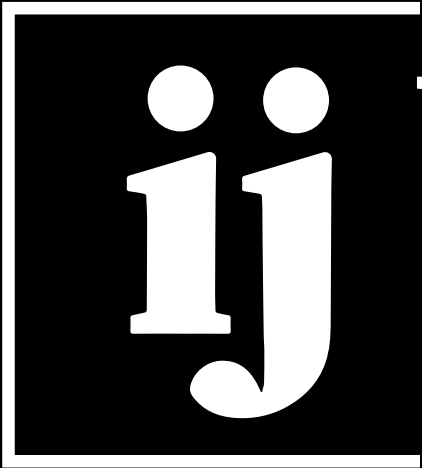




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Wound Research

International Journal of Wound Research / June 2025 / Volume 1 Issue 1



The Future of Wound Care is Accessible and Circular



Manifesto

International Journal of Wound Research (IJWR) is an international peer-reviewed scientific journal that promotes the development and exchange of knowledge in wound care research and clinical practice. IJWR supports evidence-based interventions and encourages critical reflection on the science and innovation of wound management.

The journal particularly welcomes studies that evaluate complex wound care strategies and health policies, using rigorous research designs appropriate to clinical and interdisciplinary inquiry. IJWR also aims to strengthen research quality by publishing methodological papers on clinical tools, treatment protocols, and investigative techniques. The journal publishes original peer-reviewed articles of interest to the global wound care community.

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PIXARTPRINTING SPA
 Quarto d'Altino, Italy

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Publisher

iEditore
 Via Gorizia, 1A, Trani (BT),
 76125, Italy
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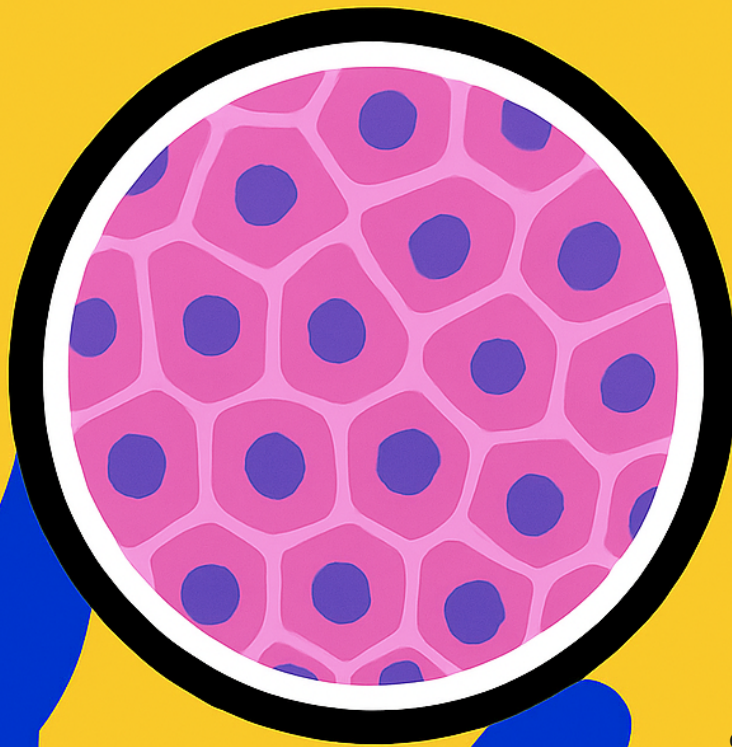
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**Omega-3 Fatty Acids and Wound
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Chronic Ulcers**

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The Epidermis Under the



Beyond a Physical Barrier

Once seen as a passive boundary, the epidermis is now recognized as an active immunological interface, constantly sensing and responding to environmental and microbial stimuli. Far from a mere physical barrier, it interacts with both innate and adaptive immune systems.

Basal keratinocytes, beyond their regenerative role, actively participate in immune surveillance through pattern recognition receptors (PRRs), such as TLRs and NOD-like receptors, which detect microbial and danger signals ¹. Upon stimulation, they produce pro-inflammatory cytokines - including IL-1 β , IL-33, and type I interferons - contributing to local and systemic immune responses ^{1,2}.

Single-cell transcriptomic analyses have revealed distinct keratinocyte states that regulate the secretion of cytokines, β -defensins, and alarmins, adapting to spatial and environmental cues ². These mediators influence Langerhans cells and dermal dendritic cells, and help maintain tolerance toward commensal microbes ^{1,3}.

Together, these findings redefine the epidermis as a central immuno-epithelial hub, orchestrating immune activation, barrier integrity, and tissue homeostasis.

Microscope: New Insights

Key Scientific Highlights

Functional Heterogeneity of Epidermal Stem Cells

Recent advances in lineage-tracing and single-cell transcriptomics have revealed that the basal layer of the human epidermis contains functionally diverse populations of stem and progenitor cells. These subsets exhibit unique proliferative kinetics and differential capacities for long-term maintenance, lineage commitment, and regenerative response following injury ⁴. In contrast to earlier binary models of epidermal renewal, current evidence supports a hierarchical and spatially distributed organization, where lineage priming and differentiation occur progressively, rather than as abrupt switches ⁵. This heterogeneity is crucial for maintaining epidermal architecture and ensuring tissue adaptability to physiological and pathological demands.

Environmentally Responsive Epidermal Turnover

The complete renewal of the human epidermis typically occurs over a period of 40 to 56 days, but recent studies have shown that this process is highly plastic. Factors such as ultraviolet radiation, microbial exposure, and mechanical injury can modulate the turnover rate by altering basal cell cycle dynamics and stem cell activation thresholds ⁶. Environmental stressors lead to compensatory hyperproliferation, primarily mediated through cytokine signaling and epithelial stress pathways (e.g., TNF- α , IL-6). These adaptive mechanisms allow the epidermis to rapidly restore barrier function and prevent pathogen entry following acute damage.

Langerhans Cells and Microbiome-Immune Regulation

Langerhans cells (LCs), long viewed as passive antigen-presenting cells, are now understood to exert active immunoregulatory functions within the epidermis. In steady-state conditions, LCs contribute to immune tolerance toward commensal organisms and limit unnecessary inflammatory responses through TGF- β signaling and regulatory T cell induction ⁷. During epithelial disruption or microbial invasion, they switch to a defensive mode, producing pro-inflammatory cytokines and facilitating microbial clearance and tissue repair ⁸. This dual functionality is essential to maintaining the delicate balance between tolerance and defense that characterizes skin immune homeostasis.

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Healing Through Research: The Future of Wound Care Is Accessible and Circular

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Citation: Nicolosi B. "Healing Through Research: The Future of Wound Care Is Accessible and Circular" (2025) *International Journal of Wound Research* 1(1): 1-4. DOI: 10.64115/ijwr-2025-1

The prevalence of chronic wounds among Medicare beneficiaries increased from 14.5% in 2014 to 16.4% in 2019, corresponding to a relative increase of approximately 13% and an absolute increase of 1.9 percentage points.¹ This increase was particularly pronounced among patients under 65 with disabilities, highlighting a worrying trend that may be linked to factors such as population aging, the growing incidence of chronic conditions such as diabetes and obesity, and improved diagnostic techniques that allow more cases to be identified.¹ During this same period, while the number of patients with chronic wounds increased, total treatment costs decreased, dropping from \$29.7 billion to \$22.5 billion according to the most conservative calculation method.¹

This data suggests a shift in care management, with a progressive transfer of care from hospitals to medical offices and outpatient services. In fact, while spending on hospital outpatient departments drastically decreased from \$10.5 billion to \$2.5 billion, home care costs declined from \$1.6 billion to \$1.1 billion. At the same time, spending on medical office visits increased from \$3.0 billion to \$4.1 billion, indicating a growing emphasis on managing wounds in less expensive and more accessible settings for patients.¹

However, not all costs have decreased: spending on venous ulcers has risen from \$1,206 to \$1,803 per patient, and the costs for durable medical equipment have doubled, suggesting an increased use of advanced dressings and home wound management devices. The causes of this redistribution of healthcare spending

can be attributed to several factors, including the introduction of value-based reimbursement systems, improved efficiency in outpatient wound management, and a possible reduction in access to more expensive hospital-based treatments.¹

This scenario highlights the need to closely monitor the evolution of the wound care sector to understand whether these changes have effectively improved patient outcomes or, conversely, have led to limitations in access to quality care. The progressive increase in the prevalence of chronic wounds, especially among younger and more vulnerable individuals, necessitates reflection on prevention strategies and the sustainability of care models, considering that the number of patients with these conditions will likely continue to rise in the coming years.¹

These changes in the wound care landscape not only reflect the evolution of clinical management and spending models but also raise fundamental questions about the role of scientific research in supporting these processes. Improving care does not solely depend on optimizing economic resources but requires an increasingly in-depth and shared knowledge of the most effective and sustainable therapeutic strategies. However, for wound care innovation to translate into tangible benefits for patients, the fragmented and complex accessibility of scientific knowledge must be addressed.²

Wound care research is facing a paradox: while technological innovations are advancing rapidly, the dissemination of knowledge remains limited

by academic and economic barriers.² Despite scientific and technological progress, significant barriers persist in the dissemination of knowledge and collaboration among professionals in the field. The sharing of evidence and clinical experiences is often hindered by academic, economic, and geographic constraints, limiting access to innovative solutions adaptable to different contexts.² This fragmentation not only slows scientific progress but also hinders the spread of effective practices that could improve the quality of care. To address this challenge, a paradigm shift in wound care research is necessary: an approach that goes beyond the traditional hierarchy of evidence and embraces a circular model, more inclusive and adherent to clinical reality.²

Traditionally, scientific research has been based on a hierarchy of evidence, with randomized controlled trials (RCTs) at the top, while clinical experiences and observational studies are considered secondary.³ However, this model presents significant limitations, especially in wound care, where patients, care settings, and available resources are highly heterogeneous.³

The concept of circular research proposes a more flexible and representative alternative to the complexity of clinical practice. Instead of a pyramidal approach, the circular model values all forms of knowledge—from RCTs to observational studies, from case studies to data collected in daily practice—integrating them to provide a more realistic and effective picture of wound management.³

Adopting a circular vision means recognizing that clinical experience, supported by biology and scientific plausibility, is just as valid as the most rigorous experimental evidence.³ This approach promotes a more balanced integration of knowledge and allows for the development of treatment strategies that are truly applicable and scalable in different contexts.³ One of the main obstacles to disseminating best practices in wound care is the difficulty of translating scientific evidence into protocols adaptable to everyday clinical practice.¹

Wound management is a multidisciplinary challenge that involves physicians, nurses, physiotherapists, and other healthcare specialists, each operating in contexts with different resources and infrastructure.⁴ Many studies focus on highly technological environments, overlooking settings where access to advanced devices is limited.⁴

However, it is precisely from these contexts that innovative and sustainable solutions often emerge, which could be applied on a larger scale if adequately shared.⁴ For this reason, the recognition of clinical experiences and case studies is essential: documenting and disseminating effective strategies, in all environments, even with limited resources, helps improve the quality of care worldwide. Inclusion in research also means making access to knowledge fair and transparent.^{3,4} Advanced research is often confined to paywalled publications or adopted only in elite healthcare settings, leaving behind a significant portion of the medical community and patients.⁴ Digitalization and big data collection can offer unprecedented opportunities to personalize treatments and predict patient responses.⁴ However, for these technologies to be truly effective, they must be shared transparently and be accessible on a global scale.⁴ The adoption of open-access platforms for sharing clinical evidence and research data is a key strategy to democratize knowledge access and improve wound care quality.²

