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# Triangle of Wound Assessment Made Easy: Revisited

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**ABSTRACT**

**Objective:** We have provided evidence based critical review of the "*Triangle of wound assessment made easy*".
**Background:** Wound assessment is a vital step in managing patients with acute and chronic wounds in daily clinical practice. The natural progression of most wounds is to heal naturally in a coherent and timely manner, although a minority of wounds will fail to heal. The aim of treating recalcitrant wounds that fail to heal is to control symptoms and delay or prevent complications. One vital step in managing wounds is proper and comprehensive evidence based wound assessment.
**Methods:** We have carried out literature review including systemic reviews, met analysis pertaining wound assessment including international guidelines.
**Results:** We have found few gaps in the proposed "Triangle *of wound assessment made easy*" which have been addressed accordingly. We have revised the concept of (infection) i.e. "*raised white blood cell (WBC) count as a sign of infection*" and argued that in up to one-half of patients, even with severe diabetic foot infection raised temperature, WBC count, or sedimentation rate are absent. A second point of concern is the omission of "*probing to bone sign*" in the diagnostic criteria of local signs of infection. Recent clinical studies have demonstrated that in the presence of a clinically infected ulcer, a positive Probe-to-Bone Test (PTB) test is highly suggestive of osteomyelitis, but a negative test does not rule out the diagnosis; conversely, in the situation of an apparently uninfected foot wound, a positive PTB test is not specific for osteomyelitis, but this diagnosis is unlikely if the PTB test is negative. Lastly, the authors have suggested reducing wound bio burden/manage infection through the use of topical antimicrobial therapy-including antiseptic agents. Topical antiseptics have inconclusive proof of efficacy in various etiology wounds and concern remain regarding their residual cytotoxicity when in contact with newly forming granulating tissues especially when highly concentrated rinse solutions is the common practice in developing countries of the world.
**Conclusion:** On the basis of these analysis, we propose revising the "*Triangle of wound assessment made easy*" in order to address these gaps and maximize its utility in clinical practice.

We read the article of Dowsett et al,[1] "Acute wounds, Assessment and diagnosis, Complex wounds" published in the May 2015 issue of Wound International Journal with interest.

A wound occurs as a result of the disruption of the normal structure and function of the skin and soft tissue structure secondary to a variety of etiologies and mechanisms.[2] Initial assessment of a wound starts by differentiating its etiology whether it's acute or chronic in nature. The orderly physiologic cascade of inflammation, proliferation and maturation occur as healing is expected to occur in an acute wound,[3,4] whereas in chronic wounds the cascade is impaired due to many reasons including impaired cellular mechanism, proliferation, migration, dysfunctional angiogenesis and impaired innervation among other reasons.[5] Examples of chronic wounds include diabetic, arterial ulcers, venous ulcers, and infected wounds including surgical site infections.[6,7]

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Although, the majority of wounds heal without difficulty. Some wounds, however, will become chronic and non-healing. In these circumstances, the aim is to manage symptoms and delay or prevent complications.

Before initiating treatment of any wound a diagnostic hypothesis must be in place to ensure optimal healing outcome. A comprehensive clinical history of wound duration, history of trauma, previous ulceration, wound characteristics (site, size, pain, periwound area characteristics, odor, presence of infection or not and (discharge or exudate), family history of ulceration, skin temperature, current medical history (for example, diabetes mellitus, cardiovascular disease, neuropathy, autoimmune disease, venous insufficiency), previous surgery, smoking history, medications, radiation and allergic reactions to dressings and medications and quality of life (QoL).

Wound assessment is vital in formulating a management plan in order to achieve wound healing and patient well-being. The authors of the wound triangle made a considerable effort in devising a simple and practical assessment tool for clinician's worldwide. However, there are few shortcomings that need to be examined when utilizing this tool in daily practice and these include (Figure 1):

Under the section (infection) raised WBC are documented as a sign of infection.

Although this is true in most situations however in patients with diabetes the clinical diagnosis of diabetic foot ulcer infection poses a complex issue to most clinicians and the ideal method to identify localized diabetic foot ulcers (DFU) infection with certainty remains elusive. Many patients with diabetes may not feel pain, do not suffer from fever, and will not have raised WBC count or raised erythrocyte-sedimentation rate.[8-10]

The presence of virulent pathogens and extensive tissue damage usually mount systemic signs or symptoms in the host, however in up to one-half of patients, even with severe diabetic foot infection raised temperature, WBC count, or sedimentation rate are absent. None the less worse clinical outcomes of treatment is predicted when these markers are elevated.[11]

Two recent prospective clinical studies[12,13] of patients with a diabetic foot ulcer have demonstrated that procalcitonin levels were more sensitive markers of clinical evidence of infection than levels of WBC, C-reactive protein (CRP) or erythrocyte sedimentation rate (ESR). Clinically uninfected wounds can be differentiated accurately from those with mild or moderate infections based on the combined levels of CRP and procalcitonin.[12] Therefore, the inclusion of raised WBC count is insensitive marker and may delay the diagnosis of diabetic foot infections if it was taken into consideration as a sign or marker of infection in patients with diabetes.

