

Assessment tools for the healing of wounds: an integrative review

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ABSTRACT

The assessment of wounds in patients requires the selection of appropriate tools; however, it may be difficult to select the tool that is best suited to each case as each tool has a different set of parameters. This study aimed to identify the tools, and their respective parameters, that are used for evaluating wound healing. This integrative review was carried out using the following databases *Literatura Latino-Americana e do Caribe em Ciências da Saúde*, *Cumulative Index to Nursing and Allied Health Literature*, PubMed, Web of Science, and Scopus. Thirty-five studies were considered; the most commonly used instrument was PUSH, followed by BWAT, DESIGN and DESIGN-R. The most frequently assessed components were size (area, volume, depth), exudate, tissue type, and signs of infection or inflammation. The tools revealed the complexity of both the process and the evaluation of healing. Thus, the study contributes to ensuring the selection of the best tool for each individual case.

Descriptors: Wound Healing; Wounds and Injuries; Nursing Assessment.

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INTRODUCTION

From the moment of injury or wounding, the body initiates a process of tissue repair called wound healing⁽¹⁾. Wound healing is a dynamic process regulated by cellular, humoral and molecular mechanisms, which begin after injury and can last for years, depending on the degree of involvement of cutaneous tissue⁽²⁾.

This healing process occurs in sequential phases, and for teaching purposes is divided into the phases of inflammation, proliferation and wound remodeling. The first phase involves the cascade of steps of haemostasis, leukocyte migration, and the beginning of tissue repair. The second phase is characterized by fibroplasia, angiogenesis and reepithelialization. In fibroplasia, fibroblasts migrate and proliferate, simultaneously to synthesizing new extracellular matrix components, and thereby initiating granulation tissue development. In the third phase, understood as tissue remodeling, there is an increase in the resistance of the damaged wound bed⁽³⁾, resulting from tissue contraction and collagen realignment.

Therefore, a wound is considered healed when the continuity of the skin allows for normal tensile strength. However, the healing process can be influenced by various factors, including local factors, such as pressure, a dry environment, trauma, infection, necrosis; and systemic factors such as age, presence of chronic diseases and nutritional deficiencies⁽¹⁾.

Because it is a multifactorial process, it is important to consider not only local factors during assessment, but also systemic factors such as wound etiology, nutrition and the presence of diseases that can influence the healing process. It is an overall assessment of the individual, not only of a wound⁽⁴⁾. The holistic evaluation of patients is essential, as their clinical condition will have a direct implication on the success of the healing process⁽⁵⁾.

Appropriate assessment enables intervention in situations that may be harmful, thus making way for complete healing⁽⁶⁾. Consequently, it is of utmost importance that tools are used that address all the components of the healing process, as well as the holistic evaluation of the individual.

In the literature⁽⁷⁾ the terminology used to describe the assessment of wounds is diverse, making it difficult to establish consensus about which parameters are most appropriate for monitoring the evaluation process for different types of wounds. In addition, some instruments assess wound of specific etiology, while others make a broad assessment. Thus, knowing the different tools, their assessment parameters, and their specific relation to each etiology is fundamental for choosing the right one at the time of the care.

An accurate assessment of the wound is fundamental to treatment, as it will direct the decision-making process concerning care of the wound⁽⁸⁻⁹⁾. The management of care given to the patient is the responsibility of the nursing professional and thus, for the best quality of care, the decision-making process must be based on scientific evidence⁽¹⁰⁾.

An adequate assessment is essential for making treatment decisions and the management of the healing process includes monitoring the wound, recognizing and preventing possible complications. Consequently, this study aimed to identify the tools, and their respective parameters, that are used for evaluating the healing of wounds.

METHOD

An integrative review to identify the main tools used to assess the healing of wounds and their components.

To develop the research protocol (Table 1), as recommended by the Joanna Briggs Institute⁽¹¹⁾ for studies of this nature, these steps were followed: number of reviewers, protocol title, review objectives, review questions, literature support, inclusion criteria (PICO strategy), research strategies, data extraction and data synthesis.

