ESTIMA
Brazilian Journal of Enterostomal Therapy

REVIEW ARTICLE
https://doi.org/10.30886/estima.v23.1596_IN

Nursing Interventions for Biofilm Treatment and Control in People with Chronic Wounds

Giulia da Cunha Novais[1,*], Euzeli da Silva Brandão[1]

ABSTRACT

Objective: To map the actions performed by nurses related to the control and treatment of biofilm in individuals with chronic wounds. **Method:** Scoping review following the JBI guidelines. The search was performed across four databases, and Google Scholar (as a source of Gray Literature), using the PCC framework as inclusion criteria: Participants: People with chronic wounds; Concept: Biofilms in chronic wounds; Context: Nursing care, with no language or time frame restrictions. A total of 572 publications were identified and, after the eligibility criteria were applied by two independent reviewers, 20 studies were included in the review. **Results:** The studies selected, published between 2006 and 2021, were predominantly in English. Of these, nine were narrative reviews, two were randomized clinical trials, and one was a systematic review. The treatment and control actions identified included debridement techniques and use of products such as polyhexamethylene biguanide, silver, and iodine, as well as negative pressure wound therapy and ultrasound. **Conclusion:** The actions identified mainly focus on wound care without prioritizing a comprehensive assessment of the individual. Given the nature of the publications, there is a need for further research with more robust scientific evidence and a broader, more holistic approach to care.

DESCRIPTORS: Nursing care. Wounds and injuries. Biofilms. Enterostomal therapy.

Ações do enfermeiro no tratamento e controle do biofilme em pessoas com feridas crônicas

RESUMO

Objetivo: Mapear as ações do enfermeiro relacionadas ao controle e tratamento do biofilme em pessoas com feridas crônicas. **Método:** Revisão de escopo conforme preconiza o JBI. A busca ocorreu em quatro bases de dados e no Google Scholar, como fonte de literatura cinzenta, utilizando como critérios de inclusão o PCC, em que: participantes: pessoas com feridas crônicas; conceito: biofilmes em feridas crônicas; e contexto: cuidados de enfermagem, sem restrições de idioma ou recorte temporal. Foram identificadas 572 publicações e, após aplicação dos critérios de elegibilidade por dois revisores independentes, 20 foram incluídas na revisão. **Resultados:** Os estudos selecionados foram publicados entre 2006 e 2021, predominando o idioma inglês, sendo nove revisões narrativas, dois ensaios clínicos randomizados e apenas uma revisão sistemática. Entre as ações de tratamento e controle, destacam-se técnicas de desbridamento e uso de produtos como polihexametileno biguanida, prata e iodo, além da terapia por pressão negativa e ultrassom. **Conclusão:** As ações mapeadas têm como foco a ferida, sem privilegiar a avaliação integral da pessoa. Diante das características das publicações, constata-se a necessidade da elaboração de pesquisas com evidências científicas robustas e com abordagem mais ampla.

DESCRITORES: Cuidados de enfermagem. Ferimentos e lesões. Biofilme. Estomaterapia.

[1]Universidade Federal Fluminense – Niterói (RJ), Brazil.
*Corresponding author: giulianovais7@gmail.com

Section Editor: Manuela de Mendonça F. Coelho
Received: Jun. 8, 2024 | Approved: Apr. 25, 2025
How to cite this article: Novais GC, Brandão ES. Nursing Interventions for Biofilm Treatment and Control in People with Chronic Wounds. ESTIMA, Braz J Enterostomal Ther. 2025;23:e1596. https://doi.org/10.30886/estima.v23.1596_IN

Actuación de enfermería en el tratamiento y control del biofilm en personas con heridas crónicas

RESUMEN

Objetivo: Mapear las acciones de enfermería relacionadas con el control y tratamiento del biofilm en personas con heridas crónicas. **Método:** Revisión de alcance según la recomendación del Instituto Joanna Briggs (JBI). La búsqueda se realizó en cuatro bases de datos y en *Google Scholar* como fuente de literatura gris, utilizando como criterios de inclusión los CCP: Participantes: Personas con heridas crónicas; Concepto: Biopelículas en heridas crónicas; Contexto: Cuidados de enfermería, sin restricciones de idioma ni recorte temporal. Se identificaron 572 publicaciones y, tras aplicar los criterios de elegibilidad por dos revisores independientes, se incluyeron 20 en la revisión. **Resultados:** Los estudios seleccionados fueron publicados entre 2006 y 2021, predominando el idioma inglés, siendo nueve revisiones narrativas, dos ensayos clínicos aleatorizados y solo una revisión sistemática. Entre las acciones de tratamiento y control se destacan las técnicas de desbridamiento y el uso de productos como la polihexametilenbiguanida, plata y yodo, además de la terapia de presión negativa y el ultrasonido. **Conclusión:** Las actuaciones reseñadas se centran en la herida, sin favorecer una valoración integral de la persona. Dadas las características de las publicaciones, es necesaria una investigación con evidencia científica robusta y con un enfoque más amplio.

DESCRIPTORES: Atención de enfermería. Heridas y lesiones. Biopelículas. Estomaterapia.

INTRODUCTION

Chronic or difficult-to-heal wounds are characterized by the failure to progress in the physiological healing process[1]. Among the factors that can contribute to the chronicity of wounds, the following are particularly notable: infectious complications, the patient's clinical condition, and the severity and extent of the injury[2].

The global incidence of chronic wounds ranges from 3 to 5 cases per year per 1,000 inhabitants.[3] Among these, pressure injuries and lower limb ulcers are the most common, which affect health care quality indicators and result in high costs. They are also significant causes of morbidity and mortality in hospital, outpatient, or primary care settings[3].

When skin integrity is compromised, the wound becomes a source of nutrients for microorganisms and a favorable environment for microbial colonization. This may occur from strains found in hospital or community settings or from the individual's own microbiota, following an imbalance in its normal state[4].

