteinases, which produce chronic tissue turnover, preventing epithelialization; and high inflammatory cytokine levels and low glucose levels, both of which are associated with nonhealing wounds.

In chronic wounds, the amount of exudate may be maintained or may increase for a variety of reasons.[21] Wounds in patients with chronic venous insufficiency or lymphedema may be associated with a large amount of exudate.[22] Individuals with decreased serum protein levels, either as a result of excessive protein loss or decreased production, have increased capillary fluid leakage, producing a greater volume of wound fluid.[23] A high exudate volume may indicate local infection or osteomyelitis, and a sudden increase in exudate may signal an increased bacterial burden in the wound bed, even in the absence of typical signs of infection. Bacteria, necrotic tissue, and foreign materials in the wound all increase exudate production.

Assessing wound exudate, also known as wound fluid or wound drainage, is an essential component of comprehensive wound assessment. Serial documentation of the quantity and quality of wound exudate assists in monitoring wound response to treatment and in diagnosing infection.

The characteristics of wound exudate that can be assessed are quantity, quality and odor. Assessing these characteristics is inherently subjective and primarily qualitative. Descriptive terms used for exudate volume include absent, scant, small, moderate, heavy, high and copious. Perceptions of the meaning of these terms vary considerably and, although standardized definitions have been proposed, no consensus has been reached.[21] Even experienced wound care clinicians have difficulty in estimating exudate amount and in agreeing on the amount.[24] Evaluating the state of the dressing when it is changed may provide a rough guide to exudate quantity. However, it is important to document the dressing type, degree of saturation, and frequency of dressing change required as a result of drainage. One measurement system bases the description of exudate quantity on 10-cm gauze squares and on the frequency of dressing changes required as a result of exudate production.[23] Although such a system introduces an element of objectivity into assessing exudate volume, its application is limited to the use of 10-cm gauze squares. Adaptation of the volume estimates used to other dressing types with different absorptive capabilities would be necessary.

The MEASURE approach suggests using a simple numerical scoring system, first proposed by Falanga, for quantifying the amount of exudate, using none (0), small (1), moderate (2), and large (3) and provides definitions for each category (Table 3).[25]

In addition to quantity, other important wound exudate characteristics are quality and odor.[2] As terms describing exudate quality may be confusing if not

Table 3. Exudate volume quantification

Numerical score	Description	Definition
0	None	No exudate
1	Small (scant)	Exudate fully controlled
		Nonabsorptive dressing may be used
		Wear time up to 7 days
2	Moderate	Exudate controlled
		Absorptive dressings may be required
		Wear time 2–3 days
3	Large (copious)	Exudate uncontrolled
		Absorptive dressings required
		Dressing may be overwhelmed in < 1 day

Adapted from Falanga 2000.[25]

clearly defined, the MEASURE system recommends describing exudate quality using the following definitions (Table 4).[10,23] Serous refers to exudate that is clear, contains no debris, blood or pus, and is generally odorless. Serosanguineous fluid is pink to light red in color, possibly with a yellow tone, and thin and watery. Sanguineous fluid is bright red and bloody. Serous and serosanguineous exudate reflect the normal inflammatory and proliferative phases of healing, whereas sanguineous drainage signifies disrupted blood vessels. Seropurulent drainage is cloudy and yellow to tan in color, and purulent exudate is yellow, tan, or green. These types of exudate may be accompanied by a foul odor.[10] Purulent drainage is typically thick and may be translucent or opaque.[10,22] Conversion of exudate to seropurulent and then to purulent drainage suggests bacterial proliferation or progression to wound infection.

However, the presence of purulent exudate does not necessarily indicate infection. The diagnosis of infection in chronic wounds is not straightforward. A large study found that increased wound pain and wound breakdown were the most valid signs and symptoms of infection in chronic wounds, with a specificity of 100 percent.[26] The same study found that friable granulation tissue and foul odor were more reliable signs and symptoms of infection than purulent exudate. However, infection may also be present without significant odor being evident. Accurate diagnosis of wound infection in nonhealing wounds is challenging and relies on careful clinical observation, assessment of an individual's risk of infection, and appropriate investigations, including quantitative or semiquantitative culture.[2]

Assessing wound odor is an important part of wound assessment, although descriptions are necessarily subjective and standard terminology has not been adopted.[2] A change in the amount and type of odor may indicate a change in wound status. However, it is important to remember that all occluded wounds have an odor, and that the type of dressing used may affect wound odor.[22] Hydrocolloids, for example, may

