

The use of ultrasound by nurses in the assessment of complex chronic wounds: a scoping review

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ABSTRACT

Introduction Chronic wounds are difficult-to-heal lesions that generate high healthcare costs and significantly affect patients' quality of life. Current visual assessment is limited, as it does not allow detecting subclinical alterations or deepening tissue assessment. Ultrasound, a non-invasive technique, provides accurate information in real time, improving diagnosis and early interventions.

Hypothesis/aim The main objective was to review the current knowledge on using ultrasound for complex chronic wound assessment, diagnosis, prevention, treatment and progression by nurses.

Material and methods Research articles published over 16 years (2008–2024) were collected. After screening, 31 articles were analysed for assessment. Data sources: Scielo, PUBMED, The Cochrane Library, Scopus and Cinahl were used.

Main results The studies identify ultrasound as useful for the diagnosis and follow-up of chronic wounds. Applications were found in different types of wounds, highlighting pressure ulcers. Lack of realisation by nurses is identified.

Discussion and conclusions Ultrasound is a promising tool for assessment and diagnosis in the management of chronic wounds, promoting evidence-based care.

Implications for clinical practice Ultrasound is a promising tool for evaluating and monitoring chronic wounds, providing objective data and improving management, although it remains an underexplored area. Its use can enhance the role of advanced nursing practice.

Keywords wounds and injuries, nurse, ultrasonography, wound care, wound prevention, advanced practice nursing.

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KEY MESSAGES

Predominance in prevention and diagnosis: The literature reviewed focuses primarily on prevention and classification, while follow-up is less frequently addressed.

Emerging role of advanced nursing: Although nurses value ultrasound, its direct use in daily practice remains limited, generally conditioned by specific training.

Need for standardisation and evidence: Future research should focus on standardising ultrasound protocols, validating its use in different clinical settings.

Significant potential for clinical practice: Ultrasound offers objective and measurable information that can transform wound management.

INTRODUCTION

A chronic wound (CW) is a lesion characterised by a slow healing progression or delayed, interrupted, or stalled healing.

Healing inhibition can be attributed to intrinsic and extrinsic factors affecting the individual, the wound and the healing environment.¹

There are various types of hard-to-heal wounds. Many results from late diagnosis, while others are due to complexity in assessment and follow-up. In most cases, this delay is associated with patient status, including advanced age, presence of intrinsic comorbidities, and high levels of dependency.²

Among the most significant chronic wounds are skin dependence related skin injuries (SDRSI), a term encompassing pressure ulcers (PUs), shear injuries, friction-related injuries, moisture-associated skin damage (MASD), and skin tears.³ In addition, wounds with a vascular component, including diabetic foot ulcers and complications in surgical wounds, should be considered.⁴

The most recent national prevalence study of dependence-related skin lesions (DRSL) in Spain conducted by the Grupo

Nacional para el Estudio y Asesoramiento en Úlceras por Presión y Heridas Crónicas (GNEAUPP) in 2022 highlights a prevalence of 0.18% in the general population in primary care, 0.12% among individuals over 65 years, and 5.82% in those enrolled in home care programs.³ Additionally, the prevalence in residential and socio-healthcare centers was 9.28%.⁵ In our community care setting, specifically in the province of Lleida, Catalonia, Spain, a 2023 study estimated the prevalence of chronic wounds in the community at 0.19%.⁶

Regarding the cost of CW care, it is estimated that healthcare expenditures related to them account for from 2% to 4% of the health budget in Europe.⁷

Apart from their high costs, CWs or long-standing wounds contribute to increased hospital stays, collateral issues like infection, potential severe health consequences for affected patients, and a significant impact on their quality of life.⁸

In recent years, significant advances have been made in understanding CW treatment and prevention. Studies have evaluated the effectiveness of educational interventions and continuous staff training, though few adapt these interventions to the socio-healthcare environment.⁹

The management of complex chronic wounds (CCW) requires comprehensive and coordinated interventions addressing prevention, early detection, diagnosis, treatment, follow-up, and psychosocial and rehabilitative aspects. This necessitates improving clinical organisation and coordinating care levels to address the broad spectrum of CCW while adapting to the healthcare system's organisation.¹⁰

Proper wound assessment is crucial for the treatment of CCW. Currently, healthcare professionals determine wound severity, location, depth, and the presence of tunneling or undermining through visual inspection and observation of wound characteristics. However, visual observation may not capture all aspects of the wound. While significant progress has been made in developing treatments for them, advancements in their diagnosis and assessment have been minimal.¹¹ Consequently, CCW are often evaluated subjectively, complicating baseline measurements and tracking progression.¹²

Visual inspection reliability and validity vary significantly, with global figures suggesting moderate agreement. Another challenge is that skin visualisation focuses on surface changes rather than sub-surface conditions. When sub-surface damage becomes visible, it is often too late for preventive action, as deeper tissue damage surfaces later.¹³ Delays in selecting appropriate treatment strategies further exacerbate the issue.