It is estimated that approximately 60% to 80% of chronic wounds contain biofilms[5], which are characterized by three-dimensional microbial colonies formed by complex clusters of microorganisms. They organize and accumulate on surfaces, surrounded by an extracellular substance or exopolysaccharide matrix. The majority of the biofilm (80–85%) consists of extracellular polymer, with the remainder composed of microorganisms[6].

Chronic infections are one of the most favorable environments for biofilm development, which functions as an ecosystem, enabling bacteria to interact with the host. Key characteristics of biofilms include reduced treatment efficacy and increased bacterial resistance. Thus, the rising incidence of chronic wounds contributes to the increased occurrence of biofilms[4].

According to COFEN Resolution 567/2018, which regulates the role of the nursing team in caring for individuals with wounds, nurses are responsible for "evaluating, prescribing, and performing dressings, as well as coordinating and supervising the nursing team."[7]

As health care providers, nurses must possess scientific knowledge, technical skills, and use appropriate technologies for managing these wounds, aiming to promote healing and rehabilitation for individuals[1]. Therefore, interventions must be precise, evidence-based, and focused on identifying coping strategies, preventing complications, and providing effective management to ensure comprehensive care[8].

However, regarding biofilm management, a study revealed knowledge gaps among nurses, as evidenced by the higher number of incorrect responses on the topic[9].

In this context, it is essential to prepare nurses working in various health care settings to assess, plan, and intervene to promote healing, especially for wounds that may harbor biofilms, as these require specific knowledge and strategies for proper control and treatment.

A preliminary search was conducted in the Cochrane Database of Systematic Reviews, Open Science Framework, and Figshare, but no systematic or scoping reviews specifically addressing the topic were identified. Thus, the following question arose: what are the actions of nurses related to biofilm control and treatment in individuals with chronic wounds?

OBJECTIVES

The objective of this study was to map the actions of nurses related to biofilm control and treatment in individuals with chronic wounds.

METHODS

This is a scoping review following the Joanna Briggs Institute (JBI) guidelines[10], based on the *PRISMA-ScR* (*Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews*) Checklist[11], with its protocol registered in the Open Science Framework (https://doi.org/10.17605/OSF.IO/XB36S).

A search was conducted during April/May 2023 in the following sources: *Base de dados de Enfermagem* (BDENF), *Medical Literature Analysis and Retrievel System Online* (MEDLINE), *Literatura Latino-Americana e do Caribe em Ciências da Saúde* (LILACS) and *Excerpta Medica Database* (EMBASE). Google Scholar was used as a Gray Literature source, applying the eligibility criteria to all the publications retrieved. No restrictions were placed on language or time frame for the pre-selected studies.

The eligibility criteria for the studies were based on the PCC mnemonic (participants, concept, and context):

Participants: Studies involving individuals with chronic wounds (pressure injuries, venous/arterial/mixed ulcers due to diabetes, and infectious)[3], from any age, race/ethnicity, and location, in hospital or outpatient care settings. It should be noted that studies involving in vitro models and animals were excluded.

Concept: Biofilm in chronic wounds[5,6], excluding dental plaque, invasive devices, catheters, in vitro models, and other types of wounds.

Context: Publications addressing nursing actions in the care of people with wounds, including assessment and the use of techniques/products in any health care setting, as stipulated by COFEN 567/2018[7]. Publications by other professionals and/or those containing actions exclusive to other professionals were excluded.

Controlled terms from DeCS (Descriptors in Health Sciences) and MeSH (Medical Subject Headings) were used to guide the search strategies in the databases, as shown in Chart 1.

Chart 1. Mnemonic: Participants, Concept, Context/Descriptors/Synonyms and Free Term

	Descriptors (DeCS/MeSH)	Synonyms (tw, ti)	Free Term (tw, ti)
P	Ferimentos e Lesões/Wounds and Injuries/Heridas y Lesiones	Injury	Ferida crônica
C	Biofilmes/Biofilms/Biopelículas		
C	Enfermagem/Nursing/Enfermería Cuidados de enfermagem/Nursing Care/Atención de Enfermería Atenção à Saúde/Delivery of Health Care/Atención a la Salud	Outpatient Care/ Urgent Care	

Source: The authors.
PCC: participantes, conceito, contexto.

The search strategies were developed by a librarian, incorporating all descriptors/terms identified, along with Boolean operators (AND and OR), as shown in Chart 2.

Experimental and quasi-experimental studies, randomized/non-randomized trials, time-series studies, observational studies (cohort, case-control, cross-sectional), prospective and retrospective studies, case studies, qualitative studiesnarrative, integrative, and systematic reviews, as well as Gray Literature, including expert recommendations, were considered.

It is important to note that during the pre-selection process, while reading the titles and abstracts of the identified publications, some, although addressing the topic of "chronic wounds and biofilm", did not specify the professional category of the author(s). It was necessary to investigate whether the authorship included a Nursing professional.

After pre-selection, the studies identified in each database and in Google Scholar were collected and imported into EndNote Web (Clarivate Analytics, PA, USA) for duplicate removal. They were then exported to Rayyan software for title and abstract reading. The evaluation was blind, conducted by two reviewers following the established criteria.

For data extraction, the researchers developed an instrument, based on an adapted model[10], which included: author/year, title, journal, method and nurses' actions in controlling and treating biofilm, as shown in Chart 3[12-31]. The items included in the instrument were defined considering the review objective to ensure the standardized extraction of relevant information from the included studies. The development of the instrument enabled the adaptation of the extraction criteria to the specificities of the investigated topic, ensuring a comprehensive approach in synthesizing the data.

To avoid bias, a pilot test was conducted with the developed instrument before the start of the publication selection. This was performed using a random sample of titles/abstracts selected for eligibility criteria analysis, with the aim of discussing discrepancies and making modifications.

The evidence analysis was conducted according to the results found, and two tables were created: one with the characteristics of the included publications and the other with a description of the treatment and control actions, aimed at addressing the research question[10].