Table 4. Exudate quality description

Descriptor	Definition		
	Consistency	Color	Odor
Serous	Thin, watery	Clear to yellow	Usually odorless
Serosanguineous	Thin, watery	Pink to light red	Usually odorless
Sanguineous	Frank blood	Bright red	
Seropurulent	Thin, watery	White to cream	Possibly foul odor
Purulent	Thick, translucent to opaque	White to cream	Possibly foul odor

Adapted from Keast et al.[10]

emit a foul odor upon removal. Necrotic tissue in a wound contaminated with anaerobes may produce exudate with a particularly foul odor.[2] Finally, specific organisms may have a characteristic odor. If *Pseudomonas aeruginosa* is present in a wound, the exudate may be a characteristic lime-green color and have a sweet odor.[22] One proposed scale for assessing odor with the dressing in place uses the following scale: no odor at close range, faint odor at close range, moderate odor in room, and strong odor in room.[2]

Recommendation

Consistent and clear terminology, definitions, qualitative descriptions, and quantitative measures of wound exudate, such as those proposed by Falanga and described in Tables 4 and 5 should be used in wound assessment in clinical practice and in research.

A – Appearance

Direct observation of the wound bed is fast and simple to perform, but it provides critical information about the etiology of the wound, contributes to accurate diagnosis, and helps to identify treatment goals and an appropriate plan of care.[3,19] Reevaluation helps to determine treatment progress.

Assessing the clinical appearance of the wound bed depends on thorough observation and involves describing its color and texture and noting any deeper tissue structures that are palpable or visible. Considerable variation exists in wound bed color, but black, yellow, red, pink, and white are most commonly used to describe the wound bed (Table 5 and Figure 7).[3] This selection is often simplified to black, yellow, and red.[2] Little data exist concerning the reliability of this system, but one study of six observers found good inter-rater agreement.

Table 5. Wound bed tissue types

Tissue type	Description
Granulation	Red, firm and pebbled. Friability may indicate infection
Fibrin	Yellow and firm. Represents collagen in the wound bed.
Slough	Yellow to gray-green and loose. May represent necrotic fascia.
Eschar	Black: soft and wet or hard and dry. Necrotic tissue.

Adapted from Keast et al. 2003.[10]

A black or dark brown wound can be seen when dehydrated necrotic tissue has compacted in the wound, most often in arterial ulcers with local ischemia. This necrotic tissue, or eschar, represents full-thickness tissue destruction, and it may cover the wound bed completely or patchily. Eschar retards healing and should be removed from healable ulcers. However, in lower extremity ulcers associated with compromised circulation, stable eschar should not be removed.

A yellow wound bed generally points to either fibrous tissue or slough. Fibrous tissue, which is composed of fibrin, is firm in texture. It appears in the wound bed before granulation tissue develops. Slough is composed of cellular debris and may adhere tightly to the wound bed or be loose and stringy.[3,27] If large numbers of white blood cells are present, slough may be a creamy yellow color, and if necrotic fascia is present, slough may appear yellow to gray-green.[3,10] Desloughing a wound must be performed cautiously if slough is adherent to fibrous tissue in the wound bed to avoid unnecessary wound trauma and prolongation of the inflammatory response.[3]

A red wound bed indicates the presence of granulation tissue, with a bright red, moist appearance indicating healthy granulation tissue and a paler appearance with spontaneous bleeding possibly indicating ischemia, infection, or a comorbidity such as anemia.[3] Dark red or beefy-looking granulation tissue may also indicate infection.

Pink epithelializing wounds represent the final stages of healing.[3] At this stage, pink, white, or translucent areas of epithelialization may be seen overlying a healthy bed of granulation tissue, migrating either from the wound margin or from hair follicles within the wound. However, these cells may be obscured by exudate or slough or confused with macerated skin at the wound edge.

The texture of the wound should also be noted. Black eschar is usually hard and leathery, but it may also be soft and wet. Granulating wounds usually have an uneven texture, but significantly raised areas of granulation, referred to as hyper-granulation, may indicate excess moisture in the wound. Pocketing at the base of the wound may signify infection. A prospective study evaluated healing in 100 patients with unsutured pilonidal sinus excisions.[28] Of 30 patients participating

in the study who were not receiving antibiotic therapy, 10 had pocketing at the wound base that was found to be related to infection and that prevented granulation.

If deeper anatomical structures are visible, severe tissue destruction is present. Structures that may be seen include tendon, bone, and joint capsule.

FIGURE 7. Wound appearance descriptions: (a) Eschar: heel with extensive tissue necrosis or eschar. (b) Slough: loose white-to-yellow necrotic slough in wound bed. (c) Fibrin: firm yellow fibrin representing collagen deposition in healing wound with buds of granulation and an epithelializing border. (d) Granulation: firm, uneven red granulation tissue, with some fibrin in the center of the wound. (e) Epithelialization: Advancing edge of pale pink epithelial tissue, especially prominent in the lower right corner of the wound.