In advanced CCW care, professionals need resources, tools, and technologies to expand and improve their practice to provide optimal care.¹⁴

Ultrasound is a diagnostic technique that offers real-time evaluation of inflammatory tissue responses.¹¹ It can reveal significant differences in skin structure and changes not visible during clinical inspection. Some of these changes require further research as they remain unexplained or incompletely described.¹⁵

Studies have indicated that using magnetic resonance imaging (MRI) or computed tomography (CT) to examine wound regions can reveal abscesses or cavities under or around the wound. These techniques are effective for observing subcutaneous tissues but are not widely available, require specialised personnel, and are costly.

In contrast, ultrasound can be used bedside, overcoming these limitations. It allows measurement of damage extent and soft tissue depth in the wound region. Reports suggest ultrasound is effective for assessing the pathogenesis of pressure ulcer development.¹⁶

Ultrasound can enhance CCW severity classification by identifying subclinical lesions and clinically invisible skin changes.¹⁵ Scientific literature highlights ultrasound's predictive power in detecting early signs of tissue degradation before ulceration.¹⁷ For instance, what initially appears as a Stage I PU may progress to Stage II or even III. Ultrasound also enables evaluation of wound morphology, volume, and depth, making it highly useful for tunneling or undermining wounds.¹⁸ Thus, identifying patterns through ultrasound can help predict prognosis.¹⁵

Previous studies have observed wound sites appearing as hypoechoic or anechoic regions, indicating inflammation. Necrotic tissue often presents as hyperechoic images.¹⁶

Integrating ultrasound into CCW assessment can significantly advance patient care by improving diagnostic precision and enabling early preventive and curative interventions. These can improve clinical outcomes and the quality of life for affected patients.

The diagnosis and treatment of CCWs in our setting are closely linked to nursing within multidisciplinary teams. The development and application of most techniques depend primarily on this discipline. In community care, high-resolution ultrasound can be developed by advanced practice nurses (APNs), representing a turning point in CCW assessment. Using ultrasound as a nursing tool is a frontier recently crossed and should be expanded.

Ultrasound is a reliable, non-invasive diagnostic tool widely used in healthcare. Within nursing, its use is increasing in areas such as catheterisation or diagnosing vascular diseases. Imaging methods complement physical examinations, enhancing diagnostic precision. Dermatological applications have also been documented in various studies.^{18, 19, 20}

Different studies demonstrate the occasional use of ultrasound by nurses. Considering APNs' role in wound care, it is pertinent to describe the use of ultrasound in prevention and as a prognostic factor in the evolution of DRSL. There are several systematic reviews on the use of ultrasound in wound care; however, these are not focused exclusively on the use of ultrasound in complex wounds or on how nurses specifically use ultrasound. Some reviews include ultrasound along with other technologies or focus on specific types of wounds, which are not directly related to the focus of this review on wounds related to dependency.

A large number of articles^{18,19,21,22,23} highlight the importance of further research into the use of ultrasound in wound care, pointing out the lack of evidence to translate this into practice. In any case, there is no review of the literature on this

topic that would allow the evidence on the subject to be put together.

Therefore, it was proposed to conduct a scoping review of the literature to answer the PICO question²⁴ described in Table 1, as this type of review allows for a broad exploration of the different approaches and methodologies existing on the use of ultrasound in wound care, encompassing both primary and secondary studies.

The scoping review aims to answer the following research question:

What is the current state of knowledge in the scientific literature on the application of ultrasound in wound care in nursing, considering the different clinical and academic contexts?

The main objective was to review current knowledge on using ultrasound for CCW assessment, diagnosis, prevention, treatment, and progression by nurses.

Secondary objectives were defined as:

- Identify and classify available evidence on wound care using ultrasound based on methodological quality and evidence level
- Explore the contribution of nurses using ultrasound in wound care within the nursing process

METHODS

To address the research objectives, a scoping review of the literature was conducted. The review protocol was developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews (PRISMA-ScR) guidelines.²⁵

The review protocol was registered in the PROSPERO database on 31 May 2023, under registration number RD42023311914.

Six databases were reviewed: Scielo, PUBMED, The Cochrane Library, Scopus, and Cinahl. Additionally, bibliographic reference lists of included articles were examined to identify additional studies.

