

The importance of continuous wound measuring

Wound measurement provides baseline information while continuous measurement helps to predict healing and aids monitoring of treatment efficacy and evaluation. It is also objective and can be useful in cost-benefit analysis. Methods such as the ruler technique are inaccurate and do not account for changes in wound shape and such practice should be discouraged. Acetate and planimetry are widely available, easy to use and have a good inter-rater agreement as demonstrated by many studies. The result of most methods of wound measuring depends on the accuracy of the original tracing. Methods, however, are not interchangeable.

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KEY WORDS

Area measurement
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Prediction of time to healing
Wound measuring

The pace of change in wound management is placing an emphasis on the development of more objective tools by which to assess and evaluate wound healing. At present, there are no predictive factors to guide clinicians to differentiate patients who will heal readily from those who will have prolonged courses of treatment (Sheehan et al, 2003).

Some studies propose that percentage change in wound area over a four-week period of 30% or more is a good predictor of healing in venous leg ulcers and diabetic foot ulcers (Kantor and Margolis, 2000; Sheehan et al, 2003). This article will review the use of continuous wound measurement, the methods to obtain it, the evidence to promote it and its contribution to wound management. A further review

of the current most commonly used methods to measure wounds will also be presented.

Why wounds should be measured

Recording wound area and volume is considered a routine part of patient assessment and provides information on the progress of healing (Romanelli, 2002). 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 help to determine appropriate interventions at each stage (Keast et al, 2004).

Accurate wound measurement is an integral and objective component of the assessment process and is required for comparative results and analysis of treatment regimens (Melhuish et al, 1994). However, in two studies of documentation of wound assessment, statements such as 'healing well' were commonly used whereas actual wound size was only recorded in six out of 40 patients' notes with the method of wound measurement never mentioned (Hon and Jones, 1996; Sterling, 1996).

Being able to predict whether wounds will heal readily with conventional treatment and deciding which patients are candidates for often expensive new treatments is important (Tallman et al, 1997; Kantor

and Margolis, 2000). Continuous monitoring of changes in wound size is key to the outcome of this process. Knowing which ulcer will probably fail to heal within a 24-week period allows the clinician to consider alternative and perhaps more aggressive treatment strategies after only four weeks of therapy, using simple measurements accessible to any practitioner (Kantor and Margolis, 2000).

The value of knowing wound size is demonstrated by Margolis et al (2000). In a retrospective cohort study of 260 patients they were able to predict ulcer healing in venous leg ulcers at 24 weeks in 95% of cases when compression therapy was used. To predict this outcome they devised a scoring system. This system allocated one point to wounds greater than 5cm² and one point to those greater than 6 months in duration. A total of 93–5% of those with a score of 0 healed at 24 weeks compared with 13–37% of those with a score of two.

Predicting ulcer healing is especially important in the current managed care environment in which cost-containment and the need for referral to a specialist have assumed great importance (Tallman et al, 1997). If further referral and investigation are warranted then the measured ulcer area is an important piece of medical information (Charles, 1998).

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Continuous monitoring and research implications

In the wider context, continuous monitoring of changes in wound size and being able to predict ulcer healing could have implications for the design and duration of research studies. Tallman et al (1997) propose that pilot studies have the potential to be shortened and larger trials could use the shorter end-point of early positive healing rates as a substitute and accurate surrogate for complete healing. In addition, limiting clinical trials to those patients with recalcitrant ulcers may substantially reduce the cost associated with many studies, as fewer participants would be needed in order to retain a population of patients with existing wounds (Kantor and Margolis, 2000).

Flanagan (2003) suggests an additional advantage of wound size monitoring is that plotting healing rates against initial wound area and then comparing them with a defined standard helps to inform clinical decision-making and reduces the likelihood of ineffective treatments. Eventually, this information may help in establishing baseline healing rates for different wound types, which would facilitate meta-analysis, allow objective comparisons of different treatments and assist reliable cost-benefit analysis (Flanagan, 2003).