Wound care research requires a collaborative ecosystem that transcends geographic and academic barriers, allowing professionals to share experiences, learn from one another, and develop more effective care strategies. Leadership in wound care cannot be isolated: it must be supported by collaborative networks that enable professionals to improve their skills through continuous exchange.^{3,5}

A multidisciplinary approach to research is crucial. Wound care is not just about medical techniques: factors such as pain management, nutrition, psychological support, and complication prevention play an equally significant role.^{2,5} The future of wound care cannot overlook participatory medicine: the patient must not be a passive subject of research but a true co-creator of scientific knowledge. Incorporating patient experiences in evaluating treatments is essential to develop strategies that align more closely with their real needs.⁵

Active patient involvement in research is essential; their experience must be an integral part of the care evaluation process, contributing to the definition of guidelines that better reflect the actual needs of those managing a wound daily.¹ The inclusion of Patient-Reported Outcome Measures (PROMs) allows for the assessment of treatments not only from a clinical

perspective but also in terms of their impact on quality of life.^{4,6}

From these needs arises the *International Journal of Wound Research (IJWR)*, which I like to define as a platform designed to overcome barriers to knowledge sharing in wound care. IJWR is not limited to publishing academic research but aims to be a global collaboration space where professionals from different disciplines and settings can engage, share experiences, and contribute to the collective growth of the field. The goal is to promote a research approach that is circular, open, and based on a balanced integration of all forms of evidence. The platform welcomes contributions ranging from clinical trials to case reports, comparative analyses to field experiences, while also providing space for more general information, recognizing the value of every form of knowledge in improving care.

As in any scientific field, the evolution of wound care depends on our ability to build a global network of collaboration, where every contribution, regardless of its origin, can be valued and made available to the entire scientific community.⁵ Only through a shared commitment can we ensure that every patient receives the best possible treatment, wherever they are in the world.

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What Kind of Difference Do We Want to Make in Burns?

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Citation: Stiles K. "What kind of difference do we want to make in burns?" (2025) *International Journal of Wound Research* 1(1): 7-10. DOI: 10.64115/ijwr-2025-8

Most of us will have a personal experience of having a minor burn and will have gained some appreciation of how painful, emotive, and all-consuming burns can be for the person affected. As healthcare professionals, we may regularly encounter minor burns in our practice and will recognise that they are rarely "minor" to our patients and the families involved. Those of us who have cared for patients with severe burns will rarely forget them and will have imprinted those experiences in our memories, carrying them with us for the rest of our working lives.¹

Often described as "low incidence, high cost" injuries, burns are some of the most devastating forms of trauma a human body may endure. Globally, burns are responsible for over 8 million injuries and approximately 180,000 deaths annually.^{2,3} The burden of disease falls disproportionately on the low- and middle-income countries, where inequity in access to care, treatment and resources is responsible for increased morbidity and mortality after burns.^{2,4} It is no surprise that the populations most at risk of burn injuries are the most vulnerable members of our communities - older adults, individuals with reduced mobility, sensory impairment, reduced mental capacity and individuals who are neurodivergent.⁵ What is disheartening though is that burn incidence remains consistently at its highest in the under-5 age group demographic worldwide. In the UK, majority of paediatric burns are in babies and toddlers under 2 years old, with almost half of all burn service admissions represented by children under 5.⁵⁻⁷

Global burn injury data shows us that burns are close to home. While adults are most likely

to sustain their burns during work related activities, burn injuries in children largely happen in a home environment, often with the adult caregiver present.⁶ Considering that young children do not make hot drinks, cook, or use heated domestic appliances, it is striking that hot drink scalds and contact with heated surfaces are the dominant mechanisms of injury in children.⁶ Modern trends in our lifestyle, new migration patterns and the socioeconomic impact of the cost-of-living crisis have also introduced some novel and challenging burn injury aetiologies into our clinical practice, such as burns due to lithium-ion battery fires, hot water bottle scalds, chemical-type burns as a result of prolonged skin contact with seawater and fuel, treadmill and vacuum cleaner related friction injuries, button battery ingestions, and burns associated with social media challenges.^{2,7,8}

Burns are complex and multifactorial injuries. Contained within a single term are multiple mechanisms of injury: flash or flame burn, hot liquid scald, contact with hot surfaces, injury by steam, hot air, chemical, electricity, radiation, cold, or friction - each requiring a tailored treatment pathway.¹⁻³

Burns destroy layers of skin, irreparably impairing some (or all) of the functions of the largest organ in the human body - its ability to protect from infection, to retain moisture, to feel touch, temperature, pain, or itch, to regulate temperature, to reduce harmful effects of UV radiation, and to produce Vitamin D. The depth of burn injury will dictate how many of the skin's functions will recover and whether the essential skin appendages, like hair growth, sweat secretion, and oil production, will continue to

function after healing. Burns in children and older adults are likely to be significantly deeper as a child's skin is thinner due to an underdeveloped dermis, whereas ageing skin starts to thin as the dermal layer shrinks with age. This lack of robust dermal thickness puts young children and older adults at a higher risk of deeper burns with lower temperatures and shorter exposure times.^{7,9}

Burn injuries can also be responsible for morbidity far beyond the skin: smoke inhalation burns can impair breathing, ventilation and lung function; large surface area burns may result in Multiple Organ Dysfunction Syndrome contributing to higher mortality and morbidity in critically ill patients; electrical burns may cause deep tissue necrosis, internal organ damage, fractures, neurological deficits, or lead to an amputation; and chemical injuries may cause systemic toxicity, and progressive and irreversible cell damage.^{2,3,8,9}

In order to heal and recover their injuries, burn survivors may require numerous debridements, skin grafting procedures, frequent painful dressing changes and rehabilitation therapy over many weeks, months, and sometimes years. Burns that take longer than 10-21 days to heal are more likely to result in a scar.^{9,10} For many burn survivors, the excitement at the completion of the wound healing process is short-lived when they realise that the outcome of their wound repair is fibrous tissue that has replaced their normal skin, which doesn't look, feel or function like their skin did before injury.⁹

Scarring may be the result of a skin graft, a donor site, or a burn wound healing by secondary intention, and takes around 18-24 months to mature. Scar symptoms, such as neuropathic scar tissue pain, pruritis, thickening, lack of pliability, redness, pigment changes, uneven scar texture, and contractures can significantly affect burn survivors' quality of life and will usually require long term treatment by specialist burn therapists and surgeons. Scars can lead to physical impairments, affecting strength, function, and range of movement. As an acquired visible difference, scars can also attract unwanted social attention and stigmatisation causing the survivors emotional distress, social anxiety, concerns about body image and mental ill-health.⁹

Quantifying the severity of a burn injury is far from simple. The standard assessment of severity is based on burn size, depth, presence of

inhalation injury, additional traumatic injuries, and co-morbidities, which are recognised as clinical predictors of survival following burn injury. However, experiencing a burn injury is deeply personal and unique to each survivor.^{8,12} There are many burn survivors who were deemed to have "non-survivable" injuries living their lives to the full today and others, with seemingly minor burns, whose lives have been thwarted by their injuries.¹

If we see our clinical success purely in terms of patient survival, we would have failed in our ethical principle to avoid causing harm to others and would have ignored the ongoing challenges and suffering that form part of survival after burn injury. Burns continue to be part of our patients' lives for months, years and sometimes decades after their wounds have healed. The long-term burden of burns has recently resulted in the condition being redefined as a chronic disease.^{5,9} Acknowledged to have life-long physical, functional, social, and psychological impact, burn injuries are now further recognised for their distinctive broad spectrum of secondary pathologies. Hence, a true marker of a successful outcome would be burn survivors' satisfaction with their quality of life, long after their wounds have healed. This is not an easy task for any one clinician or discipline, which is why burn care is founded on a multidisciplinary team concept of care. Professor Fiona Wood once famously said that "the quality of the outcome must be worth the pain of survival" in recognition that surviving a burn injury marks only the beginning of our patients' journey to the rest of their lives.^{5,10}

As numerous studies have shown, timely and effective first aid can dramatically alter burn outcomes, there is, however, a silver lining – an often-overlooked intervention in burns that can change the trajectory of wound healing outcome.¹¹⁻¹⁵

Burns are suggested to have three distinctive zones representative of the levels of tissue damage and potential for recovery. Early interventions, such as timely and appropriate first aid, fluid resuscitation, pain relief, and atraumatic wound care can help recover the struggling tissues. Without this, what would have been salvageable tissue will progress to necrosis, resulting in a larger and deeper burn.^{5,9}

While clinical treatments may be firmly in the domain of healthcare professionals, burns first aid is a simple, non-medical intervention that

can be delivered by any member of the public.¹⁶

Current evidence-based guidance for burns first aid recommends application of cool running water for at least 20 minutes within the first three hours of burn injury.¹⁶ This early treatment has been shown to improve healing time, reduce burn depth progression by 20%, restore 25% of skin thickness, reduce the need for surgery or a skin graft, reduce percentage of the total body surface area requiring a graft, reduce the length of hospital stay, and reduce the likelihood of infection and long-term scarring.^{11-13,15}

When burn injury happens, the first person able to respond is rarely a burn specialist and is most likely to be a family member, a bystander or an emergency services professional. However, despite the growing evidence for therapeutic benefit of cool running water first aid, many inappropriate and harmful “treatments” like toothpaste, ice, butter, turmeric, creams, egg, vinegar, honey, and oil are still widely used and, and in some cases, no first aid is applied at all.⁴ Children from low socioeconomic background, especially children under 2 years old, are least likely to receive appropriate burns first aid within 3 hours of injury.⁶

It seems that both the public and healthcare providers lack sufficient knowledge about appropriate first aid for burns, the value of cooling burns with running water for at least 20 minutes, and the 3-hour efficacy timeframe after which the opportunity to reverse the damaged tissue is lost.¹⁴

Globally, burn specialists are working to tip the balance in favour of burn prevention and awareness. Prevention efforts aim to stop a burn injury happening in the first place, whereas the awareness campaigns offer effective and evidence-based solutions for initial interventions that can make a difference to outcome if a burn injury occurs.^{2,3,8}

“The Family Oops and Burns First Aid” is a children’s book that allows a bedtime story to guide families through the most common circumstances experienced by children and adults affected by burns. Since its publication in 2019, this book has become available in hard and electronic copies, as a narrated YouTube flipbook, and has been translated into English, Welsh and Italian languages. By helping children and their carers learn how to manage burn injuries when accidents happen, the magic and awe of a fairytale helps nurture our next

generations of burns first aiders.

If burns are close to home, then our first steps in burn prevention and awareness should begin there – with those we care for the most. As burn injury does not discriminate and every age group is affected, what better way to ensure our personal and societal resilience to burns than to make these conversations part of our everyday lives.