The search terms used were seven Medical Subject Headings (MESH) descriptors, both individually and in combination. Boolean operators “AND” and “NOT” were applied. The search strategies included: (Ultrasonography) AND (Pressure Ulcer) AND (decubitus ulcer), (Surgical Wound Dehiscence) AND (Ultrasonography), (Diagnostic imaging) AND (ulcer pressure), ((wound) AND (injury)) AND (Ultrasonography)) NOT (trauma), ((wound) AND (Ultrasonography)) NOT (trauma) NOT (vascular) NOT (venous) NOT (doppler) NOT (Pressure Ulcer) AND (chronic wound diagnostics).

These terms were based on similar studies and expert recommendations in wound care research. The volume of

terms was necessary due to the novelty and difficulty of locating results on this topic.

The following search criteria were considered:

Inclusion criteria

- Articles published in scientific journals.
- Articles including case reports, case series, uncontrolled studies, clinical trials, systematic reviews, and meta-analyses.
- Based on an initial exploratory search conducted prior to the formal design of this review, we identified that the first relevant publications began to appear in 2008. Therefore, we established the inclusion period between June 2008 and June 2024.
- Articles in any language.
- Studies involving adult populations with or at risk of developing CW, including PUs, shear injuries, friction-related injuries, MASD, skin tears, lower extremity ulcers, and surgical wound complications, provided that ultrasound was used for evaluation or monitoring.
- Studies conducted on humans.

Exclusion criteria:

- Book chapters, doctoral theses, master’s or undergraduate dissertations, editorials, professional position papers, care protocols, and care plans.
- Studies focusing exclusively on vascular assessments.
- Studies involving terminally ill or deceased patients.

The variables described in Table 2 were considered and taken into account for the analysis of the identified works.

The quality and scientific evidence of the articles was assessed according to the methodological quality criteria of the Joanna Briggs Institute,²⁶ in order to evaluate the risk of bias and the quantitative methodology of the articles, assigning them three different levels of quality. However, this assessment was not used as an exclusion criterion, consistent with the nature of a scoping review (Table 3).

Once the articles included in the review were selected, the results were organised and presented in a data extraction table with 15 categories. This process is part of the methodology used to organise and analyse the data extracted from the selected studies. The categories included key variables, such as the country of origin, study design, type of technique used, professional training, types of wounds treated, primary and secondary objectives, study population, ultrasound variables, among others. These variables were selected to facilitate a thorough analysis of the characteristics and outcomes of the included studies, allowing for a clearer comparison of the approaches used in the application of ultrasound in wound care.

Table 1. PICO research questions

Patient	Patients with chronic and complex wounds requiring assessment and follow-up
Intervention	Use of ultrasound as a diagnostic and monitoring tool in the management of complex wounds
Comparison	Conventional wound assessment methods, such as visual evaluation, clinical palpation, or photography
Outcomes	Diagnostic effectiveness, early detection of complications, improvement in clinical decision-making, reduction in healing time, and enhancement of clinical outcomes

The analysis of the results was triangulated by JETB and LMR in order to assess possible discrepancies in the articles, thus ensuring a more accurate assessment. This approach also allowed us to identify and maintain adequate consistency and quality in the analysis.

Ethical aspects

The study selection process was carried out in two phases: first, the titles and abstracts were assessed to apply the inclusion and exclusion criteria, and then the full texts of the selected articles were reviewed. Any discrepancies in the selection were resolved by consensus among the evaluators. The methodological quality of the articles was evaluated according to the criteria of the Joanna Briggs Institute. The quality assessment also included the review of potential biases in the studies.

This study has been structured according to the general principles of PRISMA-ScR, aiming to ensure rigor in the selection and analysis of the studies through transparent documentation of why the review was conducted, what the authors did, what they found, and how the studies were selected.²⁵

The results of the review are presented in the order of the different variables taken into account: country of study, study design, author's discipline, research setting, who performed the ultrasound technique, technical training in ultrasound, types of wounds analysed, primary objectives of the articles, secondary objectives of the articles, sample size, population studied, whether the ultrasound technique is compared with another technique, non-ultrasound variables, ultrasound variables, the nursing process and the level of scientific evidence.

RESULTS

The bibliographic search was conducted between June 2023 and June 2024. The initial search identified 3713 records. After title screening, 3488 records unrelated to the use of ultrasound in wound assessment were excluded. Additionally, 98 duplicates and one record unavailable for full-text reading were removed.