Depending on the severity of the wound, as healing progresses, wound color usually changes from an initial black or yellow to red and then to pink. Typically, many ischemic wounds, venous ulcers with associated small-vessel disease, and some pressure ulcers follow this progression.[19] Epithelialization in these wounds does not begin until the black or yellow eschar has either debrided itself or been debrided and healthy granulation tissue has developed. Neuropathic ulcers and uncomplicated venous ulcers, however, frequently present with a red wound bed.

A qualitative color-based evaluation is inadequate to assess wound appearance accurately, as many wounds show a combination of stages of healing, and hence, of colors.[2] As a result, investigators have developed a variety of qualitative and quantitative rating scales to describe more accurately the wound surface and document treatment effects. A percentage can be estimated for each tissue type present in the wound. Validity and reliability studies of this strategy have not been conducted, but estimating the tissue type percentages is more precise than simply noting the dominant wound color. Limited research on the reliability of visually estimating a percentage range for different tissue types indicates that this approach, although insufficiently reliable for research uses, is more precise in assessing progress than ratings simply indicating whether a tissue type is present or absent. This approach is highly subjective, but standardizing terminology facilitates comparison between ratings by different observers.[18]

Qualitative and quantitative approaches can also be combined to produce a wound bed appearance scoring system, such as proposed as part of the MEASURE approach (Table 6).[10] Numerous evaluation tools are available to document various aspects of pressure ulcers, although they are incompletely validated.[29] Tools include the pressure sore status tool (PSST), the Pressure Ulcer Scale for Healing (PUSH), the Sussman Wound Healing Tool (SWHT), the Wound Healing Scale (WHS), and the Sessing Scale (SS).

Wound photography can provide valuable additional information. Both standard and Polaroid photography are useful and practical ways of documenting wound status in many clinical settings. Digital photography, however, may be impractical due to the large file size and lack of color consistency, especially for reds. Houghton et al. compared the reliability and valid-ity of a photographic wound assessment tool (PWAT), a modification of the PSST, to that of full bedside assessment using the PSST.[30] The study evaluated the tool using chronic pressure ulcers ($n = 56$) and vascular leg ulcers ($n = 81$). The authors found the PWAT to have good intra-rater (ICC = 0.96) and inter-rater (ICC = 0.73) reliability and concurrent validity ($r = 0.70$) compared with PSST. Assessment using the PWAT was found to be sensitive to change in healing, but not in nonhealing, ulcers. Wound photography, although useful for many types of chronic wounds, is not applicable to wounds extending around a limb or to wounds with extensive undermining.

Recommendations

Consistent and clear terminology, definitions, and descriptions of wound appearance, such as those proposed by Keast and described in Table 4, should be used in assessing wound appearance in clinical practice and research.

The wound bed appearance score proposed by Falanga and summarized in Table 5, which has yet to be validated, may form the basis of a quantitative wound appearance scoring system for clinical practice. Validated wound bed appearance tools should be used in research studies.

Wound photography may provide a valuable record. However, it is not practical for all wound types and it may not be feasible in some clinical settings. As a result, wound photography cannot be recommended as a standard part of assessing wound appearance.

S – Suffering

Assessment of pain is an important component of local wound assessment, both from the perspective of patient comfort and as a clinical indicator of wound infection.[10] Pain accompanies many chronic wounds and is a serious concern for many patients, significantly affecting quality of life and general well being.[31] As pain is often an intense and distressing subjective experience that can have significant psychological ramifications and a negative impact on an individual's functional status, it is critical that a patient-centered approach be incorporated into pain assessment and management strategies.[32]

Table 6. Wound bed appearance scoring system

Appearance score	Granulation tissue (red)	Fibrinous tissue (yellow)	Eschar (black)
A	100%	−	−
B	50–99%	+	−
C	< 50%	+	−
D	±	±	+

Adapted from Falanga 2000.[25]

Management of wound pain poses a substantial challenge in clinical practice, as the assessment of pain may be difficult in individuals with cognitive or sensory impairments; numerous underlying causes and local factors can contribute to wound pain; and diverse interventions may be required for different clinical presentations.[32] Little research on chronic wound pain has been performed, and what little data are available suggest that wound pain is both infrequently assessed and inadequately managed.[31,32]

The initial assessment of wound pain should include a complete history; an evaluation of the underlying cause of the pain, often related to the individual wound pathophysiology; local wound factors, frequently associated with wound manipulation; determination of the nature, onset, intensity, and duration of the pain; identification of factors that worsen or relieve the pain and effect of the pain on activities of daily living and functional status.[32] Pain should be monitored frequently to evaluate response to treatment, and it should be reassessed regularly as part of the wound reevaluation process.