The impact of a burn injury can last a lifetime, but each one of us has the ability to change a burn survivor’s outcome from the very first contact. The burden of responsibility lies with us as healthcare professionals to create a lasting change for our future generations. Dr Jane Goodall’s famous words will be the wind beneath our wings: *“What you do makes a difference, and you have to decide what kind of difference you want to make”*.^{5,9,17}

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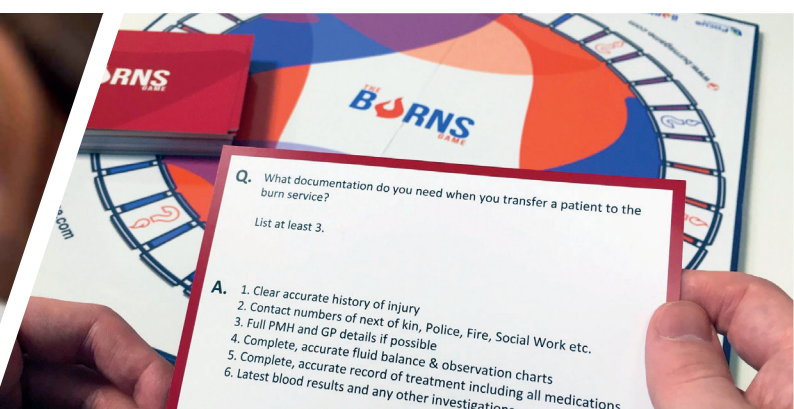
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Effective Preventive Strategies for Pressure Injuries in Neonatal and Pediatric Intensive Care: Analysis of an Implemented Pathway

Citation: Cavalieri S, Costa A, Buratti S, Moscatelli A, Scelsi S. “Effective Preventive Strategies for Pressure Injuries in Neonatal and Pediatric Intensive Care: Analysis of an Implemented Pathway” (2025) *International Journal of Wound Research* 1(1): 13-18. DOI: 10.64115/ijwr-2025-5

Received: April 25, 2025

Revised: May 17, 2025

Just accepted online: June 30, 2025

Published: June 30, 2025

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Data Availability Statement: All relevant data are within the paper and its Supporting Information files. This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination, and proofreading process, which may lead to differences between this version and the Version of Record.

Competing Interests: The author(s) declare(s) no conflict of interest.

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Abstract

Introduction. This descriptive observational study aimed to assess the impact of a structured pressure injury (PI) prevention program on the incidence of PIs in critically ill neonatal and pediatric patients implemented in the Neonatal and Pediatric Intensive Care Unit of the IRCCS Istituto Giannina Gaslini. The program, coordinated by a nurse specialized in wound care, included the use of pediatric risk assessment tools (Braden, Braden Q, and Glamorgan scales), evidence-based protocols, frequent repositioning, support surfaces, and targeted staff training.

Methods. The primary objective was to assess the impact of these interventions on the incidence of PIs. Prospective data collection was carried out to document the implementation of the measures and the progression of PIs.

Results. A direct comparison between data collected prior to the systematic introduction of preventive strategies (incidence rate: 5.6%) and data collected after program implementation (average incidence rate: 1.6%) revealed an overall 71% reduction in PI cases.

Discussion. The program's success appears to be linked to a multifactorial approach: systematic risk assessment, continuous staff training, and the use of appropriate support devices and dressings. The role of the wound care nurse proved essential for clinical supervision and team engagement. However, fluctuations in incidence rates during staff turnover periods highlight the need for sustained education and a strong culture of prevention. The variable application of risk assessment tools also suggests that standardized use and interpretation should be promoted to improve consistency.

Conclusions. The adoption of a structured, multidisciplinary program—with the involvement of a wound care specialist nurse

and the use of pediatric-specific assessment tools—appears promising in reducing the incidence of pressure injuries in critically ill neonatal and pediatric patients. Further prospective studies are needed to confirm these results and to identify specific risk predictors.

Keywords: Pressure Injuries, Pediatric Intensive Care Unit, Prevention Program, Risk Assessment, Staff Training

Introduction

Pressure injuries (PIs) are among the most common and preventable complications in hospitalized patients,¹ with significant repercussions on quality of life, length of hospital stays, morbidity and overall healthcare costs. Although traditionally considered a problem primarily affecting adult and geriatric populations, recent scientific literature has increasingly drawn attention to the pediatric population, recognizing that newborns, infants and children – especially those hospitalized in critical settings such as intensive care – are also at risk.^{2,3}

In pediatric patients, PIs often exhibit distinct characteristics due to the fragility of their skin, the high incidence of complex pathological conditions, and the frequent, prolonged use of both invasive and non-invasive medical devices (probes, endotracheal tubes, CPAP masks, pulse oximeters, etc.). Particularly in premature infants or children with serious chronic or unstable pathologies, factors such as prolonged immobility, poor nutritional status, hemodynamic alterations, and invasive ventilatory assistance represent determining risk variables for the development of PIs.^{1,4}

The prevalence of PIs in Neonatal Intensive Care Units (NICU) and Pediatric Intensive Care Units (PICU) can vary widely, depending on organizational characteristics, clinical practices, and the implementation of preventive strategies.⁵ However, a proactive prevention approach – centered on early and systematic risk assessment, evidence-based protocols, and ongoing staff training – has been shown to significantly reduce the incidence of these adverse events.^{1,3}

Within this context, this study aims to assess the effectiveness of a structured PIs prevention program implemented at the Complex Operative Unit of Neonatal and Pediatric Intensive Care of the IRCCS Istituto Giannina Gaslini. The primary

objective was to evaluate the impact of specific interventions – such as the introduction of pediatric-specific risk assessment tools, nursing staff training programs, and the routine adoption of preventive care measures – on the incidence of PIs over a multi-year period.

Through this study, we aim to contribute to the dissemination of best practices and to promote a culture of prevention – an essential element in ensuring patient safety, equity, and quality of care in intensive settings dedicated to the most vulnerable patients.

Method and Materials

Study Design

This descriptive observational study was conducted to assess the impact of a structured pressure injury (PI) prevention program on the incidence of pressure injuries in a neonatal and pediatric intensive care setting.

Setting and Sample

The study was carried out in the Neonatal and Pediatric Intensive Care Unit of the IRCCS Istituto Giannina Gaslini. The unit comprises 16 beds (expandable to 21) and is staffed by a team of over 60 nurses, all highly specialized in the care of critically ill neonatal and pediatric patients. Data were collected over a seven-month period (from July 1 to January 31) for each of the following years: 2019–2020, 2020–2021, and 2021–2022. A further data collection phase occurred from July 1, 2023, to January 31, 2024, after the implementation of the Glamorgan Scale.

Nursing Staff Involved

As part of the project, a nurse specialized in wound care was appointed to coordinate the prevention and management of pressure injuries. In collaboration with the Directorate of Health Professions (DIPS), this nurse played a key role in designing, implementing, and monitoring a structured program aimed at

reinforcing preventive strategies. The specialist also ensured adherence to protocols, offered continuous on-site support, and promoted team engagement.

The prevention strategies implemented encompassed several actions: increasing staff awareness through dedicated training sessions on pressure injuries, risk assessment tools, and evidence-based care practices; reviewing and updating clinical procedures according to international EPUAP/NPIAP/PPPIA guidelines;⁶ increasing the frequency of repositioning; using pressure-relieving support surfaces appropriate to patient weight; applying prophylactic dressings; and conducting systematic skin assessments to detect early signs of injury. The specialist nurse maintained a continuous supervisory role, provided operational support, and ensured consistent team adherence to the prevention protocol.

Assessment Tools

To assess the risk of pressure injuries (PI), several age-specific tools were used during the study period (Table 1).

Table 1. Overview of the pressure injury risk assessment tools adopted in the study, detailing the target age range, main evaluated factors, and specific implementation notes. The tools supported age-appropriate and clinically tailored risk stratification in the neonatal and pediatric intensive care setting.

Assessment Tool	Target	Age Evaluated	Factors Notes
Braden ⁷	> 8 years	Sensory perception, moisture, activity, mobility, nutrition, friction/shear	Used in patients > 8 years
Braden Q ⁸	3–8 years	Mobility, activity, moisture, sensory perception, friction/shear, general condition, medical devices	Validated for pediatric use, adapted from Braden
Glamorgan ⁹	0–18 years	Medical devices, mobility, nutritional status, neurological condition, tissue perfusion, skin condition	Adopted since 2023 as the main tool for all pediatric ages

Initially, PI risk assessment was performed using different tools based on patient age: the Braden Scale for patients over 8 years of age, the Braden Q for children between 3 and 8 years, and a structured clinical assessment for those under

3 years.

While these tools initially allowed for age-appropriate and clinically tailored risk assessments, their heterogeneity posed challenges in terms of standardization, documentation, and data comparability within the unit.

To overcome these limitations and harmonize the assessment process, the Glamorgan Scale was systematically introduced in January 2023. This tool was selected for its validated application across a broad pediatric age range (0–18 years) and its inclusion of critical risk factors such as the use of medical devices. The adoption of a single, standardized tool aimed to ensure a more consistent, reproducible, and clinically relevant approach to PI risk stratification in critically ill pediatric patients.

Data Collection

A dedicated data collection tool was created to monitor the implementation of preventive strategies, including: 1) Daily number of repositioning interventions; 2) Use of pressure-relieving support surfaces; 3) Application of prophylactic dressings; 4) Utilization of risk assessment scales.

All interventions were individualized according to the patient's clinical and developmental condition. The collected data were analyzed to determine PI incidence, expressed as the number of new cases relative to the total number of patients admitted during each observation period. This allowed a longitudinal evaluation of the effectiveness of the implemented prevention measures.

Ethical Considerations

This study was conducted as a retrospective descriptive observational study using anonymized clinical data collected during routine care. No experimental interventions or deviations from standard clinical practice were introduced. According to the Italian Medicines Agency (AIFA)¹⁰ Circular dated June 7, 2012, and the opinion of the Italian National Bioethics Committee (2014),¹¹ ethical approval is not required for observational studies that do not involve direct patient interventions and use anonymized data collected as part of standard clinical activity. The study was carried out in compliance with the principles outlined in the Declaration of Helsinki and applicable data protection regulations (EU Regulation 2016/679 – GDPR).^{12,13}

Results

The data collected referred to the number of repositioning interventions performed, the use of pressure-relieving surfaces, the application of prophylactic dressings, and the adoption of a formal risk assessment scale (Glamorgan scale).

In the seven months preceding the structured implementation of preventive measures – namely staff training, systematic use of risk assessment scales, use of prophylactic dressings and pressure-relieving surfaces – 22 cases of PIs were recorded out of 388 patients admitted to the Operative Unit, corresponding to an incidence rate of 5.6%.

Following the progressive implementation of these interventions, the data collected from July 2019 to January 2024 show a significant and stable decline in incidence. (Table 2)

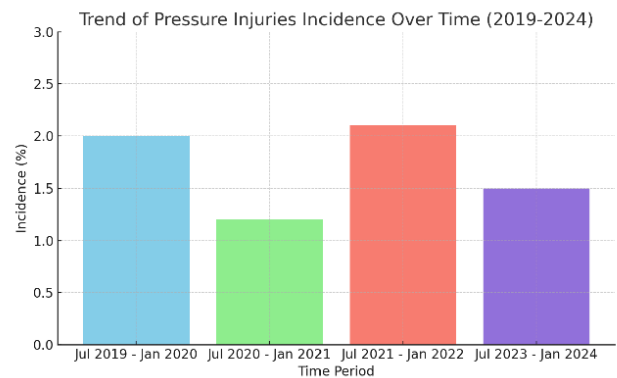
Table 2. Incidence of PIs in patients admitted to neonatal and pediatric intensive care units before and after the introduction of preventive measures (2019–2024).