Subsequently, 127 records were retrieved for abstract review. Of these, 73 were excluded based on the abstract, and 29 were removed after full-text review for not meeting all inclusion and exclusion criteria. Six additional studies were identified through searches in the reference lists (snowballing), where relevant studies were found by reviewing the citations of the included articles.

Ultimately, 31 studies met the inclusion and exclusion criteria and were included in the scoping review. This selection process is summarised in the PRISMA diagram (Figure 1).

According to the country of origin of the studies analysed, 11 studies came from the United States^{18,23,28,20,29,30,31,32,33,34,35} and 11 from Japan,^{36,21,22,16,37,38,39,40,19,41,42} these two countries being the most prolific in publications on this topic. They are followed by Ireland¹³ United Kingdom,⁴³ Egypt,⁴⁴ Switzerland,⁴⁵ Australia,⁴⁶ Poland,⁴⁷ India,⁴⁸ Malaysia⁴⁹ and Italy,¹⁵ each with one related article.

In terms of study type, six prospective observational studies,^{21,18,23,44,45,16} three cross-sectional^{38, 36, 41} and four

longitudinal^{28,20,29,43} were identified. In addition, three descriptive studies,^{30,31,32} six case series,^{22,37,46,19,47,33} two single case studies,^{39,40} one cohort study,¹⁵ one study with retrospective design⁴⁵ and five literature reviews^{13,34,35,49,48} were included, only one of which was systematic. All the studies found have a quantitative and empirical design with a strong focus on the evaluation of the use of ultrasound for wound assessment.

In relation to the setting in which these studies were conducted, a remarkable diversity of academic and clinical contexts is observed. Ten of the studies were conducted in nursing schools,^{36,21,22,37,20,29,30,31,41,43} followed by four in medical schools,^{44,15,38,46,47} suggesting a strong academic interest in the topic and highlighting the significant involvement of nurses over physicians in the research. In addition, four studies were conducted in hospital settings under the supervision of nurses^{18,39,40,19} and two under the supervision of physicians,^{16,28} confirming the leadership of nurses in the hospital setting.

Additionally, two articles came from biomedical schools,²³ one from an engineering school⁴³ and one from a collaboration between engineering and medicine,⁴² ending with two in a collaboration between a nursing and medical school.^{45,11} This variety of contributions, including other health and engineering specialties, brings a valuable interdisciplinary approach to research.

In terms of sample size, a wide variability was observed in the field studies, with an average of 36.6 participants and a range that varied significantly from one to 150 individuals. The median sample size was 18.5 participants, reflecting the central distribution of the data, while the mode was 50 participants, indicating the most frequent value in the studies analysed. In the case of literature reviews, the average number of articles related specifically to ultrasound and wounds was 12, with a median of 10 articles.

Sample size analysis revealed a heterogeneous distribution of data in the literature reviewed. This variability may be justified by differences in the types of studies, the diversity of patients observed and the limited production of specific studies on this topic.

In terms of the type of population studied, there is significant diversity in the research approaches. Hospital inpatients were used in seven studies,^{16,46,39,40,40,23,42,43} while three included wheelchair patients.^{36,38,41} In addition, two studies focused on patients with surgical interventions at the time of the study^{21,19} and three addressed patients with chronic pathologies.^{44,18,15} Another study included intubated patients³⁴ and one more focused on those with a Braden index below 18.³² One specific study investigated patients with chronic wounds.⁴⁵ On the other hand, two studies were conducted in a population with no medical history,^{30,31} using nursing students as participants. Importantly, six studies did not clearly specify the type of population studied.^{22,37,47,28,29,33} The inclusion of diverse populations, such as hospitalised patients with chronic pathologies, paraplegics and a young asymptomatic population, highlights the breadth and clinical relevance of the studies analysed; however, this also creates a significant difficulty when comparing the studies.

In relation to the research objectives, the findings in the literature provide us with a significant range of key

Table 2 Variables analysed.