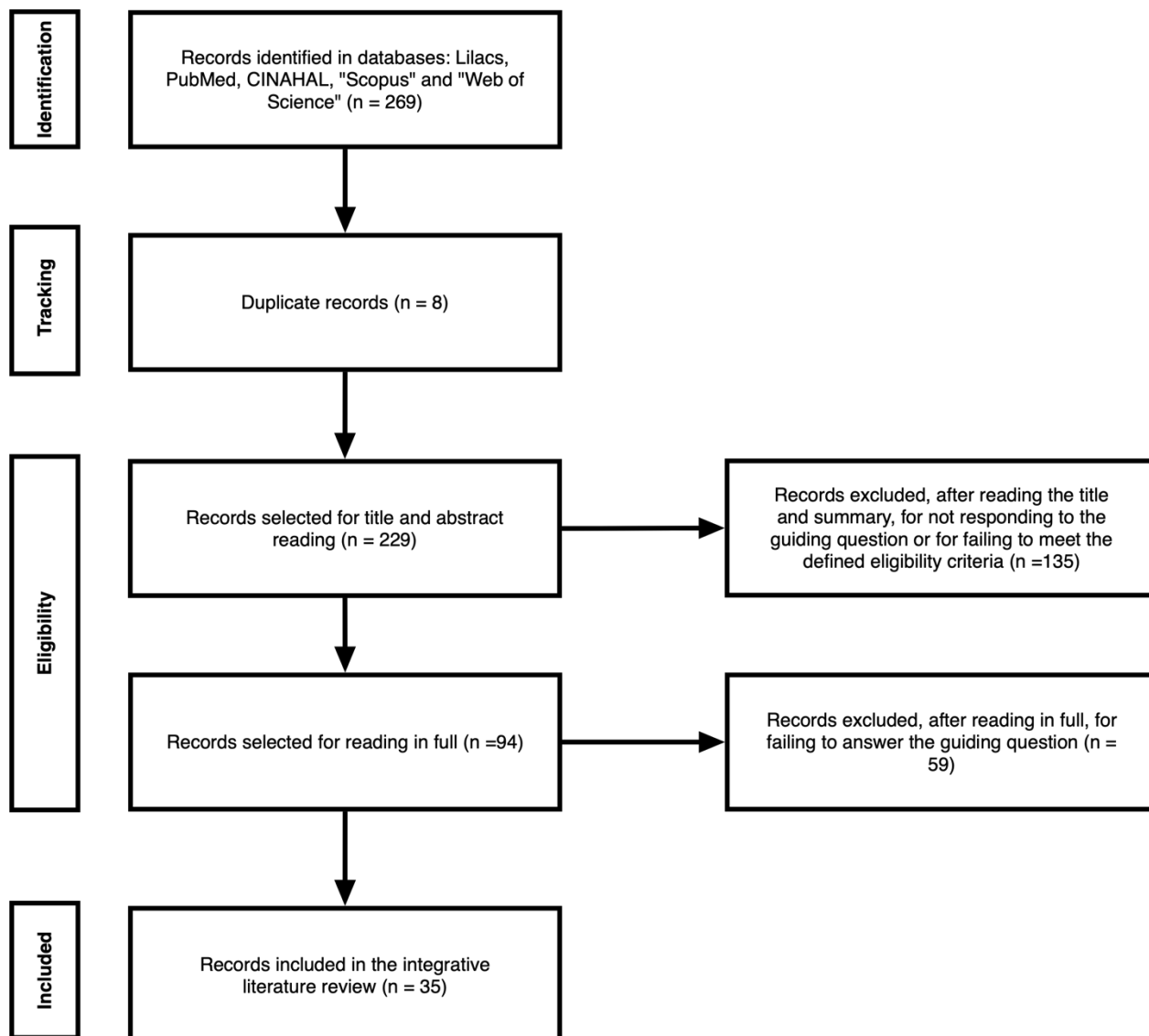
Table 1: Protocol for conducting an integrative review of the literature: Assessment tools for the healing of wounds.