Observational Period	Patients (n)	PIs (n)	Incidence (%)
July 2019 - January 2020	471	10	2.1
July 2020 - January 2021	386	4	1
July 2021 - January 2022	320	7	2.1
July 2023 - January 2024	473	6	1.2

To complete the data reported in the table, Graph 1 visually illustrates the trend in PIs incidence over time, clearly demonstrating the positive impact of the preventive strategies adopted by our Operating Unit. The bar chart highlights the reduction of the phenomenon starting from 2020, reinforcing the effectiveness of the measures adopted and underscoring the importance of a structured and continuous approach to prevention.

Discussion

The results of this study clearly illustrate the effectiveness of a multifactorial approach to the prevention of PIs in pediatric patients admitted to intensive care. The implementation of a structured program – based on systematic risk assessment, continuous staff training, and



Graph 1. Incidence of PIs among patients admitted to the neonatal and pediatric intensive care unit at IRCCS Istituto G. Gaslini from 2019 to 2024.

targeted preventive measures – led to a significant reduction in the PIs incidence, from 5.6% at baseline to 1.2% in the most recent observation period. This trend aligns with findings reported in the literature and supports the validity of the strategies adopted.¹⁴

Despite the overall positive trend, a temporary increase in PIs incidence was observed during the 2021-2022 biennium (2.1%) and in the first half of 2023. The rate subsequently declined to 1.2% in the second half of the same year, although it remained above the 2020 minimum of 1% and deviated from the expected trend.

This increase may be attributed to the turnover among nursing staff, which resulted in the temporary loss of experienced personnel – including the expert wound care nurse – causing a phase of reorganization and reduced stability within the team, which was engaged in training new staff.¹⁵ Concurrently, a certain underestimation of the risk was noted among the team, possibly due to a perception of the problem as "resolved" or secondary to more pressing clinical priorities in critically ill patients. In this context, although the Glamorgan Scale was introduced to improve risk assessment, it was at times perceived as a bureaucratic requirement rather than a clinically valuable tool for prevention.^{16,17}

This experience highlighted the need to maintain sustained attention on the issue, constantly renewing training efforts and fostering awareness among staff.^{16,17} The prevention of PIs cannot be considered a definitively achieved goal, but rather a dynamic and ongoing process that requires continuity, motivation, and a strong culture of risk awareness. It is essential that the tools adopted – such as assessment scales – are perceived not as formal obligations, but as

practical and effective resources in daily clinical assistance.¹⁸

A key factor in the success of the program was the active involvement of the specialist nurse in skin lesions, who served as a point of reference for the entire care team. Their role facilitated the adoption of new procedures, ensured consistent clinical monitoring, and provided hands-on support to staff.¹⁹ However, the long-term sustainability of this approach depends on the team's ability to internalize preventive principles and act in a coordinate and collaborative manner.²⁰

Further studies are warranted to explore the effectiveness of additional preventive strategies, such as the use of specific skin care products or the application of new technologies. Prospective studies would also be valuable to confirm the present findings and to identify predictors of PIs development in pediatric patients.

Limitations of the study

This study presents several methodological limitations that should be considered when interpreting the results. Firstly, it was conducted in a single hospital center, which limits the generalizability of the findings to other healthcare settings with different organizational and clinical characteristics.

Secondly, PIs the risk assessment was conducted over the years using different scales depending on patient age – namely the Braden Scale, Braden Q, clinical judgment-based assessment, and, more recently, the Glamorgan Scale. This heterogeneity may have introduced variability in the data, potentially affecting both the temporal comparability and the accuracy of risk classification.

Lastly, as a retrospective, descriptive observational study, it is not possible to fully exclude the influence of uncontrolled confounding factors, such as fluctuation in care workload, the clinical complexity of patient, and internal team dynamics.

Conclusions

The findings of this study support the effectiveness of a multifactorial strategy for preventing PIs in our intensive care unit. The comparison between data collected prior to the systematic implementation of preventive measures (5.6% incidence) and data following

the intervention (average incidence 1.6%) highlights an overall of 71% reduction in PIs cases, demonstrating the significant impact of the measures adopted.

These results suggest that systematic risk assessment, ongoing staff training, adherence to evidence-based practices aligned with international guidelines, and the involvement of a wound care specialist can produce tangible and measurable improvements in care quality.

To maintain and further enhance these results over time, it is essential to continue fostering a culture of prevention, emphasizing shared responsibility of healthcare professionals. The effectiveness of any prevention program ultimately depends on awareness, motivation, and the continuity of care practices.

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Pressure Injuries in Dependent Individuals within Primary Care: A Descriptive Study

Citation: Araújo PJFAS, Loureiro HMAM, Sardo PMG, Rodrigues AM. "Pressure Injuries in Dependent Individuals within Primary Care: A Descriptive Study" (2025) *International Journal of Wound Research* 1(1): 21-30. DOI: 10.64115/ijwr-2025-7

Received: May 13, 2025

Revised: May 20, 2025

Just accepted online: June 30, 2025

Published: June 30, 2025

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Data Availability Statement: All relevant data are within the paper and its Supporting Information files. This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination, and proofreading process, which may lead to differences between this version and the Version of Record.

Competing Interests: The author(s) declare(s) no conflict of interest.

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Abstract

Introduction. Pressure injuries represent a prevalent and serious health issue among dependent individuals, especially within the primary care context. These injuries contribute to increased morbidity, diminished quality of life, and greater healthcare resource utilization. Accurate and comprehensive clinical records are essential not only for guiding individual patient care but also for supporting scientific research. They enable the identification of risk factors, monitoring of outcomes, and development of evidence-based interventions. The Aim of this study is to analyse the informatic nursing records of dependent persons in a Portuguese Primary Health Care Unit (PHCU), within the scope of the prevention and treatment of pressure ulcers/injuries (PU/PI).

Methods. Retrospective analysis of electronic health record database from 112 patients registered in the "Dependents Program" of the Informatic System SCLínico® of a Portuguese Primary Health Care Unit during 2019. Beyond sociodemographic characterization, the data analysis included the following variables: self-care level; PU/PI risk; co-morbidities; nutritional risk; PU/PI classification, anatomical location, assessment, and type of treatments performed; pain and the family caregiver's "ability" and "knowledge" to prevent PU/PI.

Results. During 2019, 80.4% of the participants had the self-care level recorded and 83.0% had the PU/PI risk assessment recorded. The nutritional risk assessment was not recorded in 90.2% of the participants. The PU/PI assessment through RESVECH 2.0 was registered in 72.2% of the participants. The treatment implemented and the pain assessment were documented in a residual way.

Discussion and Conclusions. The findings reveal notable strengths and gaps in the documentation practices related to

pressure injury prevention and management in primary care. While a majority of participants had their self-care level and PU/PI risk assessments recorded, critical areas such as nutritional risk assessment were largely neglected. Given the well-established link between nutrition and skin integrity, this represents a significant oversight. The use of the RESVECH 2.0 tool for PU/PI assessment was observed in great percentage of participants, indicating moderate integration of standardized assessment tools into clinical practice. However, the documentation of both treatment interventions and pain assessment was minimal, suggesting these essential aspects of care are not being systematically recorded. These findings underscore the need to strengthen comprehensive and consistent record-keeping, as incomplete documentation can hinder both the continuity of care and the generation of robust scientific evidence.

Keywords: Nursing Assessment, Nursing Records, Pressure Injury, Pressure Ulcer, Primary Health Care

Introduction

The prevention and treatment of pressure ulcers/injuries (PU/PI) is a growing concern¹⁻⁵ based on the demographic changes which leads to an increase in elderly and dependent population.⁶ Aging represents an important PU/PI development risk factor and influence the healing process, since it promotes changes in the skin and its support structures, making it more vulnerable to pressure and friction and shear forces.⁷

As a result of global population aging, there is an increase in the incidence of chronic diseases and in the prevalence of dependent persons, also leading to an even higher risk of developing a PU/PI⁸ in different care settings.⁹⁻¹¹

This risk of developing PU/PI is complex and multifactorial including intrinsic and extrinsic factors, making this an important public health problem in Portugal¹² with impact on family dynamics.^{13,14}

To determine the risk of developing PU/PI and to (immediately) access the relevant clinical information will allow professionals/nursing team to define a preventive and/or a curative care plan, personalized and adapted to each person and respective family. This care plan should also include the knowledge and training of the family caregivers, which play an important role in this domain.^{13,15,16}

At the same time, we have verified a strong

technological development and consequent improvement of the Health Information Systems (HIS). The documentation, management and research tools promote the quality and continuity of care,¹⁷ data comparison and the development of scientific knowledge.¹⁸

Based on these concerns, this study aims to analyse the informatic nursing records of dependent persons in a Portuguese Primary Health Care Unit (PHCU), within the scope of the prevention and treatment of PU/PI.

In order to address this main goal, specific aims were defined as follow: (1) To determinate incidence, prevalence and healing rates of PU/PI in this PHCU; (2) To characterize the dependent persons of this PHCU, considering their dependence level, PU/PI development risk and nutritional risk; and (3) To characterize each PU/PI according to their category/stage, anatomical location and the assessment performed through RESVECH 2.0.

Methods

Observational, retrospective and descriptive study with a quantitative methodology.

The participants included in this study were registered in the “Dependents Program” of the Informatic System SClínico® of a North Portuguese Primary Health Care Unit during 2019.

To decrease the risk of bias, the exclusion

criteria were defined as follow: (1) To be institutionalized in a nursing home or other care facilities/institutions in the period under analysis; and (2) To have a registered death during the study period.

Throughout the entire research process, the confidentiality of the data and access to the results were strictly respected, which were solely used for research purposes, respecting the 4 ethical principles proclaimed by.¹⁹ The study was performed after Northern Regional Health Administration and Ethics Committee approval (Reference Number: CE/2021/67).

Data were collected by the PCHU nursing team, based on the nursing records of the Informatic System SClínico® (in the areas “User Identification”, “Initial Assessment” and “Surveillance”). The data were coded, anonymized and archived in a separate folder and handed over to the researcher, guaranteeing the confidentiality of the subjects and the collected data.

Beyond sociodemographic characterization (age, gender and educational qualifications), data collection also included the following variables: level of self-care (Barthel Index), risk of developing PU/PI (Braden Scale), comorbidities (according CIAP-2), nutritional risk (NRS-2002 Scale), anatomical location, PU/PI classification and assessment (RESVECH Scale 2.0), pain assessment (Visual Analog Scale or Numerical Scale), type of treatments performed at the PU/PI and “ability” and “knowledge” of the family caregiver to prevent PU/PI.

The analysis of sociodemographic and clinical data was carried out using the IBM® Statistical Package for Social Sciences® version 23.0 (SPSS).

Results

Sample characterization

The sample participants (n=112) were aged between 14 and 102 years, with an average of 79.47 (± 17.51) years. Half of the participants (n=56) were between 81 and 90 years old, highlighting the fact that 87.6% of participants were aged between 71 and 90 years old (Table 1). It was also found that most of the participants were women (61.6%). Considering the educational qualifications, it was found that 53.6% of the participants only had the primary education.

Table 1. Sociodemographic characterization of the participants.

