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Review Article

The Wound Evaluation- A Necessary Condition for Diabetic Foot Ulcer Approach- Key Notes

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Abstract

This article updates the concept of Wound bed evaluation focus on the wound according with the necessary steps for the development of an appropriated local wound care. The best practice recommendations are based on scientific evidence and expert opinion.

Introduction

Cutaneous wound healing is a major burden for healthcare systems worldwide [1]. Management of wounds is a routine part of medical practice worldwide, and delays in healing represent a significant clinical and economic burden [2,3]. Consider by World Health Organization like the foot of the diabetic patient that has the potential risk of pathological consequences including infection, ulceration and/or destruction of deep tissues associated with neurological abnormalities, various degrees of peripheral vascular disease [3]. By another side a Diabetic Foot Ulcer (DFU) is defined as a full thickness wound below the ankle in a diabetic patient, a loss of epithelium extending in/through the dermis or into deeper tissues [4]. A chronic wound may be defined as: "any wound that is failing to heal as anticipated or that has been stuck in any one phase of wound healing for a period of six weeks or more" [1].

The normal healing process entails a complex interplay between growth factor activation, cellular activity, and formation of connective tissue. All of the three physiologic processes are altered in non-healing ulcers and contribute to poor healing [5]. After the whole patient is considered is necessary to looks the wound itself. Unfortunately, most wound care providers are eventually confronted by a wound that fails to heal despite their best efforts to identify the factors impairing healing and design a treatment regimen that creates an optimal healing environment for that patient's wound. Wound bed evaluation. The Accurate diagnosis of the underlying cause of lower extremity ulceration is essential for successful treatment [2,5] If it's true that the management of wounds is a routine part of medical practice worldwide, but the delays in healing represent a clinical and economic burden [3]. Once an ulcer develops, it is essential to monitor its progress. Specific characteristics of the ulcer such as: location, wound size, severity, wound bed, wound edges/margin, periwound skin, exudate, odour, measures in special situations, presence of infection and pain in the wound, should be recorded during the initial evaluation and with each subsequent follow-up visit, to focus on the clinical status of the wound and to record progress of the treatment regimen. The aim of this article is to provide an overview of and rationale for wound bed evaluation according to scientific evidence and expert opinion.

Discussion

The rapidly expanding scientific data base was used to generate a simple framework of key clinical assessments that would identify and remove/correct the barriers to healing in most chronic wounds. After the evaluation of several important factors that determine the patient's ability to heal, we need to focus on the clinical status of the wound, with the evaluation of the following local wound characteristics

Location [5,6]

Neurotrophic ulcers typically form on the plantar aspect of the foot at areas of excessive focal pressures (mal perforans ulcer). Most commonly encountered over the bony prominences of the metatarsal heads and the forefoot region because there is an increase in both static and dynamic foot pressures in a neuropathic foot Ischemic ulceration are typically located on the tips of the toes and between the digits. They also often develop on the dorsum of the foot and over the first and fifth metatarsal heads. Ischemic ulcers are uncommon on the plantar surface. Is important also the evaluation of the relation foot/shoes.

Wound Size [7-9]

Serial measurement of the wound area can help measure the rate of healing, and therefore the efficacy of treatment. There are different methods for to make this evaluation, trough the determination of the area or the volume Area evaluation (A) (express in cm^2)

a) Lineal measures of the wound

- The Calculi A= length x width (length is defined like the distance from cephalic to caudal and width from perpendicular to length)
- Like an ulcer is not a geometric figure we could improve the calculi trough a correction factor named Kundin method (A= length x width x 0.785)

b) Use of images of the wound for measurement with different options:

- with wound contact (using sterile millimetres plastic for measurement, ex. Visitrak)
- without wound contact (photographic images, ex. Image J) (Figure 1).

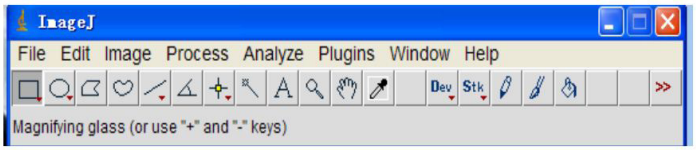

Figure 1: Interphase of the Image J Measurement System.