Assessment tools for the healing of wounds: integrative review protocol	
Objectives	Identify tools used to assess the healing process of wounds and their characteristics.
Research question	What tools are used in clinical research to assess the healing of wounds?
Literature support	Despite studies that aim to establish adequate criteria for the assessment of the healing process of wounds ⁽⁹⁾ , authors point out that various terminologies are used to describe the evaluation of these lesions, thus making it difficult to establish a consensus on which parameters are most appropriate for monitoring this evaluation process ⁽⁷⁾ .
Inclusion criteria	Population: people with skin lesions undergoing assessment and treatment;
	Intervention: use of validated tools to assess the healing process of the skin;
	Comparison: use of non-validated tools used to assess the healing and clinical variables;
	Results: base for adequate decision making;
	Studies: original articles, dissertations and theses discussing the assessment of the cutaneous healing process, in humans, through validated tools or tools constructed by the author based on clinical parameters.
	Time frame: studies published between 2004 and 2017.
Research strategies	Databases:
	- Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS): Cicatrização AND avaliação AND instrumentos
	- Cumulative Index to Nursing and Allied Health Literature (CINAHL): Wound healing AND evaluation AND tools Wound healing AND tools evaluation
	- PubMed: Wound healing AND evaluation AND tools
	- Web of Science: Wound healing AND evaluation AND tools
	- Scopus: Wound healing AND evaluation AND tools
Data extraction	The selected papers were read in full by two researchers, at which time information related to the type of study, wound etiology and tools used in healing assessment were extracted. Disagreements in the results were resolved by consensus, with the presence of a third researcher. The extracted information was arranged in a database.
Data synthesis	Descriptive. Each healing assessment tool was analyzed and the characteristics of each were then grouped and compared. In this process, one researcher was responsible for information extraction, analysis and synthesis, while three other researchers evaluated this process and the syntheses.

The research process was conducted separately by two researchers, and due to the specifications of each database, the descriptors were combined with different strategies, as described in Table 1.

The studies were selected according to the recommendations of the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* - PRISMA⁽¹²⁻¹³⁾, as shown in Figure 1.

Figure 1. Selection of studies according to the recommendations of the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses – PRISMA*⁽¹²⁻¹³⁾.



RESULTS

A total of 35 records were analyzed, including 34 scientific papers and a master's thesis. Among the works that met the established criteria, eight (22.9%) were published between 2004 and 2006, four (11.4%) between 2007 and 2009, nine (25.7%) between 2010 and 2012, ten (28.6%) between 2013 and 2015 and four (11.4%) between 2016 and 2017.

The dissertation was indexed in the LILACS database (2.9%). Of the scientific articles, 18 (51.4%) were selected in the CINAHL, 10 (28.5%) in the *Web of Science*, three (8.6%) in Scopus and three (8.6%) in PubMed.

Regarding methodology⁽¹⁴⁾, 14 (40%) studies were clinical trials; of these, 13 (37.1%) were randomized⁽¹⁵⁻²⁷⁾ and one (2.9%) was non-randomized study⁽²⁸⁾. In addition, six (17.1%) studies were cohort⁽²⁹⁻³⁴⁾, three (8.6%) longitudinal observational⁽³⁵⁻³⁷⁾, and one (2.9%) case-control⁽³⁸⁾. The other 11 (31.4%) were studies using a descriptive approach^(5,7,39-47)

Among the studies in this review, 26 (74.3%) used different validated tools to assess wound healing, and in three (8.6%) studies, more than one instrument was used. The remaining studies (25.7%) used observation and the measurement of clinical variables to assess the wounds and their characteristics.

The tools identified were: *Pressure Ulcer Scale for Healing* (PUSH) (40%), *Bates-Jensen Wound Assessment Tool* (BWAT) (11.4%), *DESIGN* (*Depth, Exudate, Size, Infection/Inflammation, Granulation Tissue, Necrotic Tissue*) (8.5%), *DESIGN-R* (*Depth, Exudate, Size, Infection/Inflammation, Granulation Tissue, Necrotic Tissue, Rating*) (5.7%), *Barber Measuring Tool* (2.8%), *Pressure Ulcer Healing Process* (PUHP) – OHURA (2.8%), *Wound Bed Score* (WBS) (2.8%), *Leg Ulcer Assessment Tool* (LUAT) (2.8%), *REEDA* (*Redness, Edema, Ecchymosis, Discharge, Approximation*) (2.8%), *Time H Modified* (2.8%), and *Diabetic Foot Ulcer Assessment Scale* (DFUAS) (2.8%) (Table 2).