Participants (n=112)		n	%
Age	<18	1	0.9
	18-60	9	8.0
	61-70	4	3.5
	71-80	21	18.8
	81-90	56	50.0
	>90	21	18.8
Gender	Female	69	61.6
	Male	43	38.4
Educational qualifications	Illiterate	25	22.3
	1 st cycle	60	53.6
	2 nd cycle	4	3.6
	3 rd cycle	1	0.9
	High School	3	2.6
	Participants without records	19	17.0

Considering the clinical characterization of our participants it was possible to identify that they present an average of 9.65 (± 5.57) diagnosed pathologies. As far as the distribution of these pathologies by International Classification of Primary Care 2nd Edition (ICPC-2) chapters was concerned, there was an average of 5.5 (± 2.39) chapters per participant. Chapter K (Circulatory), Chapter L (Musculoskeletal) and Chapter T (Endocrine, Metabolic and Nutritional) present higher averages of diagnosed pathologies with approximately 2 pathologies per participant (1.9, 1.6 and 1.5 respectively).

In the “self-care assessment”, 56.0% of participants had a “Severe Dependence” and 36.3% had a “Moderate Dependence”. Regarding the risk of developing PU/PI, 55.9% of participants were at “High Risk”. All evaluated participants were “No Nutritional Risk”.

On January 1st, 2019, only 1 participant had a PU/PI registered, resulting in a PU/PI point prevalence of 0.9%. During 2019, 13 participants developed a new PU/PI, resulting in an PU/PI incidence of 11.6%. On December 31st, 2019, 5 participants had a PU/PI registered, resulting a PU/PI point prevalence of 4.5%, which indicates an increase of 3.6 percentual points compared to the first assessment.

The total number of PU/PI registered in the period under analysis was 36. It should be noted

that 76.9% of participants with PU/PI had more than 1 PU/PI, with an average of 2.77 ($\pm 1,48$) PU/PI per participant with PU/PI.

Regarding the PU/PI anatomical location, the trochanters emerged as the most frequent area (38.9%), followed by the sacrum (33.0%) and the heels (22.2%). Considering the PU/PI category/stage in the first record, 69.2% of the PU/PI were classified as category/stage II, and only 7.7% were classified as category/stage IV. There were no records of PU/PI category/stage I in the first record.

According to the first PU/PI assessment through RESVECH 2.0, we obtained an average score of 7.73 points (SD=2.342) and a maximum score of 14. During 2019, 27 of the PU/PI (75%) were healed, with an average healing time of 50.56 days (SD=68.179).

Analysis of Nursing Records

Regarding self-care dependence assessments (Table 2), it was found that 90 (80.4%) participants had at least one record, within an average of 2.04 assessments per participant. Nevertheless, only 38 (33.9%) participants had this specific assessment recorded in both semesters of 2019.

Analysing the PU/PI risk assessment, we identified that 93 (83.0%) participants had at least one record, within an average of 2.59 assessments per participant. However, none of the participants presented a monthly PU/PI risk assessment recorded and only 7 (6.3%) participants had at least one assessment recorded in the 4 trimesters.

Table 2. Nursing records related to self-care dependence and PU/PI risk assessment.

Self-care dependence assessment	n	%
Participants without records	22	19.6
Participants with records	90	80.4
Participants with records in 1 of the semesters	52	46.4
Participants with records in 2 semesters	38	33.9
PU/PI risk assessment	n	%
Participants without records	19	17.0
Participants with records	93	83.0
Participants with records in 1 trimester	47	42.0
Participants with records in 2 trimesters	24	21.4
Participants with records in 3 trimesters	15	13.4
Participants with records in 4 trimesters	7	6.3
Total	112	100

Regarding the records of nutritional risk assessments, these are non-existent in 101 (90.2%) participants. Additionally, more than a half (61.5%) of the participants with PU/PI did not have any records of nutritional assessment.

Considering the nursing diagnoses related to the family caregiver (Table 3), 43 (38.4%) participants have diagnostic records relating to the family caregiver's ability to prevent PU/PI, and 50 (44.6%) participants have diagnostic records relating to the family caregiver's knowledge to prevent PU/PI.

Table 3. Nursing records related to the diagnoses of the family caregiver's ability and knowledge to prevent PU/PI

Family caregiver's ability	n	%
Participants without records	69	61.6
Participants with records	43	38.4
No potential to improve the family caregiver's ability to prevent PU/PI	2	1.8
Potential to improve the family caregiver's ability to prevent PU/PI	14	12.5
Family caregiver's ability to prevent PU/PI	27	24.1
Total	112	100
Family caregiver's knowledge	n	%
Participants without records	62	55.4
Participants with records	50	44.6
Potential to improve the family caregiver's knowledge to prevent PU/PI	38	33.9
Family caregiver's knowledge to prevent PU/PI	12	10.7
Total	112	100

During 2019, 36 PU/PI were documented by assessment, category, treatment and pain (Table 3). In 13 (36.1%) records the PU/PI category/stage was clearly identified and in 26 (72.2%) records the PU/PI assessment through RESVECH 2.0 was performed with an average of one assessment each 7.09 days, with a minimum of 1.5 days and a maximum of 19.5 days. Only 3 (8.3%) of the records analysed clearly document the initial treatment provided to the PU/PI.

Of the 13 participants with PU/PI, only 3 (23.1%) have recorded pain monitoring, with no record being verified for the remaining participants.

Table 4. Nursing records related to PU/PI assessment, category, treatment and pain.

PU/PI Records (n=36)	Yes (n, %)	No (n, %)
PU/PI Assessment	26 (72.2%)	10 (27.8%)
PU/PI Category/Stage	13 (36.1%)	23 (63.9%)
PU/PI/ Treatment	3 (8.3%)	33 (91.7%)
Pain Assessment	3 (23.1%)	10 (76.9%)

Discussion

Regarding the sample characterization there was a similar agreement with various studies with dependent participants already published^{20–22} The averages age and the predominance of woman among the dependent population of our study is consistent with national^{23–26} and international literature.^{27,28}

With regard to educational qualifications, Fundação Francisco Manuel dos Santos state that elderly population usually had, low education, with predominance of basic education,²⁹ similar to the data obtained in this study.

The clinical characterization of our sample is similar to a study developed by Gonçalves,²⁵ which identified circulatory system pathologies as the most frequent comorbidity in dependent persons. In our sample, circulatory/cardiac, endocrine and musculoskeletal problems presented high prevalence which according to Cascão et al.,²⁰ Laranjeira & Loureiro,²¹ Souza et al. al.²² and Aguiar et al.³⁰ could lead to the development of PU/PI.

Our results showed high levels of self-care dependence which is in line with several studies that were developed with dependent Portuguese population.^{25,31,32}

Regarding the risk PU/PI development, the results obtained were congruent with previous data, since higher levels of functional dependence increase this (specific) risk.^{8,33,34} However our results were lower than those recorded in a study carried out in Azores with dependent persons, which identified that 86% of participants presented “High Risk” of PU/PI development.³⁵

Since the risk of developing PU/PI is assumed as the first step towards the prevention of this type of injuries,^{2,16} it was expected that this intervention would be applied to all dependent persons. However, our data revealed that 19 (17.0%) of the participants didn’t have this specific assessment recorded in Informatic System SClínico®.

This data is especially important because our Quality and Safety Committee defined that this assessment should be performed at least monthly,³⁶ which was not the case for any of the study participants.

When we analyse the nutritional risk assessment records, it was found that none of the assessed participants was classified as “at risk”. These data are not consistent with the results obtained by³⁷ in a study developed in home care context, which identified that a large number dependent persons were at risk of malnutrition. According to DGS, the early diagnosis of malnutrition will allow (in most cases) to implement effective and low-cost treatments. In this way, nutritional risk screening should be an important strategy to identify patients who need nutritional intervention.³⁸

The global analysis of our data showed that more than 90% of users did not have a nutritional risk assessment record, which is assumed to be a worrying result, since the nutritional deficit is assumed to be an important factor that enhances the development of PU/PI and/or limiting their healing process.^{37,39}

The incidence of PU/PI presented in this study revealed values in line with those described by the Instituto da Qualidade em Saúde,⁴⁰ which pointed to values between 2 and 13%, in Portugal. According to Lyder,⁴¹ these values could vary between 0% and 17% in home context, and ideally they should be less than 2%, as verified in this study.

The PU/PI point prevalence reported in this study present lower values than those described in the Azores and in Spain, also in the home context (9.4%, 26.5% and 8.3%, respectively).^{35,42,43} International studies also revealed higher values than those obtained (between 3% and 20%).^{44–47}

Regarding the ratio of PU/PI per participant, the data obtained were similar to those presented for other contexts. Studies carried out in 2 Portuguese hospitals obtained a ratio of 1.76⁴⁸ and 2.60 PU/PI¹⁰ per participant while European studies revealed values between 1.4 and 1.73 PU/PI per participant.^{49,50}

The anatomical locations of the most frequent PU/PI (trochanter, sacrum and heels) are in line with the existing literature: Sardo, Simões, Alvarelhão, Simões, et al.¹¹ obtained values greater than 20% for the sacrococcygeal region and heels, while Cruz,⁴⁸ also presented values above 20% for these three anatomical locations.

Studies carried out in Germany and Spain obtained identical results, with emphasis on the sacrum and heels, with values greater than 30% and 24%, respectively.^{51,52}

In our study nearly 70% of PU/PI recorded were classified as category/stage II. Similar results were obtained in other Portuguese studies.^{48,53} Discrepant values were obtained by Yashchuk,⁵⁴ Sardo, Simões, Alvarelhão, Costa, et al.¹⁰ and Sardo, Simões, Alvarelhão, Simões, et al.,¹¹ who reported higher prevalence of PU/PI category/stage I in their studies.

Unfortunately, in about 64% of the cases, the records regarding the PU/PI category/stage were not carried out at the time of the PU/PI diagnosis. According to the DGS,¹² the PU/PI characterization and respective registration is crucial for the correct monitoring of the care provided, allowing the definition and establishment of an effective care plan.

However, according to Alves et al.,⁵⁵ this categorization is only used to classify the depth of the affected tissues, not proving to be effective for monitoring the PU/PI evolution/healing process. For this purpose, there are valid and reliable assessment instruments that allow correct and continuous wound monitoring.^{56,57}

EPUAP et al.² recommends that the PU/PI assessment should be performed at least weekly in order to monitor the healing process, contributing to the choice of the appropriate treatment.⁵⁸ Our data showed that the PU/PI assessment through RESVECH 2.0 was performed with an average of one assessment each 7.09 days which is in line with a declaration of good practices.² This data is especially important since RESVECH 2.0 is recently validated for Portuguese Population and incorporate in Informatic System SClínico®.⁵⁹

Regarding the treatment instituted, our analysis also revealed a deficit of records, since only about 8% of the cases had these data documented. According to Antunes et al.⁵⁶ and Andersson, Imberg & Rosengren,⁶⁰ recording the treatment performed is essential for monitoring the wound healing process.

In this study, a healing rate of 75% was obtained for the period under analysis, with an average healing time of about 50 days. These values also found agreement with Luz et al.,⁶¹ who indicated healing averages between 30 and 70 days.

Since all study participants were registered

in the “Dependents Program” of the Informatic System SClínico®, the self-care assessment should be recorded in 100% of the cases. Unfortunately, only about 80% of our participants had at least one self-care assessment record. Furthermore, our Quality and Safety Commission, defined as a minimum criterion, a half-yearly assessment in this area.³⁶ The data analysed revealed that only around 34% of the participants’ records complied with the defined criteria. There is clearly a deficit in nursing documentation. Different results from these were obtained by Silvestre,⁶² with this important assessment present in all clinical processes.