Numerous practical tools to assist in taking a pain history have been developed, and a variety of validated pain assessment instruments are available.[31] Visual analog scales, which are simple to use in clinical practice, have been shown to be highly reliable. More extensive questionnaires primarily have value in the research setting.

A model of the chronic wound pain experience developed by Krasner helps to guide the assessment and management of pain (Table 7).[22] This experience is defined as "a complex, subjective phenomenon of extreme discomfort experienced by a person in response to skin and/or tissue injury." The model divides pain associated with a nonhealing wound into noncyclic acute wound pain, cyclic acute wound pain and chronic wound pain. Noncyclic acute wound pain is defined as acute pain occurring as a single episode, for example pain associated with sharp debridement.

Cyclic acute wound pain is defined as acute pain recurring periodically and associated with repeated interventions, for example, daily dressing changes or repositioning. Chronic wound pain is defined as persistent pain occurring in the absence of manipulation.

Pain associated with a chronic wound can be described as either nociceptive or neuropathic. Acute nociceptive pain, an inflammatory response to tissue damage associated with a specific trigger, is often described as aching or throbbing.[32] In contrast, chronic neuropathic pain, which results from persistent nerve injury and is not associated with identifiable triggers, is often described as burning, stinging, or shooting.

Determining and addressing the underlying wound pathophysiology is the first stage in assessing and managing chronic wound pain. In patients with venous ulcers, improving venous return with compression therapy or pentoxifylline may reduce or relieve pain.[33–35] In patients with arterial ulcers, revascularization is often needed, and in those with pressure ulcers and diabetic foot ulcers, pressure offloading is required. Patients with diabetic foot ulcers usually also require debridement and normalization of blood glucose levels.

Local wound factors that may contribute to pain are primarily associated with wound care procedures, but they may also be related to wound infection.[31] Forceful irrigation, some debridement methods, dry or adherent dressings, exudate accumulation, and concentrated or harsh wound cleansing agents are all sources of wound pain and should be avoided. In addition, surveillance for infection should be carried out and local or systemic therapy instituted if warranted.

A combination of pharmacologic and nonpharmacologic approaches may be most effective in managing pain associated with chronic wounds, but research has yet to determine the most effective modalities and combinations for different types of pain.[31,32] Systemic analgesic therapy must be implemented and titrated carefully in elderly patients, however, as they are

Table 7. Chronic wound pain experience model

Pain history and assessment	• Underlying pathophysiology		
	• Local contributing factors		
	• Nature, onset, intensity, duration of the pain		
	• Effect on activities of daily living and functional status		
	• Determination of pain type		
Pain type	Noncyclic acute wound pain	Cyclic acute wound pain	Chronic wound pain
Pharmacologic interventions	Local anesthesia Systemic analgesia	Local anesthesia Systemic analgesia	Systemic analgesia Antidepressant Anticonvulsant
Nonpharmacologic interventions	Pain-reducing wound care products, techniques	Pain-reducing wound care products, techniques, patient empowerment	Relaxation strategies Transcutaneous electrical nerve stimulation
Evaluation	Monitor and reevaluate pain level, adjust intervention strategy and continue reevaluation and treatment adjustment		

Adapted from Krasner.[31]

susceptible to adverse reactions.[32] Research has shown that nociceptive pain is best treated with analgesics, following the scheme laid out in the World Health Organization pain ladder.[36,37] Neuropathic pain, however, may best be managed using tricyclic antidepressants or anticonvulsants such as gabapentin.[31] Nonpharmacologic approaches include using atraumatic or gentle wound management techniques, selecting appropriate dressings to encourage moist healing, and approaches to reduce suffering, such as relaxation therapy.
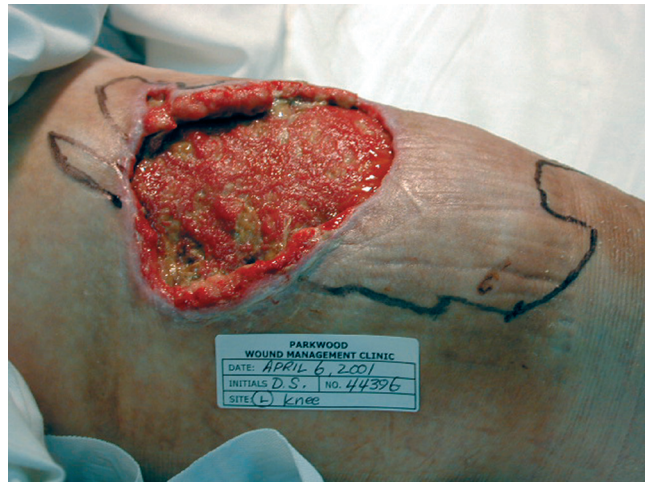
Recommendations

Intensity of pain should be measured using a validated pain instrument and reevaluated using the same instrument. Each institution should develop a protocol for comprehensively assessing wound pain that incorporates the multiple facets of chronic wound pain and a schedule for monitoring and reassessing pain.