Table 2: Characteristics of the tools used in the evaluation of the healing regarding the number of studies, assessed components and form of measurement.

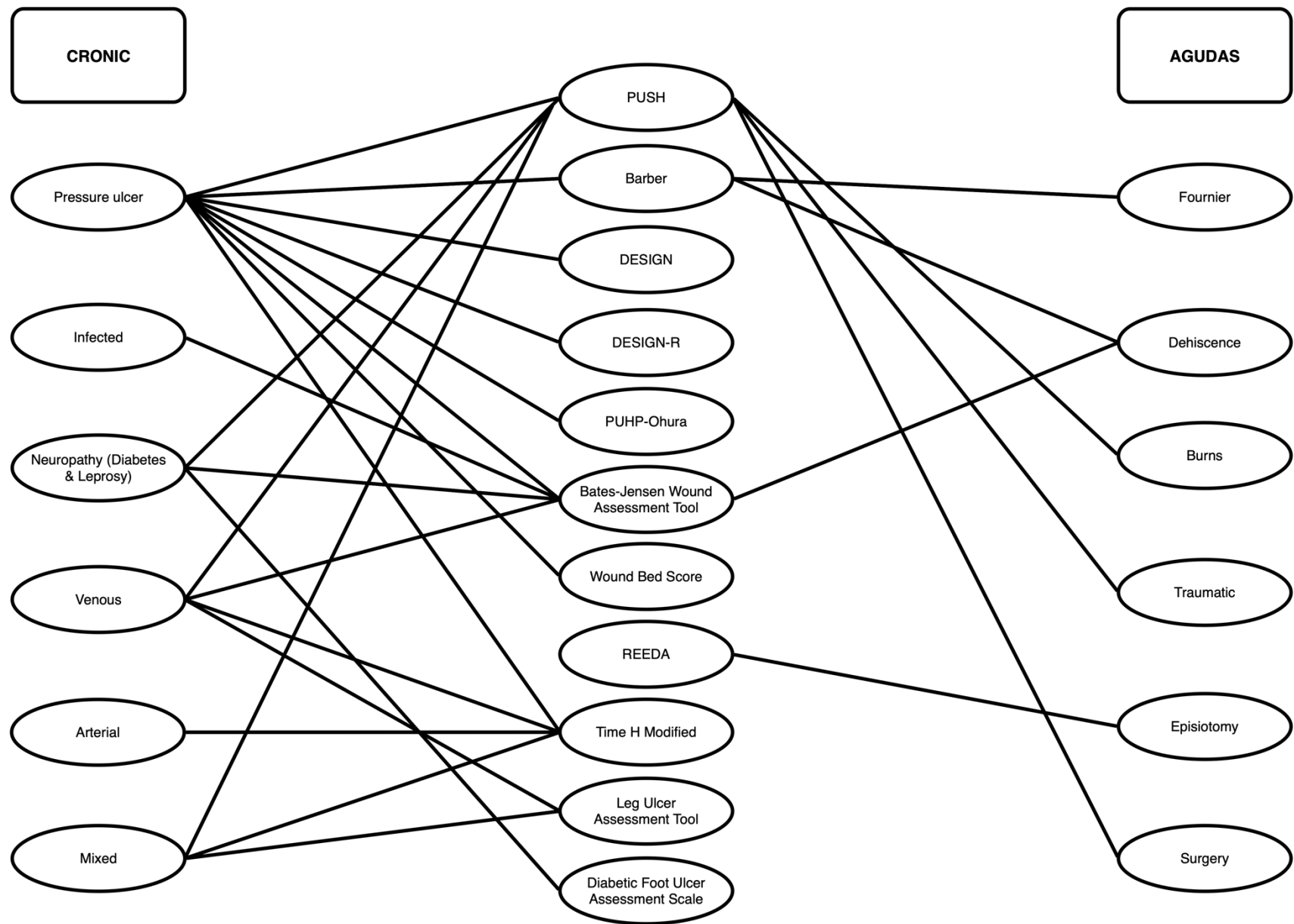
Tools and Studies	Components assessed	Form of measurement and interpretation
<i>Pressure Ulcer Scale for Healing</i> (PUSH) ^(5,7,15-17,19-20, 23-26,37,42,46)	Size and depth of wound, exudate and tissue type present in the wound bed	Scores range from zero to 17. Smaller values represent a wound closer to healing.
<i>Design</i> ^(30,32,35)	Depth, exudate, size, infection, inflammation, granulation tissue and necrotic tissue	Scores range from zero to 28. The higher the score, the more severe the wound.
<i>Design-R</i> ^(33,35)	Depth, exudate, size, inflammation/infection, granulation tissue, necrotic tissue, and undermining (pocket area is calculated by subtracting the affected area from the total area)	Scores range from zero to 66. Values closer to zero represent better healing.
<i>Barber Measuring Tool</i> ⁽⁴⁰⁾	Length, width and depth and volume.	The greatest length, width and depth are used to calculate volume and, through it, wound healing progression.
<i>Pressure Ulcer Healing Process</i> (PUHP) – OHURA ⁽³⁸⁾	Exudate, necrotic tissue, depth, granulation formation, wound edge, epithelialization, undermining, surface (area) and inflammation.	Scores range from zero to 44. Values close to zero indicate a wound closer to healing.
<i>Wound Bed Score</i> (WBS) ⁽²⁵⁾	Healing of the edges, necrotic tissue, greater depth / granulation tissue, exudate, edema, peripheral dermatitis, callus or peripheral fibrosis, and rosy bed.	Scores range from zero to 16. Highest scores indicate the best healing situations.