With regard to the family caregivers, it should be noted that there were no records regarding their ability and knowledge to prevent PU/PI in more than 60% and 55% of cases, respectively. Since this is a study carried out in a community context, the role of the family caregiver is crucial for the success of the established care plan. According to Rodrigues & Soriano⁶³ and Dopierala et al.,⁶⁴ it is essential to train them for an efficient and effective prevention of PU/PI. In this way, these data revealed a marked deficit of nursing records at this level, being lower than those demonstrated by Rodrigues & Soriano,³⁵ in a study developed in home context in Azores, which pointed to rates of teaching of the (family) caregivers greater than 70%.

This study reported a deficit in pain assessment records of participants with PU/PI. This results are in line with those described by Silvestre,⁶² in a study developed in hospital context that demonstrated that this is an undervalued area in the nursing records. Regular pain assessment in people with PU/PI is recommended by EPUAP et al.² and DGS,⁶⁵ assuming itself as an indicator of best professional practices, so these values should be close to 100%.

Conclusions

The analysed records allowed the characterization of participants with high risk of PU/PI development and the participants that already had and/or developed a new PU/PI in this Portuguese Primary Care Unit, as well as understanding the type of information recorded in the Informatic System SClínico®.

These are dependent persons with an average age of around 80 years, with a higher prevalence

of women and low educational level. Clinically, the participants mostly have a severe dependence level and associated multi-comorbidities, with emphasis on circulatory, musculoskeletal, endocrine, metabolic and nutritional problems. With regard to the risk of PU/PI development, just over a half were at “high risk”. The PU/PI point prevalence at the end of 2019 was 4.5% and the PU/PI incidence in the same year was 11.6%.

The participants with PU/PI had an average of 2.77 PU/PI identified, being the trochanters, sacrum and the heels the most problematic anatomical locations. Most of the PU/PI recorded were classified as category/stage II in the first assessment.

Although most of the participants had records related to “self-care assessment” and “PU/PI risk assessment”, these data were not systematically documented on a six-monthly, quarterly and/or monthly basis. The records related to “nutritional risk assessment” and “pain assessment” were residual.

Regarding the family caregiver information, in more than half of the files, there were no records referring to the assessments of their knowledge and abilities.

As far as PU/PI documentation is concerned, there should be a greater concern with the nursing records quality, highlighting the PU/PI assessment, the PU/PI category/stage, and the treatment implemented.

To carry out this study, data were extracted manually and individually for each participant by nursing team research cooperating. This limitation in the information systems implies the absence of some records, which limits the quality and speed of access to data for monitoring care and promoting evidence-based practice.

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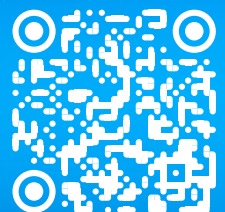
Blue Light Therapy for

Blue Light Therapy for Skin Lesions: A Scientific Advancement in Regenerative Medicine

EmoLED is a medical device for the healing of skin lesions, developed in collaboration with leading Italian research institutes in physics and medicine. It uses LED sources emitting Blue Light in the interval of 400-430nm and its mode of action is based on the direct transfer of photonic energy from the device to the patient without the use of mediators. The selected wavelengths interact with chromophores contained in the skin to promote resolution of inflammation and tissue repair. The results of clinical studies confirm that Blue Light Therapy is a potential game changer in the treatment of chronic and hard-to-heal wounds.



PUBLICATIONS



Chronic Wound Healing

1903 – 2000

The Origins of Photobiomodulation

Modern phototherapy originated with Niels Finsen, who was awarded the Nobel Prize in 1903 for his treatment of lupus vulgaris using ultraviolet-rich arc lamp light. This breakthrough paved the way for light-based medicine. The advent of lasers and LEDs enabled the precise delivery of monochromatic light, fostering the development of Biophotonics, the study of light and tissue interactions for therapeutic and diagnostic purposes.

2000 – 2018

Blue Light and Mechanism of Action

Blue light induces therapeutic effects via photobiomodulation, where light-absorbing chromophores convert light into biochemical signals. This process reduces inflammation, alleviates pain, and stimulates tissue regeneration. EmoLED technology uses blue wavelengths targeting flavoproteins and mitochondrial enzymes, facilitating tissue repair.

2018 – TODAY

Clinical Application in Chronic Wounds

Chronic wounds arise when inflammation persists due to aging, disease, or immobility. Blue light therapy reactivates healing by shifting stalled inflammatory phases. It also modulates fibroblast behavior—key in tissue repair—enhancing collagen organization and improving scarring outcomes, including in keloid prevention.

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Prevention Decalogue for Dependency-Related Skin Lesions in Neonates: A Consensus-Based Delphi Study

Citation: Buck Sainz-Rozas P, Gros-Turpin A, Balaguer-López E, Mora Morillo IM, De Frutos Pecharroman J, González García L, Cristóbal Cañadas D, Cánovas Barcelona M, Fàbregas Mitjans M, García-Molina P. "Prevention Decalogue for Dependency-Related Skin Lesions in Neonates: A Consensus-Based Delphi Study" (2025) *International Journal of Wound Research* 1(1) 1(1): 33-45. DOI: 10.64115/ijwr-2025-2

Received: March 2, 2025

Revised: June 9, 2025

Just accepted online: June 30, 2025

Published: June 30, 2025

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Data Availability Statement: All relevant data are within the paper and its Supporting Information files. This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination, and proofreading process, which may lead to differences between this version and the Version of Record.

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Abstract

Introduction. The extreme fragility of neonatal skin, particularly in extremely preterm infants, underscores the need for effective preventive measures. This study aims to validate and design a decalogue for the prevention of dependency-related skin lesions (DRSL) in the neonatal population, based on existing consensus documents.

Methods. The Delphi method was employed to validate the content of the decalogue through expert consultation across Spain. Key criteria—including relevance, clarity, ambiguity, simplicity, satisfaction, and applicability—were assessed using a 4-point Likert scale and a 10-point scale, with a 75% agreement threshold for validation. Descriptive statistics were used to analyze responses. Items not meeting the threshold were revised based on qualitative feedback and re-evaluated. The final list of interventions was established through consensus in the second round.

Results. A total of 23 experts participated in the first round, and 20 in the second. Across both rounds, all items were validated with a high level of agreement. In the second round, all items exceeded 85% agreement for relevance, clarity, ambiguity, and

Competing Interests: The author(s) declare(s) no conflict of interest.

simplicity. The average satisfaction (9.36–9.47) and applicability (9.09–9.42) revealed a high level of agreement concerning the clinical applicability of the Decalogue. The decalogue outlines essential measures for preventing DRSL in neonates, including risk assessment, postural changes, the use of specialized pressure-relieving surfaces, and monitoring of device-related pressure points. It also highlights the importance of tailored skin care based on neonatal maturity and the need for thorough documentation of preventive interventions.

Discussion. Consensus achieved via the Delphi process substantiates the Decalogue's capacity to effectively articulate key preventive strategies with clarity and brevity. Moreover, its implementation will foster evidence-based care practices, ultimately enhancing the quality of care in neonatal units. However, ongoing efforts are required to further improve DRSL prevention and continuously update strategies in light of emerging evidence.

Keyword: Pressure Injuries, Prevalence, Risk Factors, Neonatal Nursing, Infant, Newborn

Introduction

The prevention of dependency-related skin lesion (DRSL) in neonates is a critical challenge in neonatal care, given the unique vulnerability of this population. These injuries result from factors such as prolonged pressure, shear, friction, and moisture, which compromise tissue perfusion and lead to cellular damage.^{1,2} Despite advancements in neonatal care and technology, pressure injuries remain a significant concern, with reported incidence rates of approximately 3% in neonates^{1,2} and as high as 25–43% in neonatal intensive care units (NICUs).^{3–5}

The anatomical and physiological characteristics of neonates heighten their susceptibility to these injuries. The skin of newborns, particularly preterm infants, is immature, featuring a thin epidermal barrier and limited cohesion between dermal and epidermal layers. As the first line of defense against pathogens, the skin plays a crucial role in maintaining homeostasis by minimizing unnecessary fluid losses and preventing electrolyte imbalances.^{1,6}

Moreover, the use of medical devices such as endotracheal tubes, catheters, and oximetry sensors are associated with 50–70% of DRSL cases in neonatology.^{2,3,7} This issue not only affects the quality of life of neonates—causing

pain, stress, infections, long-term scarring, and prolonged hospitalization—but also presents challenges for healthcare systems due to the associated costs and complications. These include neurodevelopmental impairments, as exposure to pain and stressful conditions can disrupt brain maturation and connectivity, particularly in the white and grey matter, as well as in thalamic regions. This underscores the urgent need for effective preventive strategies.^{3,8}

The lack of consensus on best practices for preventing these injuries is reflected in the variability of current strategies. Although risk assessment tools such as the Neonatal Skin Risk Assessment Scale (NSRAS) and the Braden Q Scale exist, their implementation and impact remain inconsistent.^{9,10} Similarly, preventive strategies such as mobilization, kangaroo care, the use of pressure-redistributing surfaces, and moisture control have demonstrated effectiveness, yet their application does not always follow a standardized, evidence-based approach.^{3,9–12} This heterogeneity impacts the quality of care provided and has consequences on health outcomes; therefore, this study employs the Delphi process to identify and prioritize the recommendations.

Given the vulnerability of neonates and the importance of establishing specific, evidence-based care measures, it is essential not only to

identify current practices for the prevention of dependency-related skin injuries but also to consolidate them into a clear and accessible set of recommendations. The primary objective of this study was to design and validate a decalogue for the prevention of dependency-related skin lesions in the neonatal population, based on existing consensus documents developed by the skin care working group of the Spanish Society of Neonatal Nursing and the Upppediatria scientific group, as well as on the most recent literature. This decalogue aims not only to standardize best practices but also to serve as an easy-to-read reference tool, synthesizing the evidence into a concise format for healthcare professionals. By promoting safe and effective care that minimizes the risk of injury, it seeks to improve the quality of life of hospitalized neonates. Given the relevance of this issue, the study focused on validating and designing a decalogue for the prevention of dependency-related skin lesions (DRSL) in the neonatal population based on existing consensus documents.

Methods

The Delphi methodology was employed through an expert consultation process to validate the content of the decalogue. The ACCurate Consensus Reporting Document (ACCORD) guidelines for reporting consensus methods in biomedicine were followed. The study was structured into three distinct phases: development of the initial questionnaire, composition of the expert panel, and an electronic survey using the e-Delphi panel.¹³

Development of the Initial Questionnaire

The initial questionnaire was designed following a comprehensive review of up-to-date clinical guidelines, consensus statements, systematic reviews, and original research focused on neonatal skin care and prevention of DRSL. A systematic search was conducted in databases (PubMed, TripDatabase, and GuíaSalud), institutional repositories (GuíaSalud, NICE), and scientific society libraries. A thematic synthesis of key preventive strategies was conducted, with inclusion criteria based on clinical relevance, recurrence in the literature, and alignment with current neonatal care standards. Terminology was standardized using internationally recognized nomenclature (e.g., “medical adhesive-related

skin injury,” “moisture-associated skin damage,” “family-centered care”). The preliminary items were grouped into three conceptual domains—assessment, prevention, and management—based on an integrated approach to neonatal care. This classification was informed by theoretical models of clinical risk management and the prevention of adverse events, ensuring coherence with established frameworks in neonatal practice. Organizing the items in this way enhanced the applicability of the decalogue in clinical protocols and facilitated its structured inclusion in the Delphi questionnaire, supporting its practical adoption in neonatal units.