The value of wound measurement is therefore apparent. However, a study by Maylor (2003) asked 16 post-registration students to determine the important components of a hypothetical wound assessment form and size was only rated as crucial by five of the students.

The European Tissue Repair Society (2003) recommends that wound size should be measured and documented at least monthly. *Table 1* summarises the main advantages of continuous wound measuring (Gethin, 2005).

Wound measurement methods

Methods used to determine the area of a wound can be subdivided into contact and non-contact methods

(*Table 2*). Of the methods listed in *Table 2*, ruler technique, tracing overlays and planimetry are most commonly used in routine clinical practice (Charles, 1998).

Ruler method

The ruler method measures the maximal length by the maximal perpendicular width using a disposable paper ruler to calculate area (*Figure 1*).

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Acetate method

The acetate method involves applying a two-layer transparent acetate over the wound and tracing the perimeter with a permanent pen. The contact layer is then discarded into clinical waste and the top layer stored within the patient notes. For most cutaneous lesions, measuring the wound area from contour tracings estimates healing reliably despite the errors introduced by flattening a curved surface (Mani, 1999).

Most acetates are provided preprinted with 1 cm² measures, and the number of squares half or more within the perimeter are calculated as 1 cm² (Harding, 1995). Some acetates are preprinted in 1 mm² areas but these take too long to count and are not suited to routine practice. In addition to providing an area outline of the wound, the acetate can be used to identify areas of slough or epithelialisation and can be dated and stored within patient notes. Computerised systems, such as digital planimetry, can be used in conjunction with acetate.

Digital planimetry

Digital planimetry incorporates the same method to obtain the wound

border as the acetate method, but rather than counting squares the tracing is placed on a digital tablet, and the border is re-traced using a stylus. The underlying sensor then calculates the wound area.

The literature reports some studies that have compared methods to obtain wound area for superficial wounds. Oien et al (2002) compared the measurement of 50 leg ulcers in 20 patients by three physical therapists using four methods of area measurement: maximal perpendicular diameter; grid tracing and square counting; mechanical planimetry; and digital planimetry. The results demonstrated that all four methods had a high degree of agreement with each other, at least for ulcers with an area up to approximately 10 cm².

This is supported in another study when the level of agreement was highest for wounds with an area <10 cm² when acetate and digital planimetry were compared, but a statistically significant difference was reported for larger wounds ($P < 0.008$) (Gethin and Cowman, 2005). Oien et al (2000) concluded that ruler-based schemes were less reliable than other techniques for measuring ulcers, at least for those with an area above approximately 5 cm².

A study by Majeske (1992) compared four methods of measurement: ruler technique; counting 1 mm squares; hand-held planimetry; and the digitiser. Three therapists made two tracings each of 31 patients' venous leg ulcers. The results demonstrated good reliability for each therapist with each method but that the ruler method overestimated size. The mean sizes obtained by the ruler technique ranged from 7.9–10.2 cm², — a difference of 2.3 cm². The overall range of wound sizes was 6.1–7.2 cm² — a difference of 1.1 cm². This difference in results could be clinically significant, particularly in monitoring wound size in wounds <10 cm².

Schultz et al (2005) argue that when measuring wounds there is usually a trade-off of accuracy for

Table 1.**Summary of the main advantages of continuous wound measuring**

1. Part of initial assessment
2. Aids re-evaluation
3. Contributes to more accurate communication between professionals
4. Objective form of assessment
5. Enhances quality of patient care
6. Monitors treatment efficacy
7. Aids in cost justification for specific treatments
8. May help predict healing
9. Enhances overall wound management

simplicity. This is evident in the use of ruler measurement as the length multiplied by width can overestimate area by 44% (Schultz et al, 2005), as demonstrated in *Figure 1*. The wound size measures 32.5cm² with the ruler method, 25cm² with square counting when traced with acetate, and 22.2cm² when calculated with planimetry. There is a difference of 31% between ruler and planimetry (*Figure 1*).