	Theoretical variable	Operational variable
Country of implementation	Where the study was conducted	Name of the country.
Study design		
Author's discipline	Academic status of the researcher promoting the study	Nursing Medicine Other
Research environment		Hospital, primary care, university, laboratory
Who performs the ultrasound technique	Personnel in charge of performing the ultrasound scan	Nurse Technical unspecified Sonographer Physician: Radiologist, dermatologist, vascular.
Technical training in ultrasound	Specifies the provision of training in this field	Yes/No, how much and how.
Types of wounds analysed	Different types of wounds according to their causative agent	LCRD, surgical complication injuries and prevention of surgical complications.
Primary objectives of the articles		
Secondary objectives of the articles		
Sample size	Total number of participants	
Study population	Type of patient	Previous pathology, comorbidities, healthy patient...
Do you compare the ultrasound technique with another technique?	Comparison or not with other wound diagnosis systems	Visual scales Photographs Temperature...
Non-ultrasound variables		Age, sex, analytical values, previous pathological conditions, dependency, time of injury, use of preventive devices, etc.
Ultrasound		
Dimensions	Length, width and depth	Measured in millimetres
Presence or absence of tunneling or fistulous tracts	wounds that have a channel or tunnel extending into the subcutaneous tissue.	YES/No
Dimensions of the tunnelled route	Depth	Measured in millimetres
Vascularisation or not of the wound.	Presence or non-presence of moving blood flow	YES/No
Affection of the different planes of the skin.	It is divided into; epidermis, dermis and deep planes.	<u>Epidermis</u> : First band hyperechoic, and double soft in acral areas. <u>Dermis</u> : Corresponds to the second band, in this case hypoechoic. <u>Hypodermis</u> : Hypoechoic band furrowed by a network of hyperechoic lines corresponding to the septa. <u>Deep planes</u> : Muscle and bone.
Whether or not the deep planes are affected	Involvement below the dermis	Fascia, muscle and bone
Destructuring of the epidermis, dermis and hypodermis.	Anatomical alteration of the described structures	YES/No
Nursing process.		
The nursing process is a systematised method of delivering humanistic care focused on achieving goals in an efficient manner. It is based on the idea that, as we plan and deliver care, we must consider the ideal interests and unique desires of the health care consumer. ²⁷		Valuation
		Diagnosis
		Planning
		Execution
		Evaluation
Scientific evidence		
Level of evidence	Joanna Briggs Methodological Quality Criteria, revised 2008 ²⁶	Grade A, B and C. (Table3)

Table 3. Grades of the Joanna Briggs Criteria

Joanna Briggs Institute Quality Criteria	
Grade 1	Demonstrated effectiveness for application
Grade 2	Established degree of effectiveness indicating consideration for application of its results
Grade 3	Effectiveness not demonstrated