RESULTS

As described in the search and selection process outlined in Figure 1[12], 20 studies were included for full analysis, based on the established eligibility criteria. It is noteworthy that, although no time frame was set, the selected studies were published between 2006 and 2021. The year 2016 was the most prevalent, with a total of five publications[22,25,27,30,31]. There was a predominance of studies published in English, with 18 studies[13-20,23,24,26-32], 1 study in Portuguese[22] and 1 in Chines[21].

Most of the articles (n=12) were published in the United Kingdom[13,15,16,18,22,24-28], followed by publications from the United States[13,15,20,30], China[18,21], Brazil[22] and Japan[24]. This predominance may be related to the fact that journals such as the British Journal of Nursing and the Journal of Wound Care publish a significant number of articles on chronic wounds and biofilm, the central topic of this review. Among the methodological approaches and their respective levels of evidence, it is noteworthy that 9 out of the 20 studies are narrative reviews[14,16,18,21-23,28,29,31]

The main actions of the nurse mentioned were debridement techniques, cited in 10 studies, and the use of products for biofilm control, identified in 16 studies, as shown in Chart 4.

Chart 2. Research strategy.

Databases	Research strategy
LILACS and BDENF (via BVS)	(ferimentos e lesões OR wounds AND injuries OR heridas y lesiones OR "Ferida crônica") AND (biofilmes OR biofilms OR biopelículas OR Terapêutica) AND (atenção à saúde OR delivery of health care OR atención a la salud) OR (Cuidados de enfermagem OR Nursing Care OR Atención de Enfermería)
EMBASE	injury AND biofilm AND nursing
MEDLINE (via OVID)	MW ("wounds and injuries") AND MW biofilms OR MH (nursing care OR nursing interventions)
Google Scholar	"wounds and injuries" AND biofilms AND "nursing"

Source: The authors.

Chart 3. Characterization of the Selected Publications. Niterói (RJ), September, 2023.

Nº	Reference	Title	Journal	Method
1	Miller *et al.*[13]	Assessing bacterial burden in wounds: comparing clinical observation and wound swabs	International Wound Journal	Randomized controlled trial
2	Rajpaul[14]	Biofilm in wound care	British Journal of Community Nursing	Narrative review
3	Bradley and Cunningham[15]	Biofilms in chronic wounds and the potential role of negative pressure wound therapy: an integrative review.	Journal of Wound Ostomy & Continence Nursing	Integrative review
4	Percival and Cutting[16]	Biofilms: possible strategies for suppression in chronic wounds.	Nursing Standart	Narrative review
5	Chamanga *et al.*[17]	Chronic wound bed preparation using a cleansing solution.	British Journal of Nursing	Case study
6	Wei *et al.*[18]	Chronic wound biofilms: diagnosis and therapeutic strategies.	Chinese Medical Journal	Narrative review
7	Murphy *et al.*[19]	Defying hard-to-heal wounds with an early antibiofilm intervention strategy:'wound hygiene'.	Journal of Wound Care	Expert recommendation
8	Borges *et al.*[20]	Effect of Polyhexamethylene Biguanide Solution on Bacterial Load and Biofilm in Venous Leg Ulcers	Journal of Wound Ostomy & Continence Nursing	Randomized controlled trial
9	Zeng et al.[21]	Effects of bacterial biofilm on chronic wound healing and its treatment strategy	Chinese Journal of Tissue Engineering Research	Narrative review
10	Cruz *et al.*[22]	Feridas complexas e o biofilme: atualização de saberes e práticas para enfermagem	Revista Rede de Cuidados em Saúde	Narrative review
11	Azevedo *et al.*[23]	Hard-to-heal wounds, biofilm and wound healing: An intricate interrelationship	British Journal of Nursing	Narrative review
12	Koyanagi *et al.*[24]	Local wound management factors related to biofilm reduction in the pressure ulcer: A prospective observational study	Japan Journal of Nursing Science	Multicenter, prospective observational study
13	Torkington-Stokes *et al.*[25]	Management of diabetic foot ulcers: evaluation of case studies	British Journal of Nursing	Case study
14	Horrocks[26]	Prontosan wound irrigation and gel: management of chronic wounds	British Journal of Nursing	Case study
15	Bianchi *et al.*[27]	Recommendations for the management of biofilm: a consensus document	Journal of Wound Care	Expert recommendation
16	Newton *et al.*[28]	Role of slough and biofilm in delaying healing in chronic wounds	British Journal of Nursing	Narrative review
17	Percival and Suleman[29]	Slough and biofilm: removal of barriers to wound healing by desloughing	Journal of Wound Care	Narrative review
18	To *et al.*[30]	The effectiveness of topical polyhexamethylene biguanide (PHMB) agents for the treatment of chronic wounds: a systematic review	Surgical Technology International	Systematic review
19	Hurlow[31]	Understanding biofilm: what a community nurse should know	British Journal of Nursing	Narrative review
20	Barrett[32]	Wound-bed preparation: a vital step in the healing process	British Journal of Nursing	Case study

Source: The authors.

DISCUSSION

The assessment of the individual and the wound is an essential part of nursing care, as it determines decision-making and contributes to effective and safe care[17]. Although considered a fundamental aspect, the comprehensive assessment of the individual was not mentioned in the selected studies, which highlights a focus solely on the wound, without considering the clinical, emotional, and social aspects involved in the healing process.