Mani and Ross (1999) identify a further problem with the ruler technique in that islands of epithelium may develop within the wound and this cannot be recorded in a simple measure of linear dimensions. One has to question if the acceptance of ruler technique in wound management is promoting poor practice and results. According to Sibbald and Orsted (2005), practitioners should consider applying the same scrutiny to the practice of wound care as they do to the evaluation of other areas of practice.

The differences obtained when the ruler and planimetry are used can be simply explained. When the area of an irregular shape is calculated by multiplying length by width, it represents the area of a rectangle. This has an additional problem in that if part of the wound area heals, the greatest length and width may not change, resulting in a determination that wound size has not changed when in fact this is not the case. Thus, length multiplied by width gives an indication of wound size but should not be considered as

an accurate representation of area (Gethin and Cowman, 2005).

When squares are counted using the acetate method, some subjective interpretation of the number of squares included in the border is required. Studies have demonstrated that this method has a high degree of agreement between practitioners (Majeske, 1992; Buntinx et al, 1996; Oien et al, 2002).

The measurement of cavity wounds is difficult. Cavity wounds can have a degree of undermining, making visualisation of the area problematic. In addition, accuracy depends on the patient being in the same position at each measurement (Melhuish et al, 1994). The simplest method of determining depth is the use of a depth gauge to measure the deepest point of the wound. However, this method can only provide an indication of wound depth and does not consider volume. It is therefore not suited to accurate assessment and ongoing monitoring. Indeed, some studies suggest that circumference measurement alone is sufficient to monitor changes in size of cavity wounds (Gilman, 1990; Melhuish et al, 1994).

Flanagan (2003) proposes that the healing of cavity wounds can be monitored by measuring the circumference of the wound, as this is related directly to both volume and area. A study by Melhuish et al (1994) measured area, volume

and circumference of cavity wounds for a 10-week period or until the wounds had healed. In this study the circumference of the wound was related to both the volume and area and it was concluded that a direct correlation existed between wound area and circumference and wound volume and circumference (Melhuish et al, 1994). This finding is supported by Gilman (1990) who provides evidence that it is possible to monitor wound healing accurately by measuring circumference alone.

Mani (1999) proposes that it is necessary to measure volume in cavity wounds. The accurate measurement of such wounds is not without difficulties as the location of the wound, position of the patient when the measurement is taken and the instrument used can all result in inconsistent results. In diabetic foot ulcers, a sterile probe is recommended to assess depth and document tunnelling (Jopp-McKay et al, 1991). With the use of sophisticated equipment, such as the coherent light laser, a multidimensional wound model can be achieved which contains information that is not only quantitative but also qualitative with regard to the colours of the wound (Romanelli, 2002).

For wounds that are relatively shallow, the method of stereophotogrammetry, which takes three-dimensional measurements, can be used to calculate volume (Mani and Ross, 1999). A video camera takes an image of the wound that is then downloaded into a computer and a software package calculates area (Jones et al, 2004). This provides a printed image of the wound that can then be stored in patient notes or on the computer; it is, however, expensive and time-consuming and therefore may not be available to many clinicians (Jones et al, 2004).

The elegance of techniques such as stereophotogrammetry, lasers or even colour videomicroscopy must be balanced against the limitation that these techniques cannot account for surfaces not visible to the eye or the camera (Mani and Ross, 1999). Thus, the ulcer covered by areas of necrotic,

Table 2.

Methods used to determine wound area

Ruler technique	Laser triangulation
Depth gauges	Photogrammetry
Moulding materials	Stereophotogrammetry
Liquids	Video image analysis
Surface contour tracings	Magnetic resonance imaging
Ultrasound	



Figure 1. Measuring wound area by multiplying length by width. Note wound irregularity and thus the difficulty in measuring it accurately.

sloughy material in the foot of a patient with diabetes or the burrowed extent of a pressure ulcer in the sacrum cannot be quantified by these methods (Mani and Ross, 1999).