<i>Leg Ulcer Assessment Tool</i> (LUAT) ⁽³¹⁾	Size, depth, exudate, tissue type detachment, wound edge, peripheral skin, edema, infection, pain and quality of life.	The scale is divided into two parts. The first part evaluates the wound, with a score from zero to 56. The second part evaluates characteristics of the patient with a score between zero and 12. The higher the value, the greater the severity of the wound.
<i>Bates-Jensen Wound Assessment Tool</i> (BWAT) ^(22,27- 28,46)	Size, depth, edges, undermining, type and quantity of necrotic tissue, type and amount of exudate, skin color surrounding wound, peripheral edema, peripheral hardening, granulation tissue and epithelialization.	Score varies between 13 and 65. Lower scores indicate a better healing index.
<i>REEDA Scale</i> (<i>Redness, Edema, Ecchymosis, Discharge, Approximation</i>) ⁽³⁶⁾	Hyperemia, edema, ecchymosis, discharge and approximation of the incision edges. Assesses perineal lesions.	Scores range from zero to 15. Smaller scores indicate an incision closer to healing.
<i>Time H Modified</i> ⁽⁴⁴⁾	Wound data: Necrotic tissue, infection, moisture, epithelialization. Patient data: age, mental state, self-sufficiency, nutrition and predisposing diseases	Data from the wound score from zero to two, with smaller values closer to healing. Patient data rated A and B, where A is closer to healing than B. From this basis, a score on the predisposition of healing is given.
<i>Diabetic Foot Ulcer Assessment Scale</i> (DFUAS) ⁽⁴⁶⁾	Depth, size, inflammation, infection, granulation tissue, necrotic tissue (type and quantity), maceration, edges and undermining	Scores range from 0 to 43. Lower scores represent wounds in a more advanced stage of healing.

In addition to the assessment tool, most of the studies put forward the analysis of the outcome of the healing process.