Sample and Participants

A multidisciplinary panel of 20 experts, including neonatal nurses, university professors, and clinical researchers, was invited to participate. All panellists were members of the Upppediatria Group and/or the skin care working group of the Spanish Society of Neonatal Nursing. Experts were selected based on their experience in neonatal care and their knowledge of dependency-related skin lesions (DRSL). The inclusion criteria required more than 10 years of experience in neonatal care or at least 5 years of experience as a specialist paediatric nurse. In line with methodological considerations described by Hasson et al.¹⁴, a sample of 20 participants was deemed sufficient to ensure representativeness while maintaining manageability of data analysis. Additionally, a pilot test of the initial questionnaire was conducted with four neonatal care professionals to assess item clarity, terminology, and technical operability before initiating the Delphi rounds.

Delphi Rounds

The electronic survey was distributed via email, and responses were collected using a LimeSurvey database. Panellists were given two weeks per round to complete the survey. Intermediate results were analysed within one week, and aggregated, anonymised feedback (including median scores and interquartile ranges) was shared with participants. To maximise response rates, reminders were sent to non-respondents.

The study was conducted over four weeks, from December 2023 to January 2024. In both rounds, the objective was to establish content validity for each item. Participants independently evaluated relevance, clarity, ambiguity, and simplicity using a 4-point Likert scale:

- 1 = Not simple, unclear, irrelevant, or ambiguous
- 2 = Requires revision
- 3 = Requires minor revision
- 4 = Very relevant, clear, concise, and simple

Items achieving $\geq 75\%$ agreement advanced to the next round, while those below this threshold were revised or eliminated. To facilitate a confidential exchange of opinions, an open-ended section was included at the end of each question set.

Additionally, satisfaction and applicability of the decalogue were assessed in each round using a Likert scale (1 = worst, 10 = best). Consensus was defined as $\geq 75\%$ agreement across all items. Following recommendations from the scientific literature¹⁵⁻¹⁷, the expert panel also evaluated the content of the decalogue for subsequent calculation of the Content Validity Index (CVI) using Aiken's V statistic.¹⁸

Data Analysis

A descriptive analysis was performed to characterise the expert panel. The percentage of agreement (PA%) was used to determine the inclusion of items in the decalogue, defined as the proportion of responses rated as 3 (minor revision) or 4 (strongly agree). Consensus was established if PA% was $\geq 75\%$.

Mean and standard deviation (SD) were used to describe the central tendency and data dispersion. Data analysis was conducted using IBM SPSS Statistics 28.0.1.1. Qualitative comments were categorised thematically to identify recurring suggestions and areas of disagreement.

A freely available software developed by Merino et al. using Visual Basic 6.0 (Microsoft®, Washington)¹⁸ was used to calculate Aiken's V and confidence intervals.

Ethical Considerations

All participants provided informed consent for the processing of their personal data, and the confidentiality of their responses was maintained throughout the study.

Results

A total of nineteen scientific papers were reviewed, including two clinical practice guidelines, four consensus documents, six systematic reviews, and seven original research

papers. As a result of this literature review, a decalogue of recommendations covering ten key domains was developed.

The identification of the ten key domains comprising the clinical decalogue was based on a synthesis of recommendations derived from a comprehensive review of the scientific literature, including clinical practice guidelines, consensus statements, systematic reviews, and original research articles. These recommendations were thematically categorized and organized into an initial framework of functional domains. To minimize potential bias from a priori assumptions, domain validation was conducted through a Delphi consensus process involving clinical experts. Each item was independently evaluated, with participants invited to suggest modifications or propose additional perspectives through open commentary. This methodological approach ensured that the final domains reflected a consensus-driven and evidence-based framework, rather than solely the initial perspective of the research team.

Two rounds of consultation were conducted, involving 23 experts, of whom 20 participated in both rounds. The expert panel included professionals with extensive experience in neonatal care. Table 1 presents the background and experience of the expert panel. Of the total number of participants who met the inclusion criteria, 73.9% had more than 10 years of experience in neonatology, 26.1% held a master's degree in neonatology, and 87% were pediatric specialists. Additional qualifications included doctoral degrees, expertise in skin lesions, and more than 15 years of clinical experience in neonatology.

Table 1. Characteristics of the expert panel (n = 23).

Characteristic	n, (%)
Master's degree in Neonatology	6 (26,1)
Expert in Neonatology	3 (13)
Specialist in Paediatric Nursing	20 (87)
Continuing education in Neonatology	13 (56,5)
PhD in Neonatology	1 (4,3)
Master's Degree in Skin Lesions	2 (8,7)
Continuing Education in Skin Lesions	10 (43,5)
PhD in Skin Lesions	1 (4,3)
Experience in Neonatology (>15 years)	13 (56,5)
University teaching (>10 years)	3 (13)

In the first round, the mean validation score across all criteria was 3.821 (SD = 0.031), increasing to 3.95 (SD = 0.058) in the second round. Table 2 illustrates the evolution of validation scores across the four criteria between both consultation rounds.

Table 2. Evolution of Validation Criteria over Consultation Rounds.

Criteria	Round 1	Round 2
Relevance	3,827	4
Clarity	3,827	4
Ambiguity	3,779	3,9
Simplicity	3,852	3,9

The percentage of agreement for each criterion and item is detailed in the Table 3, as shown on the right-hand side of the table. All items exceeded 85% agreement in terms of relevance, clarity, ambiguity, and simplicity, with scores ranging between 3 (requires minor revision) and 4 (do not modify).

The first-round assessment of the Content Validity Index (CVI) for the Decalogue demonstrated high validity across all evaluated dimensions. The total CVI scores indicated strong expert agreement on the relevance (0.94), clarity (0.94), ambiguity (0.92), and simplicity (0.95) of the proposed recommendations. Among the individual items, the highest CVI scores were observed for recommendations related to protecting the skin from clinical devices and adhesives (relevance: 1.00) and ensuring regular postural changes (simplicity: 1.00), reflecting a consensus on their critical importance.

Table 3. Content validity index (CVI) Round 1 and Percentage of Agreement (Score 3 or 4) for Each Item and Round (R1 and R2)

1. Age and Care Plans					
	Content validity index (CVI) Round 1			Percentage of Agreement	
	M [SD]	CVI	CI 95%	R1	R2
Relevance	3.91 [0.29]	0.97	0.89 - 0.99	100%	100%
Clarity	3.78 [0.52]	0.92	0.84 - 0.96	95,6%	90%
Ambiguity	3.87 [0.46]	0.95	0.87 - 0.98	95,6%	85%
Simplicity	3.78 [0.52]	0.92	0.84 - 0.96	95,6%	90%
2. Regular Assessment					
	Content validity index (CVI) Round 1			Percentage of Agreement	
	M [SD]	CVI	CI 95%	R1	R2
Relevance	3.70 [0.70]	0.90	0.80 - 0.95	86,9%	100%
Clarity	3.83 [0.58]	0.94	0.86 - 0.97	91,3%	100%
Ambiguity	3.65 [0.83]	0.88	0.78 - 0.93	86,9%	95%
Simplicity	3.78 [0.60]	0.92	0.84 - 0.96	91,3%	95%
3. Postural Changes					
	Content validity index (CVI) Round 1			Percentage of Agreement	
	M [SD]	CVI	CI 95%	R1	R2
Relevance	3.87 [0.34]	0.95	0.87 - 0.99	100%	100%
Clarity	3.87 [0.46]	0.95	0.87 - 0.99	95,6%	100%
Ambiguity	3.87 [0.46]	0.95	0.87 - 0.99	95,6%	100%
Simplicity	4 [0]	1	0.94 - 1	100%	100%
4. Skin-to-Skin and FCC/DC					
	Content validity index (CVI) Round 1			Percentage of Agreement	
	M [SD]	CVI	CI 95%	R1	R2
Relevance	3.83 [0.39]	0.94	0.86 - 0.97	100%	100%
Clarity	3.91 [0.29]	0.97	0.89 - 0.99	100%	100%
Ambiguity	3.87 [0.46]	0.95	0.87 - 0.99	95,6%	100%
Simplicity	3.87 [0.63]	0.95	0.87 - 0.99	95,6%	100%

5. Special support surfaces					
	Content validity index (CVI) Round 1			Percentage of Agreement	
	M [SD]	CVI	CI 95%	R1	R2
Relevance	3.52 [0.67]	0.84	0.73 - 0.90	91,3%	100%
Clarity	3.83 [0.39]	0.94	0.86 - 0.97	100%	100%
Ambiguity	3.70 [0.76]	0.90	0.80 - 0.95	91,3%	100%
Simplicity	3.91 [0.42]	0.97	0.89 - 0.99	95,7%	100%

6. Skincare and moisturisation					
	Content validity index (CVI) Round 1			Percentage of Agreement	
	M [SD]	CVI	CI 95%	R1	R2
Relevance	3.74 [0.62]	0.91	0.82 - 0.95	91,3%	100%
Clarity	3.83 [0.49]	0.94	0.86 - 0.97	95,7%	100%
Ambiguity	3.74 [0.69]	0.91	0.82 - 0.95	95,7%	95%
Simplicity	3.96 [0.21]	0.98	0.92 - 0.99	100%	95%

7. Humidity Control					
	Content validity index (CVI) Round 1			Percentage of Agreement	
	M [SD]	CVI	CI 95%	R1	R2
Relevance	3.87 [0.46]	0.95	0.87 - 0.99	95,7%	100%
Clarity	3.78 [0.60]	0.92	0.84 - 0.96	91,3%	100%
Ambiguity	3.61 [0.78]	0.86	0.77 - 0.93	91,3%	100%
Simplicity	3.74 [0.75]	0.91	0.82 - 0.95	91,3%	95%

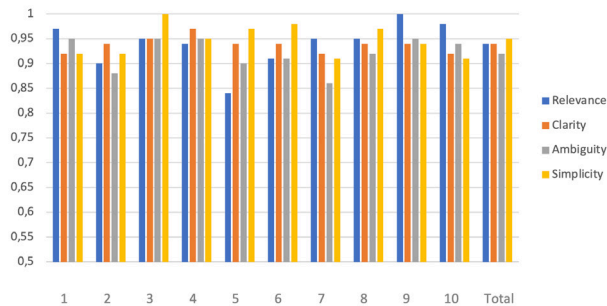
8. Nutritional Assessment and Breastfeeding					
	Content validity index (CVI) Round 1			Percentage of Agreement	
	M [SD]	CVI	CI 95%	R1	R2
Relevance	3.87 [0.34]	0.95	0.87 - 0.99	100%	95%
Clarity	3.83 [0.49]	0.94	0.86 - 0.97	95,7%	100%
Ambiguity	3.78 [0.67]	0.92	0.84 - 0.96	95,7%	95%
Simplicity	3.91 [0.29]	0.97	0.89 - 0.99	100%	100%

9. Device Protection					
	Content validity index (CVI) Round 1			Percentage of Agreement	
	M [SD]	CVI	CI 95%	R1	R2
Relevance	4 [0]	1	0.94 - 1	100%	100%
Clarity	3.83 [0.49]	0.94	0.86 - 0.97	95,7%	100%
Ambiguity	3.87 [0.46]	0.95	0.87 - 0.99	95,7%	95%
Simplicity	3.83 [0.49]	0.94	0.86 - 0.97	95,7%	95%

10. Documentation					
	Content validity index (CVI) Round 1			Percentage of Agreement	
	M [SD]	CVI	CI 95%	R1	R2
Relevance	3.96 [0.21]	0.98	0.92 - 0.99	100%	100%
Clarity	3.78 [0.52]	0.92	0.84 - 0.96	95,7%	100%
Ambiguity	3.83 [0.49]	0.94	0.86 - 0.97	95,7%	100%
Simplicity	3.74 [0.54]	0.91	0.82 - 0.95	95,7%	100%

CVI total of the Decalogue			
	M [SD]	CVI	CI 95%
Relevance	3.82 [0.14]	0.94	0.85 - 0.97
Clarity	3.82 [0.04]	0.94	0.85 - 0.97
Ambiguity	3.77 [0.10]	0.92	0.83 - 0.96
Simplicity	3.85 [0.09]	0.95	0.87 - 0.98

Conversely, the recommendation concerning the selection of special support surfaces received the lowest relevance score (0.84), highlighting the need for further refinement. (see Graphic 1 and Table 3).