U – Undermining

Complete wound assessment includes measuring the internal wound area, including the degree of undermining, tunneling, and sinus tracts.[10] This is a critical evaluation, as healing will not occur unless the wound edge is firmly attached to the wound bed and any undermined areas have resolved. The extent and degree of undermining are correlated with the severity of tissue necrosis.[38] Necrosis of subcutaneous fat initiates undermining of skin, and penetration of deep fascia permits rapid undermining of deeper structures. Ulcers with undermining contain more bacteria than those without undermining.

Both the depth and extent of undermining can be measured. To assess the presence of wound undermining, a sterile swab can be used to probe the entire wound margin, and the extent of undermining simultaneously can be marked on the skin.[10] The extent of tunneling and the path of sinus tracts can be identified in the same way. If possible, the undermined area should be inspected, using a sterile tongue depressor to gently lift the lip. If significant quantities of fibrin, slough, or necrotic tissue are present, both the lip of the wound and the internal wound margins may benefit from excision and debridement. Healing does not proceed until the wound edges adhere.

Information about undermining should be carefully documented to facilitate evaluation of change (Figure 8).[2] A clock system can be used to record the extent of undermining in four quadrants, with 12:00 o'clock representing the cephalad direction, with the body in the anatomic position. To facilitate comparison and increase accuracy of progress assessments, measuring and recording procedures should be standardized and consistently used.

FIGURE 8. Undermining assessment. Undermining, due to a large hematoma from a traumatic wound, mapped out on skin.

Recommendation

Measurement of undermining should be a routine part of wound assessment, and the clock system is proposed as the standard approach to measuring this parameter.

R – Reevaluate

Numerous factors affect the decision on how often to monitor and reevaluate the wound.[2] In this context, monitoring refers to inspecting or checking the wound, for example, for signs of infection, and reevaluation refers to assessing selected wound parameters to determine and quantify progress toward healing.

Information from the initial assessment of the patient and the wound is a major determinant of the appropriate assessment frequency.[2] The baseline assessment provides information about wound stage, severity, and depth, patient comorbidities, and other factors that might affect the healing rate or the risk of infection. Short- and long-term treatment goals and the patient care environment may also influence the reevaluation frequency. In turn, assessment frequency often directs the choice of dressing or treatment. Various other factors may change monitoring or assessment frequency. For example, assessment frequency may decrease once patient or caregiver wound care education is accomplished or after an initial response to the intervention has been observed. Frequent monitoring of a wound should be performed after wound treatment has been initiated, to identify early signs of effectiveness, such as edema reduction in response to compression bandaging, and to detect the development of allergic or sensitivity reactions to dressings or bandages used.

For some types of ulcers, guidelines or recommendations have been developed regarding appropriate

monitoring frequency, whereas for other types, clinical judgment and the individual patient presentation remains the best guide. The United States Agency for Health Care Quality and Research (previously the Agency for Health Care Policy and Research) has developed guidelines for monitoring and reassessment for pressure ulcers.[39,40] These guidelines recommend that pressure ulcers should generally be monitored regularly and reassessed weekly. More frequent monitoring and assessment should be performed if deterioration occurs. Reassessment of venous ulcers every week or every 2 weeks is often sufficient.[2] The optimal reassessment frequency for diabetic ulcers has not yet been defined.[41] However, as diabetic ulcers are associated with a high risk of complications, such as infection and amputation, patients with diabetic ulcers should receive frequent monitoring and reassessment. The use of appropriate validated assessment tools can assist in standardizing assessments and provide a common language to discuss wound status.

It is important, however, not to reevaluate the progress of healing too frequently, as the evaluation of progress becomes difficult, and too frequent evaluation may lead to inappropriate treatment decisions.[3,10] Overall, however, wound parameters should be monitored and documented at each dressing change, and wounds should generally be reevaluated every 1–4 weeks or when a significant change in wound status occurs.

Recommendation

Wounds should be monitored for infection or deterioration at least at every dressing change, and they should be fully reassessed every 1–4 weeks, based on clinical judgment.