The studies covered the healing of different types of wounds, both chronic and acute. In chronic cases, the most frequent wound type was pressure ulcers, present in 17 studies (48.6%), followed by ulcers in the lower limbs (venous, arterial and mixed) (25.7%), plantar ulcers in people with peripheral neuropathy (diabetes mellitus and leprosy) (22.8%) and infected wounds (2.8%). Among the acute wounds (5.7%) were: dehiscence (5.7%), surgical wounds (5.7%), traumatic wounds (2.8%), episiotomy (2.8%) and Fournier's syndrome (2.8%). It is noteworthy that some studies evaluated more than one type of wound.

Figure 2 lists the tools used to assess each type of wound.

Figure 2: Schematic representation of the tools used to assess acute and chronic wounds, according to the etiology.



Of the 11 scales cited in the publications, eight (72.7%) were developed to assess wounds of a specific etiology, of which five (45.4%) were for pressure ulcers, one (9.1%) for leg ulcers, one (9, 1%) for episiotomy and one (9.1%) for wounds due to diabetic neuropathy. This fact may limit the use of these scales in different types of wounds. The PUSH, Barber and Bates-Jensen Wound Assessment Tool scales were used to evaluate the healing of both chronic and acute wounds, with PUSH being the most frequently used.

Among the studies analyzed, nine (25.7%) used observation and measurement of clinical variables to assess wounds and their characteristics^(18,21,29,34,39,41,43,45,47). These characteristics were based on the assessment of pain, odor, exudate, tissue type, wound edges, ease of dressing removal, surrounding skin, infection, edema, eczema, wound bed trauma and peripheral sensitivity. In addition to these characteristics, the studies measured the area and volume of the wound to track healing progress.

Variables that were used for clinical evaluation of wound healing and that were not included in the tools include: odor, eczema, peripheral sensitivity and presence of trauma in the wound bed. Other variables, such as pain sensitivity and volume (related to wound extension) were present only in the Barber Measuring Tool and LUAT, respectively.

Of the complementary tools used by the studies to evaluate the healing process, the most frequently used was the photographic record, found in 11 (31.4%) of the 35 studies. Both conventional and digital cameras were used in conjunction with computer programs to provide measurements and comparative data on the appearance of wounds. Two of the studies also used microorganism culture tests to assess the presence of infection.

DISCUSSION

Although there are a variety of tools for different purposes, tools used to assess wound healing lead to improved quality of care, as they standardize care practices based on validated scales and strong evidence. Thus, identifying in the scientific literature the tools used and their respective parameters for wound healing assessment, enables nurses to choose the most appropriate tool for each case.

Of the assessment scales in the analyzed studies, the PUSH scale was the most prevalent (40%). The PUSH scale evaluates pressure ulcers quickly and safely⁽¹⁵⁾. When the scale was submitted to cross-cultural adaptation to the Portuguese language, it presented an excellent concordance index (Kappa coefficient between 0.90 and 1.0) between the observations of nurses and enterostomal therapists for all subscales and the total score⁽⁴⁸⁾. The PUSH scale is a clinically practical, easy-to-apply tool that allows the rapid assessment, at the bedside, of several types of wounds^(20,37). These characteristics were evident in this study, since in addition to being the most frequently used instrument in the studies, it was used to assess a wider diversity of wounds.

BWAT was the second most prevalent scale, identified in 11.4% of the studies. Its 13 components are evaluated on a Likert scale of one to five, in which the smaller values indicate a wound closer to healing. Originally developed in 1990 as the Pressure Sore Status Tool (PSST), it was redesigned in 2001 and renamed⁽⁴⁹⁻⁵⁰⁾. The BWAT was translated and adapted to the Brazilian culture with success by Alves⁽⁵¹⁾. The validity and reliability of the original version of this tool were verified in the study. The translated version, despite being easy to apply in both clinical practice and research, requires further research into its validity and reliability⁽⁵⁰⁻⁵²⁾.

In the included studies, the Bates-Jensen Wound Assessment Tool and PUSH scale, although initially developed to assess pressure ulcers, were used to assess the healing of chronic wounds of different etiologies and to assess acute wounds as well.

The third most frequently used scale (8.6%) in the identified studies was the DESIGN scale, which was also developed to assess pressure ulcers⁽³³⁾. The DESIGN-R, used in two studies, besides assessing pressure ulcers, makes it possible to compare the severity of different ulcers in an individual and in different individuals⁽³⁵⁾.