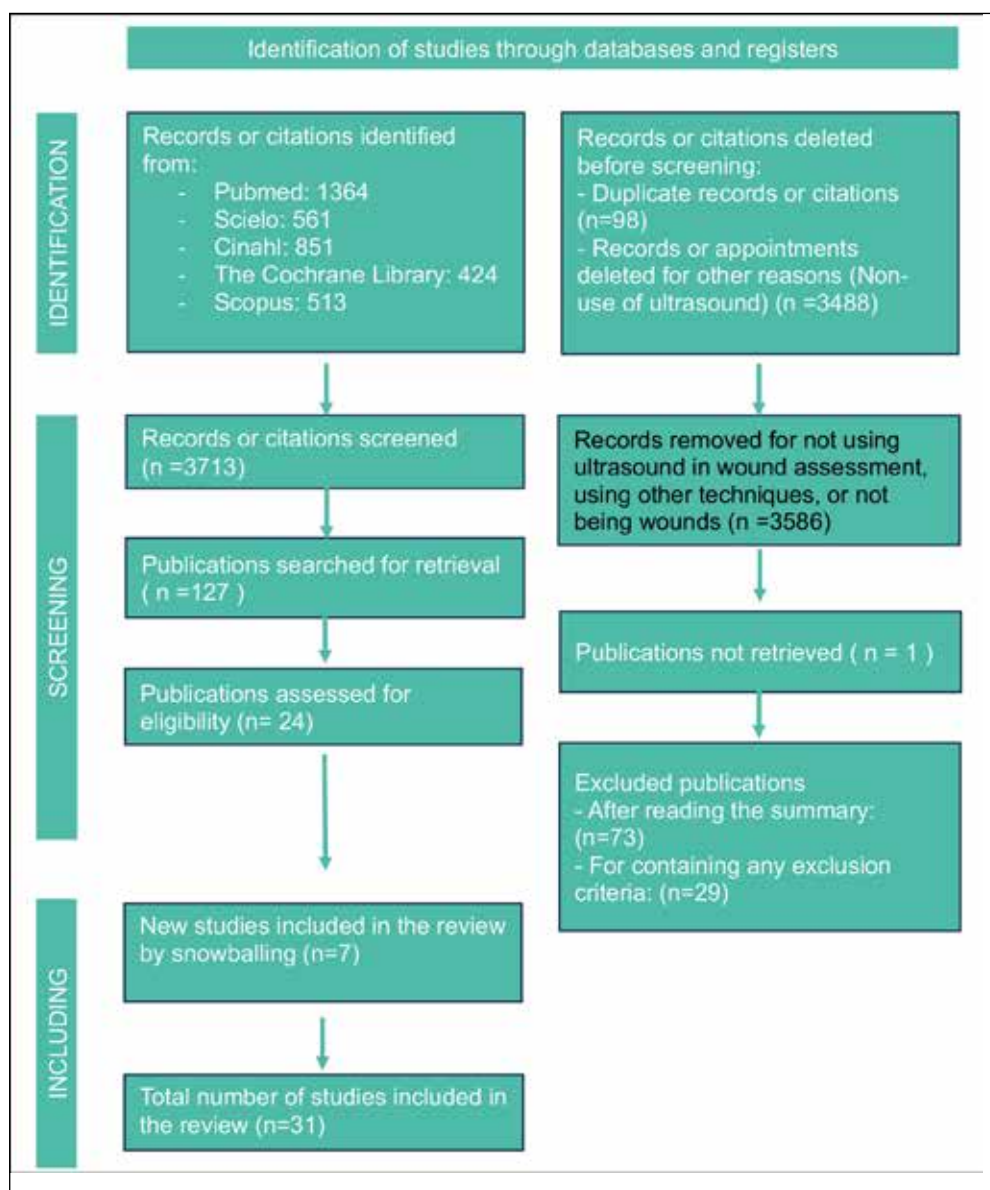


Figure 1. PRISMA ScR flowchart

conclusions and relevant perspectives on the research topic, which are outlined below.

Regarding the current state of knowledge on the use of ultrasound in the assessment, diagnosis, prevention and/or treatment and evolution of CW, the following results are highlighted.

The elements that emerge from the analysis of the articles in relation to intervention on treated wounds is that they mainly focus on risk assessment and prevention of pressure ulcers,^{36,44,21,18,38,46,20,29,32} as well as the classification of pressure ulcers.^{22,16,37,39,40,28,41,43,42} To a lesser extent, follow-up and evolution of these wounds with specific treatments, such as grafting,^{45,15,33} parameters of normality in healthy patients^{30,31} and their healthy-sick comparison,^{23,19} and one on patients with wounds in the lower extremity,⁴⁷ have emerged.

In two of the studies, a comparison is made between ultrasound imaging and other modalities of lesion assessment such as skin thermography^{23,42} without highlighting with evidence which is better than the other. In 11 of these studies, a direct comparison is made with photographs and visual inspection,^{45,18,37,46,39,40,47,28,43,33} while in one specific study, Tamai³⁶ compares ultrasound imaging with creatine kinase (CK) levels obtained by blood tests. On the other hand, in the remaining 12 studies reviewed,^{44,21,15,16,38,19,20,29,30,31,41,32} no comparison with other techniques is performed and they are limited exclusively to detailed description of the lesions by ultrasound. Contrast with traditional modalities, such as visual inspection or photography, may highlight the therapeutic utility of ultrasound in wound assessment. This comparison is essential to establish the accuracy and usefulness of ultrasound as a diagnostic and follow-up method.

In most of the cases analysed, ultrasound variables are mainly focused on the quantification of inflammation of the subdermal layers, this being the subject of study in 11 investigations.^{21,45,18,15,15,22,38,32,41,43,29,30} This approach underlines a particular interest in understanding and characterising the inflammatory changes that may precede or accompany skin lesions. In nine studies, a detailed ultrasound description of the lesion area or risk of lesion is carried out,^{16,46,40,23,28,33,42,19,20} demonstrating the need for further research to standardise objectification and subdermal composition, which are essential for the diagnosis and prediction of lesions, while three studies assess skin and muscle thickness and quality.^{36,44,31} Yabunaka³⁹ in his study uses 3D technology, while Krauze⁴⁷ describes the granulation tissue of the lesion at dermal level. In one case, it could not be clearly determined which ultrasound variables were used.³⁷

Most of the variables assessed are limited exclusively to ultrasound.^{4,16,37,46,39,47,28,20,29,4,32} However, in those studies that included other variables, these focus on socio-demographic aspects, analytical values such as CK, geriatric assessment scales, as well as more detailed visual injury assessment scales, and assessments of basic and instrumental activities of daily living.