E – Edge

The wound edge and surrounding skin, or periwound area, provide important information that can assist the clinician in diagnosing and treating wounds appropriately.[2] A comprehensive assessment can also help to ascertain the status of the wound, response to treatment, stage of healing, and presence of other dermal pathologies. Careful inspection and assessment of these areas is an integral aspect of the wound assessment process.

Key factors to note are attachment or lack of attachment of the wound edge and any undermining; ulcer shape and edge configuration; and the condition of the surrounding skin, noting especially induration, inflammation, and maceration (Figure 9).[10] Attachment can be identified by the presence of an indistinct edge with epithelium advancing over the wound. Unattached edges are generally sharply demarcated from the wound. The nature of unattached edges should be described and undermining identified and measured.

FIGURE 9. Edge appearance descriptions. (a) Maceration: white, waxy appearance of periwound tissue as a result of uncontrolled exudate from a venous leg ulcer. (b) Induration: firm erythematous border around a neuropathic diabetic foot ulcer may represent soft tissue infection.

Induration is defined as firm swelling with or without redness, and it may indicate infection or an inflammatory process. The presence of maceration, which refers to white, waxy, soft and wet-looking tissue, may indicate poor exudate control.

The stage of development or resolution of the ulcer may be reflected in the condition of the wound edge and the surrounding skin. As a pressure ulcer develops, a large area of skin without discernible edges becomes a shallow lesion with a visible edge.[38] Progressive necrosis produces a more distinct wound edge, until the established ulcer has a thick, inwardly rolled margin comprised of proliferating epithelial cells migrating over the wound edge. Ongoing injury and repair may produce firm, indurated wound edges with fibrosis, which may affect epithelial cell migration. An indistinct wound edge may indicate epithelialization, and healing of chronic wounds is eventually completed by epithelial proliferation and migration across the wound.[2]

The ulcer shape and the appearance of the wound edge and surrounding skin may indicate the wound

etiology.[42] Arterial ulcers tend to have a smooth, sharp margin, often described as a punched-out or cookie-cutter edge, and surrounding skin is usually pale. In contrast, an irregular margin with a more gently sloped border and brown-pigmented periwound indicates lipodermatosclerosis and a venous ulcer. Vasculitic ulcers may have an irregular edge and hyperemic skin around the ulcer. Gangrene or edge necrosis may also be seen with vasculitis, but these features may instead point to ischemia or pyoderma gangrenosum.[43] A rolled, possibly painful, skin edge also points toward an inflammatory etiology, such as rheumatoid vasculitis or pyoderma gangrenosum. Diabetic ulcers usually have a smooth margin and the surrounding skin is often callused.[42] The appearance of the wound margin and surrounding skin in pressure ulcers is variable.

Careful observation of skin appearance, color, and texture may also provide additional clues to the wound etiology and valuable information about pathological processes that may be preventing wound healing. Abrasions and island denuding may indicate subcutaneous deterioration, friction, or shear. Abnormal skin color is an important observation. Red skin may indicate a cellulitis pressure area, vasculitis, arterial disease, suboptimal patient or wound care, or contact dermatitis.[2,43,44] Macerated skin indicates large amounts of exudate or moisture at the wound base and prolonged exposure time of the skin to moisture. A purplish skin tone may signal an underlying hematoma or an area of ischemia, or it may be related to cryoglobulinemia or vasculitis. Induration of the periwound may indicate an abscess, edema, or trauma. Ridges or undulations may signify scarring within the subcutaneous tissue, whereas soft spongy or boggy areas may suggest sequestered areas of necrotic tissue, often seen in sacral or coccyx pressure ulcers. The presence of inflammation or bullae may point to dermal pathology, including fungal or yeast infection, bullous pemphigoid, psoriasis, or other conditions. Skin suppleness should be noted, as both overly moist and very dry skin, which may be seen in patients with impaired peripheral circulation, is more prone to injury.[2]

Assessment of the wound edge and surrounding skin includes careful visual inspection, measurement, and documentation.[2] The size and location of the wound should be well described and the periwound area assessed for skin integrity. The wound edge characteristics should be described in as much detail as possible. The appearance, color, and texture of the surrounding skin and the location and extent of any abnormalities or pathology should be noted. The interface of the wound base and skin should be gently palpated to determine whether the lip of the wound is attached to the wound base or if it is mobile and possibly concealing undermining. Induration and edema can be assessed by gently pressing the skin within 4 cm of the wound. The details of the assessment should be documented to facilitate comparison with future reassessments and determine wound healing.

Recommendation

Assessment of the wound edge should include an evaluation of attachment or lack of attachment and any undermining; observation of ulcer shape and edge configuration; and inspection of the condition of the surrounding skin, noting especially induration, inflammation, and maceration. Documentation should use standard terminology and descriptions, such as those described here.