When comparing the components of each tool, the most frequently occurring components were related to wound extension (size and depth), exudate, tissue type and identification of signs of infection or inflammation. These components were also present in the studies that did not use specific tools, in which assessment was performed by observation and the measurement of clinical variables, as well as characteristics of the wounds.

Assessing wound size and depth is an important instrument to monitor the progress of wound healing. These measurements provide objective data on the decrease of the injured area and the increase of scar tissue. However, when used in isolation they do not provide the necessary data for a broad understanding and qualitative assessment of this complex process.

The best practice guidelines of the Ontario Nurses' Association for the assessment and treatment of leg ulcers, pointed out that measuring the surface of the wound at regular intervals to monitor its progress has level B of evidence. The guidelines state that this assessment can be performed using the greatest length and largest width or by tracing its contours using transparencies. The guidelines emphasize that level B of evidence indicates evidence from well-defined clinical studies⁽⁵³⁾.

Authors point to a positive correlation between healing and the absence of devitalized tissue with a lower quantity of exudate⁽⁵⁴⁾. The presence of devitalized tissue in the wound bed can hinder the healing process and, therefore, the removal of this tissue is essential for the progress and success of healing, both for chronic and acute wounds⁽⁵⁵⁾.

Assessing and controlling humidity are important aspects in the evaluation of healing, as both dryness and an excess of exudate can hinder healing. Dryness appears to favor tissue devitalization, while an excess of exudate increases the chances of bacterial colonization, infection and damage to the edges and skin around the wound⁽⁶⁾.

The presence of infection, especially with biofilms, is a relevant factor to be considered during assessment, because it can increase wound-related chronicity, morbidity and even mortality⁽⁵⁵⁾. Therefore, any sign of infection should be assessed and addressed promptly when identified.

Of the 11 scales in this review, seven (63.6%) indicated the presence of signs of infection as parameters, but did not provide data on how this is assessed. In addition, none of the tools emphasized the presence of biofilm as an important parameter for the identification of infections in the wound bed, which was considered a limitation of the tools.

The pink coloration of the tissue in the wound bed may indicate an increase in bacterial colonization, inflammation or infection, and should be observed⁽⁵⁴⁾ with due care, so as not to confuse this tissue with viable granulation tissue. It is important to highlight that the components described are relevant in wound healing evaluation, since they provide data that characterize essential aspects of this process. However, some elements that were cited only in some scales, such as the edges and surrounding skin, or elements that were not found in

validated tools, but only in the clinical parameters listed by the authors, including the evaluation of pain, odor and peripheral sensitivity are equally important for to evaluate healing.

The components most commonly evaluated by the scales were size (area, volume, depth), exudate, tissue type and signs of infection and inflammation. The evaluation of these parameters provides the means to monitor the effects of the treatment uniformly and objectively, since the choice of treatment considers the resolution or improvement of each of these items.

Proper preparation of the wound bed is essential for healing, especially in chronic conditions. Some of the principles involved in preparation have long been known and include the control of edema and exudate, reduction of bacterial load, stimulation for the development of granulation tissue, and removal of fibrosis and necrotic tissue⁽⁵⁴⁾.

Characteristics of the wound related not only to the exudate, but also to the conditions of the edges are highlighted as possible important markers for healing⁽⁵⁶⁾.

Wound edges with epithelial cells, even if discrete, present a greater chance of healing. It has been shown that even wounds with fibrous tissue tend to heal, provided their edges are flush with the wound tissue⁽⁵⁴⁾.

Assessing the surrounding skin for dermatitis, callosities or fibroses was shown to be important, especially in diabetic foot ulcers, as they make it difficult for healing to occur⁽⁵⁴⁾.

Edema, pain sensitivity, odor and the presence of trauma in the wound bed were hardly indicated in the scales of this review. These components are important for the adequate assessment and management of wounds, since they can provide important information about the healing process, as well as highlight any factors that could delay healing.