The reviewed studies show a variety of objectives and cover several aspects. Eight studies aim to determine the presence of subcutaneous injury by ultrasound.^{36,44,21,18,46,30,32,42} Another eight studies focus on detailed description and evaluation of the usefulness of ultrasound.^{22,16,37,40,19,20,20,31,41} Three studies compare ultrasound with visual or photographic inspection^{28,29,43} to validate its diagnostic efficacy, which may provide evidence as to whether ultrasound offers additional advantages in lesion assessment. Three other studies are aimed at evaluating the healing process of lesions using ultrasound as a follow-up tool.^{45,47,33} Also included are three studies that focus on the accurate assessment and reliability of ultrasound as a diagnostic method in this specific context.^{15,38,39} Finally, one article stands out for comparing the assessment of lesions by scanning electron microscopy (SEM) and ultrasound.²³

Information regarding methodological quality and level of evidence, following Joanna Briggs criteria, is included in Table 4.

In relation to the contribution of the nursing process in the studies reviewed, it is noteworthy that the person in charge of performing the ultrasound scans in the studies analysed shows a notable variability. In five of the studies analysed, a "sonographer" is specifically mentioned as the figure in charge of the procedure without giving more specific details of their training.^{36,21,39,36,32} While in four studies it is nurses who carry out this role.^{18,19,20,29} Another five studies were conducted by researchers with ultrasound training, although their disciplines are not disclosed.^{22,16,30,31,43} In five studies, the ultrasound scans are performed by physicians who are not specialists in radiology,^{45,15,46,47,42} in two studies by radiologists,^{44,23} with nurses standing out for their initiative in proposing and leading this type of study. However, more physicians play a relevant role as sonographers. In one study an engineer deploys his skills in this field.³³ It is important to note that in four studies it could not be explicitly determined who was in charge of the ultrasound technique.^{37,38,40,28}

Most of the studies, 19 of the total, do not explicitly detail the prior training of the operators performing the ultrasound examinations.^{36,44,21,45,15,22,42,16,37,38,46,40,33,19,47,28,30,41,43} which may be attributed to the generalised reference to "trained sonographers". Some studies detail ultrasound training, both pre- and in-process. In three of these studies, ultrasound examinations were supervised and pre-trained by a radiologist.^{23,31,32} In three studies conducted by nurses, nurses also received prior ultrasound training.^{18,20,29} In addition, in one of them Helvig,¹⁸ mentions the use of videoconferencing to improve technique.

In 15 articles there was no mention of the participation of nurses,^{36,44,45,15,37,38,46,39,40,47,28,29,30,31,33} considering that they are usually responsible for both final wound care and wound prevention in most cases, but in eight of them they are responsible for visual assessment of the lesions, categorising them and in some cases collecting other variables.^{18,22,16,23,19,41,32,42} In the remaining three articles, their work is limited to the collection of secondary variables.^{21,20,43} Of the studies where nurses carry out ultrasound scans, it only describes their role beyond what could be considered part of the nursing process.

DISCUSSION

The majority of the studies focus on the prevention and classification of chronic wounds, while follow-up care and detailed tracking receive comparatively less attention. Changes detected through ultrasound in pressure ulcers are often more apparent to clinicians unfamiliar with the technique, as interpreting ultrasound images requires specific skills and a thorough understanding of subtle changes that may not be immediately evident.⁵⁰ This difficulty becomes even more pronounced during the healing process, where changes can be less distinct.⁵¹

Another critical challenge identified is the limited access to specialised ultrasound equipment for nurses.⁵² Most available ultrasound devices in clinical settings are basic and do not offer the resolution required for observing subtle changes in superficial layers.⁵³ Using ultrasound devices with higher-frequency probes could provide better resolution of these layers, aiding in the detection of less obvious infections and changes in wounds.⁵⁴

Existing literature also highlights a lack of studies addressing the follow-up of wounds with a vascular component. In such cases, ultrasound has primarily been used to assess vascularisation rather than tracking superficial wound changes.⁵⁵ The focus on deep tissue changes may reflect the technical challenges of visualising surface-level or healing-related changes. This issue is compounded by inadequate training, unsuitable probes, or a lack of research supporting ultrasound application in these specific areas.

Complementing ultrasound with visual or photographic inspection techniques is essential. Sole reliance on ultrasound may introduce biases that could lead to diagnostic inaccuracies.⁵⁶ It is imperative to conduct further research to standardise observed results and establish clear protocols for assessment and diagnosis. The integration of ultrasound into routine nursing care is crucial to improving the precision and effectiveness of wound monitoring.