CONCLUSIONS

Wound assessment is an important clinical skill that is integral to effective wound management. During the past decade, evidence has been steadily accumulating about the prognostic value of wound assessment and the accuracy and reliability of wound assessment techniques, especially measurement techniques. As a result, wound assessment is evolving into a clinical science. However, for this important aspect of clinical care to advance further as a science, it is necessary to begin to define terms uniformly, agree on concepts, and set practice standards and guidelines. MEASURE is a simple conceptual framework that can act as the basis for developing a consistent wound assessment approach. It is hoped that this uniform approach to wound assessment, using MEASURE, will stimulate discussion and debate and assist in formulating best practice guidelines for wound assessment.

ACKNOWLEDGMENTS

REFERENCES

1. Sibbald RG, Orsted H, Schultz GS, Coutts P, Keast D, for the International Wound Bed Preparation Advisory Board and the Canadian Chronic Wound Advisory Board. Preparing the wound bed 2003: focus on infection and inflammation. Ostomy Wound Manage 2003;49:24–51.
2. van Rijswijk L. Wound assessment and documentation. In: Krasner, DL, Rodeheaver, GT, Sibbald, RG, editors. Chronic wound care: a clinical source book for healthcare professionals. 3rd ed. Wayne, PA: HMP Communications, 2001:101–15.
3. Flanagan M. A practical framework for wound assessment 2: methods. Br J Nurs 1997;6:6–11.
4. Sheehan P, Jones P, Caselli A, Giurini JM, Veves A. Percent change in wound area of diabetic foot ulcers over a 4-week period is a robust predictor of complete healing in a 12-week prospective trial. Diabetes Care 2003;26:1879–82.

5. Zimny S, Schatz S, Pfohl M. Determinants and estimation of healing times in diabetic foot ulcers. J Diabetes Complications 2002;16:327–32.

6. Gorin DR, Cordts PR, LaMorte WW, Manzoian JO. The influence of wound geometry on the measurement of wound healing rates in clinical trials. J Vasc Surg 1996;23:524–8.

7. Kantor J, Margolis DJ. A multicentre study of percentage change in venous leg ulcer area as a prognostic index of healing at 24 weeks. Br J Dermatol 2000;142:960–4.

8. Tallman P, Muscare E, Carson P, Eaglstein WH, Falanga V. Initial rate of healing predicts complete healing of venous ulcers. Arch Dermatol 1997;133:1231–4.

9. Thawer HA, Houghton PE, Woodbury G, Keast D, Campbell K. A comparison of computer-assisted and manual wound size measurement. Ostomy Wound Manage 2002;48:46–53.

10. Keast DH, Bowering K, Burrows C, D'Souza L, Evans AW, MacKean G. New techniques in assessing non-healing ulcers—measuring up. Ninth Annual Conference, Canadian Association of Wound Care; 2003 Nov 6–9;Toronto, ON.

11. Williams C. The Verge Videometer wound measurement package. Br J Nurs 2000;9:237–9.

12. Langemo DK, Melland H, Hanson D, Olson B, Hunter S, Henly SJ. Two-dimensional wound measurement: comparison of 4 techniques. Adv Wound Care 1998;11:337–43.

13. Lucas C, Classen J, Harrison D, De Haan RJ. Pressure ulcer surface area measurement using instant full-scale photography and transparency tracings. Adv Skin Wound Care 2002;15:17–23.

14. Keast DH, Cranney G. Does wound surface area as measured by length and width reflect true area: analysis of a wound data base. Ninth Annual Conference, Canadian Association of Wound Care; 2003 Nov 6–9;Toronto, ON.

15. Plassman P, Melhuish JM, Harding KG. Methods of measuring wound size: a comparative study. Ostomy Wound Manage 1994;40:50–60.

16. Schubert V, Zander M. Analysis of the measurement of four wound variables in elderly patients with pressure ulcers. Adv Wound Care 1996;9:29–36.

17. Langemo DK, Mellan DH, Olson B, Hanson D, Hunter S, Henly SJ, Thompson P. Comparison of 2 wound volume measurement methods. Adv Skin Wound Care 2001;14:190–6.

18. Flanagan M. Wound measurement: can it help us to monitor progression to healing? J Wound Care 2003;12:189–94.

19. Goldman RJ, Salcido R. More than one way to measure a wound: an overview of tools and techniques. Adv Skin Wound Care 2002;15:236–45.

20. Schultz GS, Sibbald RG, Falanga V, Ayello EA, Dowsett C, Harding K, Romanelli M, Stacey MC, Teot L, Vanscheidt W. Wound bed preparation: a systematic approach to wound management. Wound Rep Reg 2003;11:1–28.