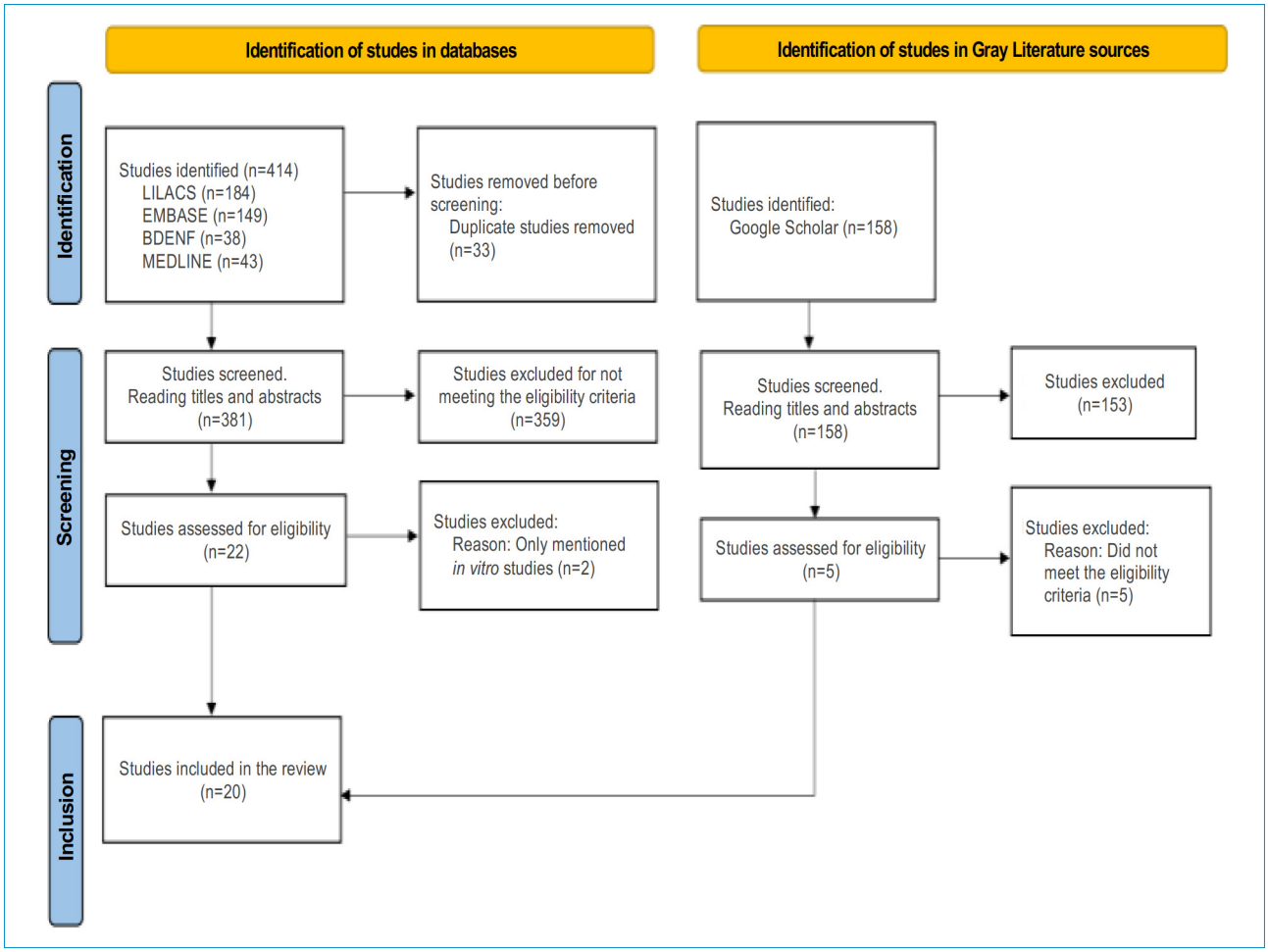

Figure 1. Flowchart showing the search and selection of studies according to the PRISMA 2020 model. Niterói (RJ), September 2023[12].

Among the goals of holistic care are: the identification of factors involved in infection development; the establishment of care goals and treatment options acceptable to the individual/caregiver; and the development of a prevention/management plan for infections, considering the preferences and care goals of the individual[33]. Thus, the nurse's clinical perspective on comorbidities, nutritional aspects, infections, medication use, and health education becomes necessary.[37].

The specific assessment of the wound was mentioned in three studies. In one of them, despite the authors citing the need for a holistic assessment, they do not present the aspects to be considered. However, they suggest the use of a clinical algorithm to assist in identifying the presence of biofilm in chronic wounds[14]. Regarding wound assessment, they highlight the identification of biofilm through biopsy[35].

Another method of wound assessment mentioned was the TIME framework: T (non-viable tissue), I (infection and/or inflammation), M (moisture imbalance) and E (epidermis)[17,22]. In 2018, two additional components were added: R (repair/regeneration) and S (social factors), forming the TIMERS framework[36].

An international consensus on wound infection, IWII-WIC (2022), provides a guide for the holistic assessment and management of the individual, their wound, and the physical environment. This includes: identification of infection based on signs and symptoms; recognition of clinical indicators of biofilm; selection of cleaning solution; debridement andpost-debridement care; and dressing choice[33].

Although the studies focus on techniques, diagnostic methods, and products, the importance of the nurse's holistic and empathetic care is highlighted, prioritizing the assessment of the individual and encompassing aspects such as knowledge, response to treatment, relationship with the wound, and willingness for self-care, among others[37].

Debridement was cited as the cited as the most effective treatment method for biofilm removal, with regular execution recommended for continuous disruption[28]. It reduces microbial load and inflammatory responses, stimulating granulation tissue[29].

Chart 4. Summary of Nursing Actions Related to Biofilm Control and Treatment in Individuals with Chronic Wounds. Niterói (RJ), September, 2023.