A second point to concern is the omission of "*probing to bone sign*" in the diagnostic criteria of local signs of infection. There is high suspicion of osteomyelitis in a wound which fails to heal after at least 6 weeks of adequate wound therapy and offloading a patient with an adequate blood supply to the affected site. Both the presence of a deep wound area and any exposed bone increase the likelihood of osteomyelitis.[14] Nonetheless, the likelihood of osteomyelitis is not influenced by either elevated WBC count nor the presence of signs of infection of the wound.[14,15]

Baseline and serial measurements of the wound size (length, width or area, and depth), appearance and location, will help to establish a baseline for treatment and monitor any response to interventions.[12,13] The method of measurement should be used consistently to aid meaningful tracking of changes over a specifi number of days (e.g. 7-14 days).[14] Problems identifi in the wound bed may extend beyond the wound edge to the surrounding skin (e.g. maceration, erythema, swelling).

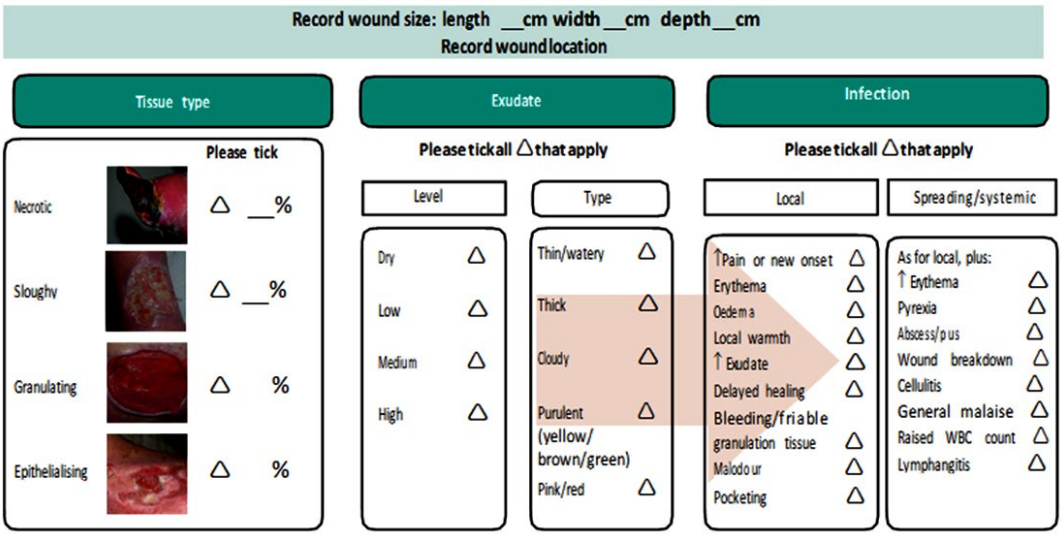


**Figure 1:** Using the triangle of wound assessment-wound bed.

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According to a recent clinical study, independent risk factors for osteomyelitis in a patient with lower limb infection were, previous history of a wound, wounds that extended to bone or joint and multiple or recurrent wounds.[16] Osteomyelitis can be differentiated from cellulitis by combining together laboratory data and clinical findings (ulcer depth>3 mm or CRP>3.2 mg/dL, ulcer depth>3 mm or ESR>60 mm/hour).[17] Currently, there is no specific clinical criteria to diagnose osteomyelitis in the lower limb of patients with diabetes, although the presence of "sausage toe" (swollen, erythematous, and lacking normal contours) is highly suggestive of the diagnosis.[18]

Health care practitioners need to be aware that the true depth of a wound is often not clinically apparent, so a sterile blunt metal probe must be introduced into the wound at each visit (the PTB test). Any wound with a visible bone or with either a positive PTB test (i.e., palpable hard, gritty bone) is highly likely to be osteomyelitis until proven otherwise.[17]