Table 4 Joanna Briggs Institute methodological quality criteria

Study (references)	Criteria Joanna Briggs				Grades of recommendation
	Yes	No	It is not clear	Not applicable	
Literature reviews	11 criteria				
13	9	2			High
34		11			Under
35	1	1	9		Medium
Narrative	6 criteria				
49	5		1		High
48	5		1		High
Observational	8 criteria				
36	6	2			High
44	6	2			High
21	6	2			High
45	5	2	1		Medium
18	5	2	1		Medium
16	7	1			High
38	8				High
23	8				High
28	4	2	2		Under
20	8				High
29	5	2	1		Medium
30	7	1			High
31	7	1			High
41	7	1			High
43	6	2			High
32	7	1			High
41	7	1			High
Cohorts	10 criteria				
15	4	2	4		Medium
Case series	10 criteria				
22	4	2	2	2	Medium
37	3	2	5		Under
46	7		3		High
19	10				High
47	10				High
33	9	1			High
Case	8 criteria				
39	8				High
40	8				High

The articles reviewed generally present high levels of evidence, indicating that ultrasound provides objective and measurable data that enhance standardisation and allow for more precise result comparisons.⁵⁴ Integrating this technique into clinical practice represents a significant opportunity for advancing the evaluation, diagnosis, prevention, and treatment of chronic wounds, ultimately improving patient outcomes.

Despite this, ultrasound remains underutilised by nurses in routine practice for wound assessment. Many studies do not explicitly identify its use as a standard nursing intervention.^{57,58} Although nurses frequently spearhead research on this technology, they do not always collect ultrasound data directly, suggesting a growing appreciation for its value and a desire to incorporate it further into standard nursing practices. When nurses do employ ultrasound, it is often following specific training, highlighting its potential as an emerging field for advanced nursing practice in wound care.

Notably, there is a marked absence of literature on the application of ultrasound in home care settings. Most available publications focus on its use in hospitals, indicating a significant gap in evidence and consensus in this context.⁵⁹

This review also identifies a gap in high-quality evidence supporting the efficacy and application of ultrasound in clinical practice. Further rigorous research is needed to validate its effectiveness and establish a robust scientific basis for its use. Additionally, future studies should prioritise standardising ultrasound protocols, evaluating its economic and clinical impact, and exploring its role in diverse care settings.

Many of the articles do not indicate who is responsible for the ultrasound scans or are not specific enough to be able to identify their authorship.

In the included case series or empirical studies, ultrasound imaging cannot be used to support the diagnosis of the wound, usually due to a lack of statistical power.

CONCLUSIONS

Ultrasound can be a valuable tool for assessing, diagnosing, preventing, and treating various types of chronic wounds. With standard ultrasound devices, the most commonly evaluated lesions are PUs, especially concerning prevention and diagnosis. This accessibility stems partly from the fact that ultrasound use does not require extensive specialised training, making it an efficient and practical option for nurses today.

Incorporating ultrasound into the nursing process and daily practice is critical, as current studies lack sufficient data to fully standardise these practices. This review suggests that for advanced practice nurses specialising in wound care to effectively integrate ultrasound into their work, further research must focus on developing and validating standardised protocols for ultrasound-based wound assessment. These investigations should evaluate its application across varied clinical contexts and assess its economic and clinical impact on daily nursing practices.

In summary, this literature review highlights the significant potential of ultrasound for wound evaluation, providing valuable insights for clinical practice and future research in this field.

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LIMITATIONS OF THE STUDY

A critical appraisal of the included studies was conducted using the appropriate tools from the Joanna Briggs Institute,

adapted to each study design. This process aimed to provide an overview of the methodological quality of the studies, but, in line with the nature of scoping reviews, the results of this appraisal were not used as exclusion criteria. Furthermore, while no formal statistical meta-analysis was performed, a descriptive quantitative synthesis of the data was included (such as frequency of study designs, clinical applications, and geographical distribution), in accordance with the objectives and scope of a scoping review.

IMPLICATIONS FOR CLINICAL PRACTICE

This research underscores the importance of ultrasound as a valuable tool for monitoring and assessing chronic wounds, addressing a relatively unexplored area in the literature. Ultrasound enables nurses to obtain objective and measurable data, facilitating the standardisation of results. Its application in wound care introduces a novel approach to wound management and expands the opportunities for advanced nursing practice.

FURTHER RESEARCH

The findings highlight critical gaps in the application of ultrasound in home care settings and in staff training, suggesting directions for future investigations. Promoting the integration of ultrasound into daily nursing practice is essential, alongside the development of standardised protocols to validate its use across diverse clinical settings.

AUTHOR CONTRIBUTIONS

Alvaro Vilela Pájaro: Conceptualisation and design, manuscript drafting, final manuscript approval.

Joan Enric Torra Bou: Data analysis and interpretation, critical manuscript review, final manuscript approval.

Laura Martinez Rodriguez: Conceptualisation and design, critical manuscript review, final manuscript approval.

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