Nº	Nursing Actions in Biofilm Control and Treatment
1	A difference in healing was observed with the use of nanocrystalline silver compared to cadexomer iodine in the first 2 weeks, with no or low levels of leukocytes, gram-positive bacilli, gram-positive cocci, or gram-negative bacteria.
2	Presents a clinical algorithm for identifying biofilm. Suggests implementing procedures (wound bed preparation, debridement, cleaning with PHMB, and antimicrobial dressing).
3	Identifies the potential of negative pressure therapy combined with irrigation, reducing bacterial load.
4	Highlights debridement, cadexomer iodine, and ionic silver for biofilm suppression.
5	Refers to the need for wound assessment and the use of ***Octenilin*** (topical antimicrobial) to reduce the biological load.
6	Presents approaches such as debridement, negative pressure therapy, and ultrasound.
7	iscusses "Wound Hygiene" as a regular decontamination action, including cleaning, debridement, remodeling, and biofilm prevention, aiming to reduce bacterial load.
8	Results reveal no reduction in bacterial load after cleaning venous ulcers with PHMB solution compared to 0.9% saline, with biofilm remaining present.
9	Debridement, ultrasound, negative pressure therapy, and silver can prevent biofilm formation.
10	Presents methods for wound assessment and products: silver, PHMB, and iodine, as well as debridement.
11	Presents antimicrobial dressings that can reduce microbial load.
12	The proportion of biofilm after one week was lower with iodine ointment compared to no iodine ointment.
13	Suggests the use of Aquacel Ag+® as part of an effective protocol for healing ulcers resulting from diabetes.
14	7 out of 10 patients using PHMB showed improvement within 3 weeks, with reduced exudate.
15	Biofilm investigation is recommended for ulcers resulting from diabetes. It is recommended to perform instrumental/mechanical debridement, except in individuals with arterial insufficiency and ischemic wounds, along with the use of antimicrobial products/dressings and antiseptics.
16	Debridement and the use of silver dressings reduce the ability of bacteria to re-establish as biofilm.
17	Presents necrotic tissue and slough as environments for biofilm development. Debridement can significantly help.
18	Six studies were examined. In five of them, participants randomly assigned to use PHMB showed improvement in bacterial control compared to the control group, as well as pain reduction.
19	Debridement and the incorporation of anti-biofilm agents can increase efficacy when combined with antimicrobial treatment, supported by dressing changes
20	ActivHeal® PHMB foam was evaluated in 32 patients. In the end, 7 wounds had healed, and 14 required the use of other products. The foam maintained exudate levels while keeping a moist wound environment.

PHMB: Polyhexamethylene Biguanide.
Source: The authors.

Maintenance debridement makes the biofilm susceptible to external agents, serving as a continuous strategy to suppress microbial growth and biofilm renewal[14]. The accumulation of necrotic tissue favors bacterial colonization by *Staphylococcus aureus* e *P. aeruginosa*[28]. After mechanical debridement, a new biofilm forms within 24 hours, presenting a challenge for treatment[29]. Some pressure injuries, even after surgical debridement, showed the presence of biofilms, indicating variability in the effectiveness of biofilm removal[35].

Although one of the publications mentions surgical debridement[22], according to Technical Opinion No. 004/2013 COREN-RJ, surgical debridement "should be performed exclusively by surgeons, in a surgical setting, and under anesthesia"[38]. This is reinforced by COFEN Resolution 567/2018, which states that it is within nurses' scope of practice to perform autolytic, instrumental/conservative, enzymatic, and mechanical debridement[7]. The choice of technique should consider the clinical context and minimize discomfort[27], with special attention to the underlying pathophysiology and comorbidities, avoiding high-risk methods in favor of safer alternatives[29].

Although essential, wound cleaning was addressed in only four studies. Considered important for promoting healing, cleaning aims to remove devitalized tissue, debris, exudates, and bacteria. It is recommended to be a regular and continuous action[19]. To delay biofilm growth, the use of antiseptics combined with antimicrobial dressings stands out[19,27,31]. The lack of effective wound cleaning in the reviewed studies suggests a gap, as mechanical removal of debris is crucial for the effectiveness of antimicrobial treatments.

The use of antimicrobial agents is recommended for wounds showing signs of increased bacterial load, at risk of bacterial contamination, and in patients with compromised immune systems. Topical antimicrobial agents are the main treatment option for controlling bacterial levels, as they allow for a high concentration of substances at the infection site[32].

Among the recommended antiseptics, a topical antimicrobial solution containing octenidine dihydrochloride was applied to three patients with ulcers resulting from diabetes, leading to a reduction in the wound and bacterial load. Despite the results, it is crucial to note the small number of participants and the interference of the simultaneous use of antimicrobial dressings[17].

Polyhexamethylene biguanide (PHMB) was the primary product mentioned for biofilm control. Although it aids in controlling biofilms *P. aeruginosa* and methicillin-resistant *Staphylococcus aureus* (MRSA), it does not completely prevent its formation or eradication. When compared to the effectiveness of chlorhexidine, it was found to be equally effective, without causing cellular toxicity and demonstrating good tissue tolerance[22].

A randomized clinical trial showed that the use of PHMB in venous ulcers did not result in a significant reduction in bacterial load when compared to a 0.9% saline solution[18]. On the other hand, a systematic review showed that only 5.3% of individuals with ulcers on the leg and foot treated with PHMB foam had polymicrobial organisms, in contrast with 33% of ulcers treated with foam dressings without PHMB[30].

It was demonstrated that PHMB foam substantially eliminated the presence of MRSA in pressure injuries. In four articles included in the review, PHMB was shown to relieve pain more effectively than the products used in the control group, a finding that can be attributed to the reduction in bacterial load, as pain can be a specific indicator of infection, with 100% specificity[31].

In a case study, 10 patients underwent wound cleaning with PHMB solution and PHMB gel. Seven of them showed improvement within 3 weeks, with biofilm elimination, reduced exudate, smaller wound dimensions, and elimination of odor[26].

PHMB foam was tested on 32 patients: 7 wounds healed, 14 showed significant improvement but required alternative treatment, and 11 continued using the PHMB foam. There was no increase in wound size, and all patients reported significant reductions in pain and exudate[32].

Despite the recognized action of PHMB in reducing/eliminating biofilms of *S. aureus* and *P. aeruginosa* species, there is no consensus on the most appropriate formulation, given the variety of presentations, concentrations, and therapeutic approaches[39].

The use of silver-based products was identified in the studies. A randomized trial compared the action of nanocrystalline silver and cadexomer iodine in 281 patients with venous/mixed ulcers, colonized/ infected. These patients were randomly assigned to receive dressings for one week. The wounds were evaluated using the swab smear technique for culture samples. Silver demonstrated better healing rates, shown by low bacterial growth, except for gram-negative bacilli[13].