Regarding the assessment of pain and peripheral sensitivity, it is believed that there is a mutual influence between the immune system and the pain itself. Traditionally, in the microenvironment formed at the wound site, migrated leukocytes were associated with the inflammatory process and the secretion of chemical mediators that produced pain⁽⁵⁸⁾. However, linked to this, proinflammatory cytokines that participate in the pain generation process can also originate in immune, neuronal and glial cells (microglia and astrocytes), both in the peripheral and central nervous system⁽⁵⁹⁾ and may trigger acute or chronic pain, with possible hyperexcitability or alterations in phenotypic expression of nociceptors, abnormal processing of pain signals and exacerbation of pain processes⁽⁵⁸⁾.

It is therefore a complex pathway involving proinflammatory cytokines (IL-1, IL-2, IL-6, IL-7 and TNF) and anti-inflammatory cytokines (IL-4, IL -10, IL-13 and the transforming growth factor β -FTC β), related to the pathophysiology of pain syndromes, playing an important role in pain, through different mechanisms and at various sites of the transmission pathways.

It is known that pain alters patients' quality of life and, given that an inflammatory process may influence the patient's nociceptive phenotypic expression, in addition to exacerbating pain, attention should be paid to this aspect. Changing the wound dressing, a core aspect of nursing care, can cause pain and suffering, and can, in various cases, result in the need to administer additional analgic therapy (drug or not).

Odor may be related to the presence of devitalized or necrotic tissue and infection⁽⁴⁾. Treatment of infected wounds requires a multidisciplinary assessment, as it may require associated drug therapy. Together with the other characteristics mentioned above, odor is an important factor in healing evaluation.

Undermining and tunneling are indicated as additional information on the progress of healing. However, these conditions are not frequently present in wounds and, for this reason, work is needed to better identify and clarify occurrence and the implications of these conditions to the healing process⁽⁵⁶⁾.

Within the study sample, photographs were identified as the most frequently used auxiliary instrument (31.4%). The photographic record in a database can be used as a permanent consultation resource, a source of data on the assistance provided to monitor the evolution of wounds^(39,60). The use of photographs for wound documentation for patient registration and follow-up was identified as an important resource in this process in hospitals, home care and in wound care centers in several countries⁽⁶¹⁾.

Moreover, photographic records may be used in conjunction with computer programs allowing a more accurate assessment of wound measurements⁽⁶⁰⁾. A current literature review showed that for accurate and reliable measurement it is necessary to use digital planimetry or conduct an analysis of the wound area with analysis software, using digital photographs⁽⁶²⁾.

The complexity of the healing process requires a dynamic and accurate analysis; and the use of tools validated for this purpose can contribute to this process, directing the assessment and treatment of wounds.

CONCLUSION

In total, 34 articles and a doctoral thesis, most published before 2012, were evaluated; the most frequently used tool to assess wound healing was PUSH, followed by BWAT, DESING and DESIGN-R. Assessment through clinical variables was used in 10 of the 35 studies, either as a single form of assessment or to complement the tools. Some tools relate only to specific wound etiology and, for this reason, may limit their use in other types of injuries.

The characteristics of the wounds that were most evaluated in both the tools and clinical evaluations were size (area, volume, depth), exudate, tissue type and signs of infection and inflammation. The items less present in the assessment tools in the study were edema, pain sensitivity, odor and presence of trauma in the wound bed.

The tools identified for assessment and their respective characteristics revealed the complexity of the process and evaluation of healing, as there is a diversity of assessment parameters. In this sense, the use of tools to evaluate healing standardizes the evaluation of wounds and contributes to effective communication of the results obtained. However, the selection of these tools for the assessment and follow-up of wounds should be based on the need of the professional and the type of injury being managed.

Most of the tools were developed to assess wounds of specific etiologies, such as pressure injuries and, as a result, when these scales are used to assess other types of injuries, compromise may be made in evaluation. Thus, knowledge concerning these tools, their applications and their components can contribute to the selection of the most appropriate tool for each case.

The study is limited to the use of scales only, and does not include objective measure tools for wound evaluation, such as image analysis software, ultrasound and other technological devices for this purpose.

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