The accuracy of the probe to bone test in predicting or excluding osteomyelitis is, however, directly related to the pretest likelihood (i.e., the prevalence in the population under study) of osteomyelitis. Recent clinical studies have demonstrated that in the presence of a clinically infected ulcer, a positive PTB test is highly suggestive of osteomyelitis, but a negative test does not rule out the diagnosis; conversely, in the situation of an apparently uninfected foot wound, a positive PTB test is not specific for osteomyelitis, but this diagnosis is unlikely if the PTB test is negative.[19-25]

This clinical sign is of great importance since early reports in 1995, Grayson et al[16] who explored the possibility of osteomyelitis in wounds by the use of a sterile blunt metal probe. They concluded that the PTB test had a positive predictive value of 89%. Later on in 2007, Lavery et al[17] followed-up 247 patients with suspected osteomyelitis concluded that the positive predictive value was only 57% in a population with a lower prevalence of osteomyelitis.[17] However, in 2014 in an outpatient setting, Morales Lozano et al[18] followed-up 132 of patients with clinical suspicion of osteomyelitis over a 36 months concluded that the PTB test had an efficiency of 94%, sensitivity of 98%, specificity of 78%, positive predictive value of 95%, and negative predictive value of 91% ($p$<0.001, κ 0.803); the positive likelihood ratio was 4.41, and the negative likelihood ratio was 0.02 (95% CI).[18] Therefore, the inclusion of "probe to bone test (PTB)" is a vital component in assessing any chronic wound especially in patients with diabetic wounds of more than 4 week duration where the suspicion of the possibility of osteomyelitis is high.

The third point which is worth considering is mentioned under "setting treatment goals" (reduce wound bioburden/manage infection (e.g. topical antimicrobial therapy-including antiseptic agents-may be used for local infection and combined with antibiotic therapy for spreading or systemic infection).

The term topical antimicrobial is a vague term and may imply the use of topical antibacterial creams and ointments. The use of topical antibiotics among patients with diabetic wounds is not justified since most wounds in patients with diabetes have polymicrobial colonization.

Topical antiseptics have inconclusive proof of efficacy in various etiology wounds and concern remain regarding their residual cytotoxicity when in contact with newly forming granulating tissues especially when highly concentrated rinse solutions is the common practice in developing countries of the world. Some authors have even warned against the routine use of antiseptic solutions due to their cytotoxicity and lack of demonstrated benefit over saline irrigation.[31] Furthermore, recently the International Working Group on Diabetic Foot Management (IWGDF) has warned against the use of topical antimicrobial dressing with the goal of improving wound healing or preventing secondary infection.[20] They went even further by saying that "currently supporting data are too limited to recommend topical antimicrobial therapy".[20-22] The use of antimicrobial dressings for DFUs was recently assessed *via* a systemic review which concluded that current evidence base is too weak to suggest any specific antimicrobial dressing.[23] The management of diabetic foot ulcers pose a challenge to attending clinicians and some advanced and expensive topical antimicrobials have been in use through the last few decades.[24] On the other hand, alternative modalities such as natural honey have been in use for a millennia and recently a new interest by clinicians worldwide have surfaced through the publications of case series and case studies highlighting its efficacy in various types of wounds.[25-32] This is quite important since natural honey offers an efficacious and cost effective alternative option characterized by its ability to provide moisture, antimicrobial cover and anti-inflammatory properties.[32] This is quite important especially in developing countries where diabetes has reached epidemic proportions and the incidence of diabetic wounds is likely to rise too thereby posing a huge economic burden on already stretched out economies. Additionally, health practitioners worldwide have over utilized antimicrobials, particularly topical antiseptics as a result of coining the controversial idea of excess wound bio burden in the medical literature, despite little evidence substantiating any benefit of these dressings over conventional therapy.[33-37] In addition to their potential for causing local reactions and expense, bacterial resistance may emerge as a consequence to the arbitrary use of these antimicrobials.[38,39] Due to these inherent risks, and a lack of sound clinical evidence of any advantages, the use of topical antimicrobials for clinically uninfected wounds is not recommended.[33] Furthermore, current data does not support any benefit to using advanced wound products such as silver-based dressings for clinically infected wounds.[40]

We believe there is an urgent need for head to head large scale multicenter randomized controlled trials to clarify the role of antimicrobial therapies in various etiology wounds and we believe that this knowledge is imperative before universal suggestions regarding wound assessment and management

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could be advised.

## HIGHLIGHTS

- A revised version of the "*Triangle of wound assessment made easy*" is urgently needed
- Specific areas of improvement of the "*Triangle of wound assessment made easy*" is proposed.
- The mechanism relies on stabilization changes of anionic ubiquinone intermediates.
- The validity and reliability of "*Triangle of wound assessment made easy*" should be tested through double-blinded randomized controlled trials controlled during turnover.

## CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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