According to the actual knowledge is preferred the use of a non-wound contact method

Volume evaluation (V) (express in cm^3)

a) Lineal measures of the wound (scale in cm)

- The Calculi V= length x width x deep (wound deep is the distance from the surface to the deepest area)

- With the use of the Kundin correction factor V= length x width x deep x 0.327

The clinical investigation related the use of the area and the volume calculi in the management of the wound, establish an important correlation between both and it means, that is why there is not necessary the volume method for the evaluation of the wound

Another method includes:

- Use of the volume of saline instilled in the wound

- Use of the Alginate

- Stereo-photography

The clinical investigation related the use of the area and the volume calculi in the management of the wound, establish an important correlation between both and it means, that is why there is not necessary the volume method for the evaluation of the wound.

b) Rules of observance

- Measurements must be taken in a consistent manner to be accurate and repeatable
- Depth cannot be measured if debris or necrotic material cover the ulcer
- Use centimetres or millimetres recording the measurements.

Importance of the wound measures. Percent Area Reduction (PAR) after 4 weeks of Diabetic Foot Ulcer (DFU) treatment has been suggested as a clinical monitoring parameter to distinguish DFUs that will heal within 12 weeks from those that will not despite standard wound care. <50% PAR after 4 weeks of treatment predicts DFU failure to heal by 12 weeks. This finding was observed in both small and larger (>1.5 cm2) ulcers. Protocols of care should be re-evaluated if 50% PAR is not achieved after 4 weeks.

Wound Severity [8,10,11]

In addition to ulcers patients may present with varying degrees of tissue loss or frankly gangrenous digits, forefoot, or hindfoot. There are two main classification systems worldwide. The first is the Wagner-Meggitt classification system, and the second is the University of Texas wound classification system. The Wagner-Meggitt classification system, which is the most widely accepted and universally used grading system; is basically anatomical, six grades (scored 0 to 5) according to 3 parameters: presence or not of wound and its deep, presence or not of infection and presence or not of gangrene, and it is not always suitable for assessing wound therapy. However, the system is limited in its ability to identify and describe vascular disease as an independent risk factor.

The University of Texas wound classification system, assesses ulcer depth, the presence of wound infection, and the presence of clinical signs of lower extremity ischemia. This system uses a matrix with grade (scored 0 to 3) on the horizontal axis and stage (scored A to D) on the vertical axis. It is more descriptive and shows a greater association with increased risk of amputation and prediction of ulcer healing than the Wagner system does; however, in the University of Texas system, wounds are classified into 16 categories, and it is difficult to understand them and to deal them with. For the clinical researches the International Working Group on the Diabetic Foot (IWGDF) has proposed the PEDIS classification, which grades the ulcer on the basis of Perfusion (arterial supply), Extent (area), Depth, Infection and Sensation.

Wound Bed Evaluation [12-15]

A complete wound description should be included in the assessment

so that a clear picture of what the clinician is observing is available to other specialists who may read the patient's chart. Considered the evaluation of the bottom of the wound, and the ability to identify viable tissue. an initial visual impression of the wound provides important clues not only to the aetiology of the lesion but also to its complexity The type of tissue includes: Granulating well-vascularised tissue caused for the growth of small blood vessels and connective tissue to fill in full thickness wounds. Tissue is identified by presence of bright, beefy red, shiny and granular with a velvety appearance, that bleeds easily; Necrotic tissues looks predominantly black, grey, and darker, thicker; Foreign body; Sloughs recognised by formation of viscous, predominantly yellow, green, lighter, thin, wet and stringy; Epithelializing is pink in appearance, tissue very fragile and needs to be kept moist. The presence of necrotic or compromised tissue is common in chronic non-healing wounds; unhealthy granulation tissue may be the result of persistent inflammation or infection and may delay healing. Regular wound evaluation and measurement is an essential element of implementing the 'E' element of the TIME framework so that non-healing wounds can be identified and treated in a timely manner (Figure 2).