UA case study used silver hydrofiber (Aquacel Ag+®) in individuals with ulcers caused by diabetes, suspected of infection and/or biofilm, with complete healing observed in two of the four lesions and improvement in the remaining two[25].

Ionic silver (Ag+) acts as a topical bactericidal, fungicidal, virucidal, and protozoicidal agent, capable of eradicating both planktonic bacteria and biofilm[28]. However, there is evidence that its repeated use may increase silver concentration in internal organs, raising concerns about potential metal poisoning[21].

Additionally, there are theoretical concerns about the possibility of silver resistance leading to cross-resistance to antibiotics. However, the low incidence of silver resistance in current clinical practice makes it unlikely that the use of silver dressings will increase this resistance[40].

The performance of iodine as a topical antimicrobial is well-known against biofilms formed by *Sthaphylococcus Aureus* and *Pseudomonas aeruginosa*[22].

A multicenter, prospective study instituted six topical treatments in 34 patients with pressure injuries. The results showed a relationship between iodine ointment and the reduction of biofilm and injury within one week. Despite these results, no causal relationship was found between the use of iodine and the reduction of biofilm[24].

Iodine cadexomer showed less irritation/allergy due to slow release as exudate is absorbed. Furthermore, iodine in the formula known as polyvinylpyrrolidone (PVPI) has dose-dependent cytotoxicity[41]. Despite this, there is ongoing

debate about the use of iodine concerning its antimicrobial potential, chemical stability, adequate concentration, and cytotoxicity potential.[22].

Among the physical methods, Negative Pressure Wound Therapy (NPWT) was elucidated. The viscoelastic characteristics of biofilms allow them to survive in areas with high shear forces, necessitating repeated breaking of fibers to remove them. Thus, it is important to investigate the potential of NPWT in interrupting biofilm formation[15].

One study involved 12 hospitalized patients with chronic leg ulcers (average 6 years of progression) who were treated with NPWT and/or conventional saline solution cleaning. The wounds were divided, with half being treated with one of the mentioned methods, so that the participant themselves acted as the control. Wounds treated with NPWT and simultaneous irrigation showed significant improvement in granulation tissue formation[15].

However, it is known that improper use of NPWT can increase bacterial proliferation. Despite the significant reduction in the proliferation of aerobic bacteria, its use is not advisable in the presence of anaerobic bacteria, as negative pressure and low oxygen concentration may promote the growth of these bacteria[21]. Despite the use of NPWT with irrigation reducing bacterial load and preventing biofilm formation, the lack of prospective and controlled clinical studies stands out, as they are needed to provide evidence of its effectiveness[15].

Another physical method mentioned was the application of high-intensity focused ultrasound, with specific parameters, which can eliminate *P. aeruginosa* and damage the biofilm structure[18]. Pulsed ultrasound with lower intensity and frequency ultrasonic waves can enhance the bactericidal efficiency of antibiotics, and a 6-hour ultrasound treatment can eradicate a biofilm[21].

The effect of ultrasound as a physical method for biofilm removal requires further research, considering factors such as bacterial sensitivity to ultrasound, types of antibiotics, intensity, frequency, and duration of ultrasound[21].

Given the findings, it is essential that care guidelines emphasize the importance of an individualized therapeutic plan, considering not only the application of the identified techniques but also the nurse's role in the thorough assessment of the individual, including clinical, emotional, and social aspects, and, later, of the wound.

In this context, future studies should explore the impact of structured clinical assessment on biofilm control to provide support for more effective and scientifically grounded Nursing practice.

Study limitations

One of the study limitations was the absence of professional category records for some authors during the pre-selection process of the studies.

Recommendations

The compilation of available studies on this topic can significantly contribute to nursing practice in the care of individuals with chronic wounds and biofilm. However, there are still important gaps in the literature that need to be explored. Future studies should investigate, through clinical trials and longitudinal studies, the impact of structured clinical assessment on biofilm control, evaluating its effectiveness in reducing microbial load and improving healing. Additionally, systematic reviews could synthesize the best available evidence to guide evidence-based care protocols.

CONCLUSION

In line with the research objective, nursing actions in biofilm control and treatment were mapped. A prevalence of publications in 2016 was identified, mainly from the United Kingdom, with narrative reviews as the primary method.

Among the nursing actions, a predominance of debridement techniques and the use of various antimicrobial products, such as PHMB, silver, and iodine, was observed, as well as physical methods, including negative pressure therapy and ultrasound.

By mapping these actions, it is concluded that biofilm treatment and control in chronic wounds by nurses still represent a challenge, given the gaps in knowledge. These gaps highlight the need for the development of research with robust scientific evidence to demonstrate the efficacy of the actions, promote healing, and consequently improve the patient's quality of life.

In this regard, a broader approach is suggested, one that goes beyond the exclusive focus on the wound and includes a comprehensive assessment of the individual, covering clinical, emotional, and social aspects.

Acknowledgments: It does not apply.
Authors' Contributions: GCN: Project management, conceptualization, data curation, writing – first draft, supervision, visualization. ESB: Formal analysis, writing – first draft, supervision, visualization.
Availability of Research Data: All data were generated or analyzed in this study.
Funding: Not applicable.
Conflict of interest: None.