21. Fletcher J. Managing wound exudate. Nurs Times 2003;99:51–2.

22. Ovington LG. Dealing with drainage: the what, why and how of wound exudate. Home Healthcare Nurse 2002;20:368–34.

23. Mulder GD. Quantifying wound fluids for the clinician and researcher. Ostomy Wound Manage 1994;40:66–9.

24. Thomas S, Fear M, Humphreys J, Disley L, Waring MJ. The effect of dressings on the production of exudates from venous leg ulcers. Wounds 1996;8:145–50.

25. Falanga V. Classifications for wound bed preparation and stimulation of chronic wounds. Wound Rep Reg 2000;8:347–52.

26. Gardner SE, Frantz RA, Doebbeling BN. The validity of the clinical signs and symptoms used to identify localized chronic wound infections. Wound Rep Reg 2001;9:178–86.

27. Bryant R, editor. Acute and chronic wounds: nursing management. 2nd ed. St. Louis, MO: Mosby, 2000.

28. Cutting K, Harding K. Criteria for identifying wound infection. Lancet 1992;339:198–9.

29. Woodbury MG, Houghton PE, Campbell KE, Keast DH. Pressure ulcer assessment instruments: a critical appraisal. Ostomy Wound Manage 1999;45:42–53.

30. Houghton PE, Kincaid CB, Campbell KE, Woodbury MG, Keast DH. Photographic assessment of the appearance of chronic pressure and leg ulcers. Ostomy Wound Manage 2000;46:20–30.

31. Krasner D. Dressing decisions for the twenty-first century: on the cusp of a paradigm shift. In: Krasner D, Kane D, editors. Chronic wound care. 2nd ed. Wayne, PA: Health Management Publications, 1997:336–43.

32. Reddy M, Kohr R, Queen D, Keast D, Sibbald RG. Practical treatment of wound pain and trauma: a patient-centered approach. An overview. Ostomy Wound Manage 2003;49 (4A Suppl.):2–15.

33. de Araujo T, Valencia I, Federman DG, Kirsner RS. Managing the patient with venous ulcers. Ann Intern Med 2003;138:326–34.

34. Cullum N, Nelson EA, Fletcher AW, Sheldon TA. Compression for venous leg ulcers. Cochrane Database Syst Rev 2000;3:CD000265.

35. Jull AB, Waters J, Arroll B. Pentoxifylline for treating venous ulcers. Cochrane Database Syst Rev 2002;1:CD001733.

36. Ventafridda V, Saita L, Ripamonti C, De Conno F. WHO guidelines for the use of analgesics in cancer pain. Int J Tissue React 1985;7:93–6.

37. Dalton JA, Youngblood R. Clinical application of the World Health Organization analgesic ladder. J Intraven Nurs 2000; 23:118–24.

38. Bates-Jensen BM. Pressure ulcer assessment and documentation: the pressure sore status tool. In: Krasner D, Kane D, editors. Chronic wound care. 2nd ed. Wayne PA: Health Management Publications, 1997:37–48.

39. Panel for the Prediction and Prevention of Pressure Ulcers in Adults. Clinical Practice Guideline Number 3: Pressure Ulcers in Adults: Prediction and Prevention. Rockville, MD: US Department of Health and Human Services. Agency for Health Care Policy and Research. 1992. AHCPR Publication 92–0047.

40. Bergstrom N, Bennett MA, Carlson CE, Frantz RA, Garber SL, Jackson BS, Kaminski MV, Kemp MG, Krouskop TA, Lewis VL, Maklebust J, Margolis DJ, Marvel EM, Reger SI, Rodeheaver GT, Salcido R, Xakellis GC, Yarkony GM. Clinical Practice Guideline Number 15: Treatment of Pressure Ulcers. Rockville, MD: US Department of Health and Human Services. Agency for Health Care Policy and Research. 1994. AHCPR Publication 92–0652.

41. Steed DL. Diabetic wounds: assessment, classification and management. In: Krasner D, Kane D, editors. *Chronic wound care.* 2nd ed. Wayne, PA: Health Management Publications, 1997:172–7.

42. Holloway GA Jr. Arterial ulcers: assessment, classification and management. In: Krasner D, Kane D, editors. Chronic wound care. 2nd ed. Wayne, PA: Health Management Publications, 1997: 158–64.

43. Jennette JC, Falk RJ. Small vessel vasculitis. New Engl J Med 1997;337:1512–23.

44. Kerdel FA. Inflammatory ulcers. J Dermatol Surg Oncol 1993;19:772–8.