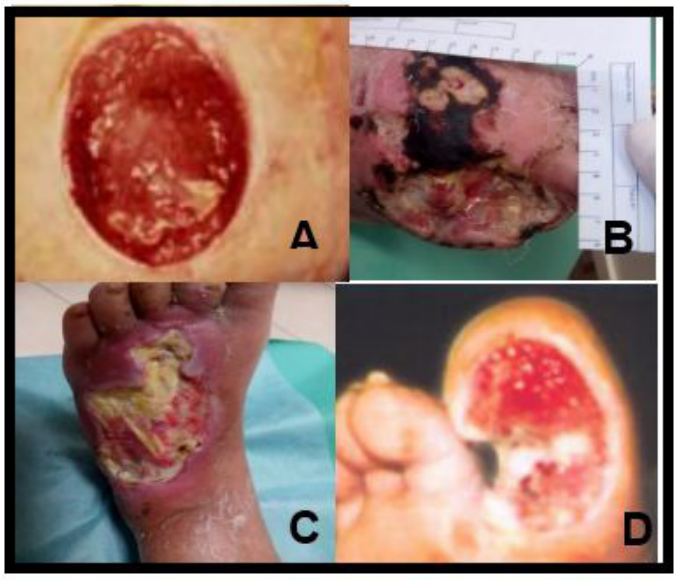

Figure 2: The Wound bed evaluations. A) Granulating well-vascularised Tissue B) Necrotic Tissue C) Sloughs Tissue D) Epithelializing Tissue.

Wound Edges/Margin [16-19]

The inside perimeter of the wound, the ring. Is not always well understood by clinicians. The typical evaluation should be focus in the presence of callus, maceration, and erythema, and oedema

- Callus areas. The resultant hypertrophy of the corneum stratum, product of the accelerated proliferation of epidermal cells, stimulated by the active hyperemia and stronger cohesion of the cells decreasing the rate of desquamation under the influence of sustained compression and loss or reduction of the sensation. Its presence is a robust predictor of neurotrophic ulceration.
- Maceration, the term may be used to describe the softening or 'sogginess' of tissues due to the retention of excessive moisture. Is caused when the wound produces excessive amounts of exudate and the wound bed becomes saturated and moisture leaks out onto the peri-wound skin causing maceration and excoriation. This in turn could lead to an increased risk of infection
- Erythema, understood like the diffuse redness due to vasodilatation, Significant erythema, on the other hand, can indicate cellulitis or infection

Periwound Skin [5,8,20,21]

Defined like surrounding tissue - outside perimeter of wound - minimum of 5 cm of the wound edges, some status includes: normal, oedema, erythematic, maceration, desiccation**,** etc.

- Oedema (Swelling). accumulation of fluid in tissues
- Erythematic diffuse redness of the skin due to vasodilatation
- Maceration. Moist, Macerated, Boggy (soft and mushy)
- Desiccation**.** drying of the skin

Wound Exudate [9,22-24]

The evaluation includes a quantity moment (defined like copious, moderate, mild, none) and a qualitative, according to colour and consistence Sanguineous, Serous-sanguineous, Serous, Serous-purulent and Purulent/pus. How to describe the exudates?

Quantitative evaluation

- Small/Minimal (wound tissues moist, drainage < 25% of bandage)
- Moderate wound tissues wet, drainage 25 -75% of bandage
- Severe (tissues filled with fluid, drainage >75%of bandage)

• Qualitative evaluation

- Sanguineous (red colour; thin, watery consistency; and indicates low blood vessel growth or disruption of blood vessels).
- Serous-sanguineous (light red to pink colour; thin, watery consistency; normal during inflammatory and proliferative phases of healing).
- Serous Clear light colour; thin, watery consistency; normal during inflammatory and proliferative phases of healing).

Serous-purulent (cloudy, yellow colour; thin, watery consistency; may be first signal of impeding wound infection)

Purulent/pus (yellow colour, thick, opaque consistency; signal of wound infection)

Establishing the optimal balance of moisture in the wound bed has dramatic effects on the healing of open wounds. This is because the amount of exudate produced by wounds can change substantially over a few days and it has a significant impact on patients' well-being and quality of life.

Wound Odour [25,26]

Evaluations consist in to determine if mal odour is absent or present. The procedures for the evaluation of the odour includes:

- Clean or irrigate wound with NS
- Note the presence or absence of odour
- Some descriptors are: strong, foul, pungent, musty and sweet
- Causes are related with presence of bacteria, dead tissue and drainage build-up

Wound measures Special situations [27,28]

(Border undefined; ulcer may be small at surface and have large subcutaneous that traduces cavity, sinus and fistula, for the evaluation we use the clock method).

Procedures for the evaluation. How to Measure Tunnelling & Undermining

- Apply a cotton-tipped applicator gently to measure depth in centimetres
- Describe the location using the face of a clock, with 12 o'clock at the patient's head and 6 o'clock at the patient's feet (Figure 3).