REFERENCES

1. Dantas JS, Silva ACO, Augusto FS, Agra G, Oliveira JS, Ferreira LM, Sawada NO, Freire MEM. Qualidade de vida relacionada à saúde de pessoas com feridas crônicas e fatores associados. Texto & Contexto Enferm. 2022;31:e20220010. https://doi.org/10.1590/1980-265X-TCE-2022-0010pt
2. SOBEST. Associação Brasileira de Estomaterapia. Feridas [Internet]. 2023 [cited on Mar 30, 2022]. Available from: https://sobest.com.br/feridas/
3. Gamba MA, Oliveira LS. Um olhar sobre os impactos causados pelas feridas cutâneas. Feridas. 2021;9(49):1745. https://doi.org/10.36489/feridas.2021v9i49p1745
4. Mihai MM, Preda M, Lungu I, Gestal MC, Popa MI, Holban AM. Nanocoatings for chronic wound repair: modulation of microbial colonization and biofilm formation. Int J Mol Sci. 2018 Apr;19(4):1179. https://doi.org/10.3390/ijms19041179
5. Rama D, Fonseca B, Blanck M. 1a Recomendação brasileira para o gerenciamento de biofilme em feridas crônicas e complexas [Internet]. 2018 [cited on Apr 20, 2023]. Available from: https://comum.rcaap.pt/entities/publication/9ddd697b-bbcb-4b00-954d-f57c32eea238
6. Omar A, Wright JB, Schultz G, Burrell R, Nadworny P. Microbial biofilms and chronic wounds. Microorganisms. 2017 Mar;5(1):9. https://doi.org/10.3390/microorganisms5010009
7. Conselho Federal de Enfermagem. Resolução COFEN nº 567/2018 Regulamenta a atuação da Equipe de Enfermagem no Cuidado nos pacientes com feridas [Internet]. Brasília: Cofen; 2018 [cited on May 10, 2023]. Available from: https://www.cofen.gov.br/resolucao-cofenno-567-2018/
8. Silva SAO, Martins FS, Silva AS, Ghelen MH, Diaz CMG, Martins ESR. O enfermeiro no diagnóstico e tratamento de biofilme em feridas. Disciplinarum Scientia. 2018;19(2):281-90. https://doi.org/10.37777/2512
9. Coimbra TL, Pompeo CM, Souza MC, Penha RM. Biofilme em feridas: conhecimento do enfermeiro na avaliação e tratamento. Res Soc Dev. 2021 Oct;10(13):e232101321223. https://doi.org/10.33448/rsd-v10i13.21223
10. Peters MDJ, Godfrey C, McInerney P, Munn Z, Tricco AC, Khalil, H. Scoping Reviews. In: Aromataris E, Lockwood C, Porritt K, Pilla B, Jordan Z. JBI Manual for Evidence Synthesis. JBI; 2024. https://doi.org/10.46658/JBIMES-24-09
11. Tricco, AC, Lillie, E, Zarin, W, O'Brien, KK, Colquhoun, H, Levac, D, Moher, D, Peters, MD, Horsley, T, Weeks, L, Hempel, S, Akl EA, Chang C, McGowan J, Stewart L, Hartling L, Aldcroft A, Wilson MG, Garritty C, Lewin S, Godfrey CM, Macdonald MT, Langlois EV, Soares-Weiser K, Moriarty J, Clifford T, Tunçalp O, Straus SE. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. Ann Intern Med. 2018 Oct;169(7):467-73. https://doi.org/10.7326/M18-0850
12. PRISMA Statement. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases, registers and other sources [Internet]. PRISMA; 2020 [cited Aug 15, 2023]. Available from: https://www.prisma-statement.org/prisma-2020-flow-diagram
13. Miller CN, Carville K, Newall N, Kapp S, Lewin G, Karimi L, Santamaria N. Assessing bacterial burden in wounds: comparing clinical observation and wound swabs. Int Wound J. 2010 Nov;8(1):45-55. https://doi.org/10.1111/j.1742-481X.2010.00747.x

14. Rajpaul K. Biofilm in wound care. Br J Community Nurs. 2015 Mar; (Suppl Wound Care):S6,S8,S10-1. https://doi.org/10.12968/bjcn.2015.20.Sup3.S6

15. Bradley BH, Cunningham M. Biofilms in chronic wounds and the potential role of negative pressure wound therapy: an integrative review. J Wound Ostomy Continence Nurs. 2013 Mar-Apr;40(2):143-9. https://doi.org/10.1097/WON.0b013e31827e8481

16. Percival SL, Cutting KF. Biofilms: possible strategies for suppression in chronic wounds. Nurs Stand. 2009 Apr;23(32):64, 66, 68 passim. https://doi.org/10.7748/ns2009.04.23.32.64.c7152

17. Chamanga ET, Hughes M, Hilston K, Sparke A, Jandrisits JM. Chronic wound bed preparation using a cleansing solution. Br J Nurs. 2015;24(12):S30, S32-6. https://doi.org/10.12968/bjon.2015.24.Sup12.S30

18. Wei D, Zhu XM, Chen YY, Li XY, Chen YP, Liu HY, Zhang M. Chronic wound biofilms: diagnosis and therapeutic strategies. Chin Med J (Engl). 2019 Nov;132(22):2737-44. https://doi.org/10.1097/CM9.0000000000000523

19. Murphy C, Atkin L, Swanson T, Tachi M, Tan YK, Ceniga MV, Weir D, Wolcott R, Ĉernohorská J, Ciprandi G, Dissemond J, James GA, Hurlow J, MartÍnez JLL, Mrozikiewicz-Rakowska B, Wilson P. Defying hard-to-heal wounds with an early antibiofilm intervention strategy: wound hygiene. J Wound Care. 2020 Mar;29(Sup3b):S1-S26. https://doi.org/10.12968/jowc.2020.29.Sup3b.S1

20. Borges EL, Frison SS, Honorato-Sampaio K, Guedes ACM, Lima VLDAN, Oliveira OMM, Ferraz AF, Tyrone AC. Effect of polyhexamethylene biguanide solution on bacterial load and biofilm in venous leg ulcers: a randomized controlled trial. J Wound Ostomy Continence Nurs. 2018 Sep/Oct;45(5):425-31. https://doi.org/10.1097/WON.0000000000000455

21. Zeng YN, Huang J, Qiu TY. Effects of bacterial biofilm on chronic wound healing and its treatment strategy. Chinese Journal of Tissue Engineering Research. 2014;18(24):3925-30. https://doi.org/10.3969/j.issn.2095-4344.2014.24.025

22. Cruz RAO, Acioly CMC, Nóbrega VKM, Oliveira PS. Feridas complexas e o biofilme: atualização de saberes e práticas para enfermagem. Rev Rede Cuid Saúde. 2016;10(3):1-11.