Monitoring changes in wound size

While a thorough assessment using objective methods such as wound size is invaluable in providing baseline information, it does not answer the question: 'Is this wound the same, better or worse than before?' This question can only be answered through ongoing monitoring and assessment. As the wound heals, ingrowth of granulation tissue decreases the wound depth and volume, and new epithelium decreases wound area. Therefore measurement of size provides a direct indicator of healing (Schultz et al, 2005). The recording and monitoring of changes in wound size, including percentage

change from baseline, can provide valuable clinical information. More importantly, it may be able to predict wound healing (Tallman et al, 1997; Sheehan et al, 2003).

Sheehan et al (2003) monitored percentage change in Wagner grade 1 and 2 diabetic foot ulcers of 203 patients over a period of 24 weeks. They calculated the percentage change in wound size from baseline at four weeks and reported that the mean percentage reduction in wound area was 82% in those that healed by 12 weeks vs 25% in those that did not heal by 12 weeks. The results were statistically significant (P<0.02) and were independent of the wound treatment the patient received. Sheehan et al concluded that percentage change at four weeks is a robust predictor of healing.

Tallman et al (1997) developed the 'mean adjusted healing rate' equation to calculate changes in wound area over time and concluded that this method reliably predicted final ulcer healing or failure to heal as early as the third week of observation.

These studies, coupled with an extensive literature review by Flanagan (2003), have concluded that a percentage reduction in wound size of 30% or more after four weeks of treatment reliably predicts ulcer healing. The period of four weeks is a good guide to practitioners for how long to continue with a particular course of treatment provided no adverse changes occur. This time period would contribute to objective wound monitoring and enhance decision-making, as determining the healing rate will help the clinician in planning proper therapeutic strategies and avoid shifts in treatment (Tallman et al, 1997).

The implications for practice for continuous monitoring of wound size could be very significant. Nurses would be able to continue with a particular treatment for a four-week period, reassess and evaluate the effectiveness of the treatment, and plan for the next stage. At this point, either a new treatment may be indicated, a more advanced treatment modality chosen or further investigation and intervention warranted. Regular reassessments are currently the only way of determining treatment effectiveness, quantifying and documenting progress, and guiding further treatment decisions (Keast et al, 2004).

Practicalities of wound measuring

In leg ulceration the problem is to obtain the epithelial edge and/or wound area given that the wound is not on a planar surface, but on a leg which is curved (Mani and Ross, 1999). Plassmann (1995) identifies three problems that are inherent in obtaining accurate wound measurements. These are definition of the wound boundary, wound flexibility in wounds that are undermined or deep, and the natural curvatures of the body (Plassmann,

Key Points

- ▶▶ It is important to use a recognised technique to obtain wound measurement.
- ▶▶ It is important that the chosen method is used consistently.
- ▶▶ Wound measurement can monitor changes in size over time and may help to predict ulcer healing.
- ▶▶ Wound measurement helps to inform clinical decision-making and reduces the likelihood of ineffective treatment.

1995). Indeed, Flanagan (2003) states that the greatest errors can occur in determining the border and not in calculating the area.

Practical points for consideration are as follows:

- ▶▶ A fine-tip permanent black pen should be used as it can be easy to misinterpret the border when using a thick-tipped pen
- ▶▶ Leaning too heavily on the wound border can distort the wound shape and should be avoided
- ▶▶ Ensure as much as possible that the patient is in the same position at each measurement (Kundin, 1989)
- ▶▶ Date and label each tracing for storage in patient notes
- ▶▶ Importantly, use the same method for each measurement, as methods are not interchangeable (Majeske, 1992).

Conclusion

To promote high standards and evidence-based practice in wound management, the use of assessment parameters that are known to be reliable, such as wound measurement, are encouraged. Accurate wound measurement is an invaluable objective component to wound assessment

and continuous wound monitoring. The acetate method is accurate with good inter-rater reliability, but planimetry is more precise and objective. Practitioners should use the correct technique when obtaining measurements and the same method consistently as methods are not interchangeable. Wound measurements can aid determination of percentage change in wound size and help predict wound healing as early as the fourth week of treatment. [WUK](#)

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