Figure 3: Exploring the Tunnelling.

Clinical Signs of Critical Colonization/Local Infection and Infection [29-33]

It had been recognised for centuries that infection and excessive inflammation could impair healing. Another recent discovery that reinforced the importance of limiting infection and inflammation in wound beds was the discovery that a majority (~60%) of chronic wounds contained bacterial biofilms. There are four terms that the clinician should know when deciding whether a wound is infected. These terms are contamination, colonization, critical colonization and infection. Assessing foot ulcers for the presence of infection is another important issue. The presence of infection needs to be defined clinically rather than microbiologically.

- Difference between Terms (relation bacterial/chronic wounds)

- Contamination. Presence of non-multiplying bacteria within a wound which account for the majority of the microorganisms present on the wound surface.

- Colonization. Presence of bacteria which are multiplying but non-producing host reaction. This includes skin commensalism. Even virulent pathogens such as *Staphylococcus aureus* may sometimes represent colonizers. Some organisms, such as *Pseudomonas aeroginosa* and enterococci, often represent colonizers and may not need to be targeted specifically.

- Critical Colonization**.** Refers to a wound in which the bacterial burden is rising due to multiplication of organisms which are now starting to cause a delay in healing. Critical colonization initiates the body's immune response locally but not systemically and will have an effect on healing.

- Infection. Refers to the presence of multiplying bacteria that are causing an associated host response. Pathogenic bacteria multiply and invade surrounding tissue resulting in host injury. If untreated, this may lead to systemic

- Signs and Symptoms of Infection in Chronic Wounds:

(a) abnormal odour - malodorous after cleansing

(b) changes in sensation or pain (type, intensity, duration)

(c) abnormal discharge - purulent, sanguineous

(d) warmth, redness, indurations, oedema, discoloration, erythema greater than 2 cm

(e) prolonged inflammatory process

(f) delayed wound healing

(g) deterioration of wound site and surrounding tissue, tissue may be friable

(h) poorly or abnormally granulating tissue; may be pale in colour, uneven in growth pattern, have areas of pocketing

(i) bridging of soft tissue and epithelium;

(j) Systemic manifestations such as fever or leucocytosis are uncommon, but their presence may suggest a severe infection.

- Diagnosis of Infection

To make an accurate diagnosis of infection, there must be an on-going holistic assessment including:

a. client status

b. wound status

c. clinical signs and symptoms of infection

d. Microbiologic analysis to confirm diagnosis and identify causative agent. It is the interplay of all the above characteristics that determine whether or not infection is present. One factor alone does not confirm the diagnosis of infection. Swab analysis alone is not conclusive of an infection; cultures should be sent, preferably from tissue specimens. The specimen should be subjected to gram staining and be processed for aerobic and anaerobic cultures. The most important pathogens causing diabetic foot infections are the aerobic gram positive cocci such as *Staphylococcus aureus*, beta haemolytic, streptococcus, and coagulase negative staphylococcus. They often cause monomicrobial infections, although patients with chronic ulcers or those who have recently been treated with antibiotics often tend to have polymicrobial infections with aerobic gram-positive cocci in association with gram negative bacilli.

e. Recognizing the presence of underlying osteomyelitis is a diagnostic challenge. The presence of underlying osteomyelitis can be expected if bone is visible or palpable on probing. A significantly elevated ESR (>70 mm/h) is also suggestive, although this finding may be less sensitive. For osteomyelitis to produce abnormalities on plain radiographs, infection should be present for at least 2 weeks.

Wound pain [34,35]

Is very important to determine the kind of pain, through the following evaluation

- Location (wound bed or other areas)

- Duration (persistent / temporary)

- Intensity (on a scale from 0 (no pain) to 10 (worst pain))

- Quality (aching, throbbing, burning, stinging, shooting, stabbing) (Table 1).

Causes of pain	Characteristics
Background pain	Pain at rest (related to wound aetiology, infection, ischemia)
Incident pain	Pain during day-to-day activities (coughing, friction, dressing slippage)
Procedural pain	Pain from routine procedures (dressing removal, application)
Operative pain	Pain associated with an intervention that would require an anaesthetic (cutting of tissue or prolonged manipulation)

Table 1: The BIPO (Background Incident Procedural Operative) causes of Diabetic Foot Ulcer pain.

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