23. Azevedo MM, Lisboa C, Cobrado L, Pina-Vaz C, Rodrigues A. Hard-to-heal wounds, biofilm and wound healing: an intricate interrelationship. Br J Nurs. 2020;29(5):S6-S13. https://doi.org/10.12968/bjon.2020.29.5.S6

24. Koyanagi H, Kitamura A, Nakagami G, Kashiwabara K, Sanada H, Sugama J. Local wound management factors related to biofilm reduction in the pressure ulcer: a prospective observational study. Jpn J Nurs Sci. 2021 Apr;18(2):e12394. https://doi.org/10.1111/jjns.12394

25. Torkington-Stokes R, Metcalf D, Bowler P. Management of diabetic foot ulcers: evaluation of case studies. Br J Nurs. 2016;25(15 Suppl):S27-33. https://doi.org/10.12968/bjon.2016.25.15.S27

26. Horrocks A. Prontosan wound irrigation and gel: management of chronic wounds. Br J Nur. 2006;15(22):1222, 1224-8. https://doi.org/10.12968/bjon.2006.15.22.22559

27. Bianchi T, Wolcott RD, Peghetti A, Leaper D, Cutting K, Polignano R, Rosa Rita Z, Moscatelli A, Greco A, Romanelli M, Pancani S, Bellingeri A, Ruggeri V, Postacchini L, Tedesco S, Manfredi L, Camerlingo M, Rowan S, Gabrielli A, Pomponio G. Recommendations for the management of biofilm: a consensus document. J Wound Care. 2016 Jun;25(6):305-17. https://doi.org/10.12968/jowc.2016.25.6.305

28. Newton H, Edwards J, Mitchell L, Percival SL. Role of slough and biofilm in delaying healing in chronic wounds. Br J Nurs. 2017 Nov;26(Sup20a):S4-S11. https://doi.org/10.12968/bjon.2017.26.Sup20a.S4

29. Percival SL, Suleman L. Slough and biofilm: removal of barriers to wound healing by desloughing. J Wound Care. 2015 Nov;24(11):498, 500-3, 506-10. https://doi.org/10.12968/jowc.2015.24.11.498

30. To E, Dyck R, Gerber S, Kadavil S, Woo KY. The effectiveness of topical polyhexamethylene biguanide (PHMB) agents for the treatment of chronic wounds: a systematic review. Surg Technol Int. 2016 Oct;29:45-51. PMID: 27608742.

31. Hurlow J. Understanding biofilm: what a community nurse should know. Br J Community Nurs. 2016 Sep;21 Suppl 9:S26-33. https://doi.org/10.12968/bjcn.2016.21.Sup9.S26

32. Barret S. Wound-bed preparation: a vital step in the healing process. Br J Nurs. 2017;26(12 Suppl):S24-S31. https://doi.org/10.12968/bjon.2017.26.12.S24

33. Swanson T, Ousey K, Haesler E, Bjarnsholt T, Carville K, Idensohn P, Kalan L, Keast DH, Larsen D, Percival S, Schultz G, Sussman G, Waters N, Weir D. IWII Wound Infection in Clinical Practice consensus document: 2022 update. J. Wound Care. 2022 Dec;31(-Sup12):S10-S21. https://doi.org/10.12968/jowc.2022.31.Sup12.S10

34. Silva PC, Silva DM, Macedo TLS, Macedo TLS, Luna BMG. The nurse's performance in the treatment of wounds. Brazilian Journal of Health Review. 2021 Mar/Apr;4(2):4815-22.

35. Nakagami G, Schultz G, Kitamura A, Minematsu T, Akamata K, Suga H, Kurita M, Hayashi C, Sanada H. Rapid detection of biofilm by wound blotting following sharp debridement of chronic pressure ulcers predicts wound healing: a preliminary study. Int Wound J. 2020 Feb;17(1):191-6. https://doi.org/10.1111/iwj.13256

36. Atkin L, Bućko Z, Montero EC, Cutting K, Moffatt C, Probst A, Romanelli M, Schultz GS, Tettelbach W. Implementing TIMERS: the race against hard-to-heal wounds. J Wound Care. 2019 Mar;28 (Sup3a):S1-S50. https://doi.org/10.12968/jowc.2019.28.Sup3a.S1

37. Soares MF, Brandão ES, Queluci GC, Braga ALS, Aguiar JS. Nursing diagnoses in patients with cutaneous affections. J Nurs UFPE on line. 2019;13:e240874. https://doi.org/10.5205/1981-8963.2019.240874

38. Conselho Regional de Enfermagem do Estado do Rio de Janeiro. Parecer CTGAE nº 004/2013 Desbridamento de feridas pelo enfermeiro [Internet]. Rio de Janeiro: COREN-RJ; 2013 [citado em 08 set. 2023]. Disponível em: https://www.coren-rj.org.br/wp-content/uploads/2015/02/PARECER-CTGAE-004-2013.compressed.pdf

39. Santos IMR. Avaliação da atividade antimicrobiana, citotóxica, antibiofilme e de cicatrização do polihexametileno biguanida (PHMB) em feridas complexas [Trabalho de Conclusão de Curso]. Maceió: Universidade Federal de Alagoas, Escola de Enfermagem; 2021.

40. Percival SL, Salisbury AM, Chen R. Silver, biofilms and wounds: resistance revisited. Crit Rev Microbiol. 2019 Mar;45(2):223-37. https://doi.org/10.1080/1040841X.2019.1573803

41. Rosa PAC. Efeitos do iodo Cadexomer [Trabalho de Conclusão de Curso]. Porto Alegre: Universidade Federal do Rio Grande do Sul, Escola de Enfermagem; 2016.