Graph 1. Content Validity Index (V Aiken) for each item and the total of the decalogue in Round 1.

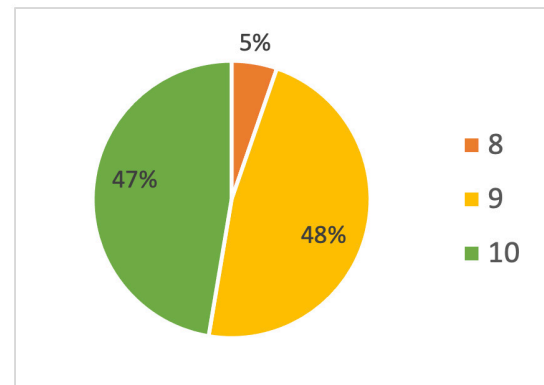
Although all items met the established consensus threshold, some were slightly reworded based on the qualitative feedback provided by the expert panel during the first Delphi round. Regarding overall satisfaction with the decalogue, the mean score was 9.35 (SD = 0.885) in the first round, increasing to 9.47 (SD = 0.679) in the second round (see Graphic 2). Similarly, the applicability score improved from 9.09 (SD = 1.083) to 9.42 (SD = 0.607) (see Graphic 3).

Table 4 presents the modifications made to the wording of certain items after the first round,

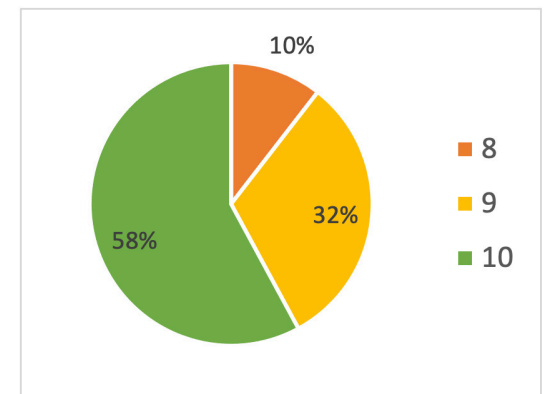
Table 4. Percentage of agreement (score 3 or 4) for each item and round (R1 or R2).

1 st Round (N 23)	Mean PA%	2 nd Round (N 20)	Mean PA%
DRSL does not depend on age but on the level of dependency. All vulnerable individuals may be at risk.	96,7	Design and implement standardised care plans to prevent DRSL, promoting continuous professional training. DRSL does not depend on age but on the level of dependency.	91,25
Regularly assess the risk of DRSL using validated and appropriate tools (e.g., e-NSRAS).	89,1	Regularly assess the risk of DRSL using validated and appropriate tools.	97,5
Ensure regular postural changes, monitoring skin condition and high-risk areas.	97,8	Ensure regular postural changes, monitoring skin condition and high-risk areas.	100
Encourage skin-to-skin contact and promote family-centered care (FCC) and developmental care (DC).	97,8	Encourage skin-to-skin contact and respect family-centered care (FCC) and developmental care (DC).	100
Select the appropriate Special support surfaces to redistribute pressure according to the pathology and risk level of neonatal patients.	94,58	Select the appropriate Special support surfaces to redistribute pressure according to the pathology and risk level of neonatal patients.	100
Provide appropriate skincare and moisturisation based on the corrected gestational age and skin maturity status.	95,68	Provide appropriate skincare and moisturisation based on the corrected gestational age and skin maturity status.	97,5
Controls excess humidity. Mixed incontinence, drains, and condensation in tubes contribute to skin damage. Nappy rash is the primary DRSL.	92,40	Controls excess humidity. Identify and manage excessive moisture sources affecting the skin: mixed incontinence, drains, condensation in tubes, etc. Nappy rash is the primary DRSL.	98,75
Assess nutritional status and promote breastfeeding, as adequate nutrition and breastfeeding reduce DRSL risk. A well-nourished neonate has a lower risk of developing new injuries.	100	Assess nutritional status and promote breastfeeding, as adequate nutrition and breastfeeding reduce DRSL risk.	100
Protect the skin from clinical devices and adhesives. Non-invasive ventilation (NIV), invasive mechanical ventilation (IMV), vascular access, and diagnostic sensors are major causes of medical adhesive-related skin injuries (MARSIs) and pressure injuries in neonatal patients.	96,78	Protect the skin from clinical devices and adhesives. Non-invasive ventilation (NIV), invasive mechanical ventilation (IMV), vascular access, and diagnostic sensors are major causes of MARSIs and pressure injuries in neonatal patients.	97,50
Record all injuries, assessments, risk factors, and preventive measures to generate epidemiological indicators and scientific evidence. Include paediatric and neonatal patients in epidemiological studies in all hospitals where they are treated. Ignoring this is not an option.	96,78	Record all injuries, assessments, risk factors, and preventive measures to generate epidemiological indicators and scientific evidence, as well as for cost-effective management.	100

based on the qualitative feedback provided by the panel, with the aim of enhancing the precision, clarity, or applicability of the recommendations.



Graph 2. Applicability of the Decalogue (N = 20) Rating from 1 to 10.



Graph 3. Satisfaction with the Decalogue (N = 20). Rating from 1 to 10.

After the literature review and two rounds of expert consultation, the final decalogue for the prevention of dependency-related skin lesions (DRSL) in neonates was established:

- Design and implement standardised care plans to prevent DRSL, promoting continuous professional training. DRSL does not depend on age but on the level of dependency.
- Regularly assess the risk of DRSL using validated and appropriate tools.
- Ensure regular postural changes, monitoring skin condition and high-risk areas.
- Encourage skin-to-skin contact and promote family-centered care (FCC) and developmental care (DC).
- Select the appropriate Special support surfaces to redistribute pressure according to the pathology and risk level of neonatal patients.
- Provide appropriate skincare and moisturisation based on the corrected gestational age and skin maturity status.
- Controls excess humidity. Mixed incontinence, drains, and condensation in tubes contribute to skin damage. Nappy rash is the primary DRSL.
- Assess nutritional status and promote breastfeeding, as adequate nutrition and breastfeeding reduce DRSL risk.
- Protect the skin from clinical devices and adhesives. Non-invasive ventilation (NIV), invasive mechanical ventilation (IMV), vascular access, and diagnostic sensors are major causes of medical adhesive-related skin injuries (MARSI) and pressure injuries in neonatal patients.
- Record all injuries, assessments, risk factors, and preventive measures to generate epidemiological indicators and scientific evidence, as well as for cost-effective management.

Discussion

With the participation of a group of healthcare professionals with expertise in skin care in the neonatal population, this study selected the ten main domains to be considered in the prevention of dependency-related skin lesions (DRSL). After two Delphi rounds, in which

experts blindly assessed each other, high validity values were obtained, demonstrating a strong level of consensus. Until this study, prevention had been approached as separate interventions depending on the type of skin lesion (pressure injuries, friction injuries, or humidity-related injuries). However, this project has designed and validated a decalogue of recommendations for the prevention of DRSL.^{19–21}

When designing a comprehensive skin care plan for hospitalized neonatal patients, it is necessary to rely on validated tools, guidelines, and protocols, agreed upon by experts in neonatal skin care, to prevent the occurrence of skin lesions.^{19–21} In neonatal care, multiple skin care practices have been identified without solid scientific evidence, often depending on the cultural, social, or healthcare context in which clinical care is provided. To ensure that essential knowledge on neonatal skin care reaches healthcare professionals, recommendations should be clearly formulated to facilitate understanding, emphasizing the main guidelines and instructions to be followed.^{22–24}

A neonatal patient is exposed to multiple interventions aimed at diagnosis and treatment. Not all procedures necessarily place the neonate at high risk of developing skin lesions. It is therefore essential to identify the key risk factors. The use of assessment tools, whether risk prediction tools—such as scales for assessing pressure injury risk^{19,20,22,25–27}—or diagnostic tools—such as scales for evaluating diaper dermatitis²⁸—can help to reduce both the incidence and severity of skin lesions.²⁹

Different authors argue that, to reduce DRSL rates, healthcare teams trained in prevention should be in place, with specific roles dedicated to identifying, reporting, and monitoring skin lesions associated with risk factors, such as clinical devices.^{19,20,30} However, the presence of specialized teams or protocols alone does not necessarily reduce the incidence of injuries without intensive and continuous training. Visscher³¹ concluded that the establishment of a specialized lesion detection team resulted in a slight decrease in incidence, although the impact was limited due to the number of factors involved in skin lesion development.

For the reduction of DRSL to be significant and sustainable, the scientific literature suggests that, in addition to having an action guide, it is essential to prioritize key interventions that have proven

effective. Jani²¹ supports the implementation of a local care guide, as suggested by other authors, but emphasizes the need to assess skin condition every four hours to prevent skin lesions.

The acquisition, availability, and use of medical devices, and inappropriate use may increase the risk of skin damage in neonates. Munson³² highlights that while these medical devices are widely utilized in neonatal units, there are no standardized protocols governing their application frequency or removal, which poses a potential risk to neonatal skin integrity. Similarly, Lund³³ reinforce the need for evidence-based, standardized protocols for neonatal skincare.

Since scientific evidence on the use of topical medical products (dressings, biological adhesives, solutions, creams, or sprays) in neonates is very scarce, with low potency and significant limitations^{34,35}, it is essential to recognize and investigate both the characteristics of these products and the preferences of healthcare professionals, depending on the care context (critical or intermediate care).³⁶ Boswell³⁷ observed that, anecdotally, neonatal nurses prefer transparent polyurethane dressings instead of hydrocolloid dressings for tube and probe fixation. However, the study found no significant differences in effectiveness between the two dressings in reducing skin lesions of the MARS type.

If we analyze one of the devices most frequently associated with skin lesions in hospitalized neonatal patients, such as non-invasive mechanical ventilation (NIV), we observe uncertainties in skin care and a need to adapt recommendations to the specific context of each center. Healthcare professionals must recognize that neonates on NIV are at high risk of pressure injuries, friction injuries, and humidity-related injuries.^{24,38–40} Therefore, they must receive consistent training in the main prevention measures, which include individualized selection of the interface^{38,41}, rotation of interfaces^{39,42}, correct fixation techniques⁴³, and selection of appropriate protective dressings.⁴⁴

Nie⁴⁵ propose a set of recommendations for the prevention of pressure injuries in pediatric patients. While their work aligns with our study in its focus on preventive measures, key methodological differences set the two apart. Our decalogue extends beyond pressure injuries to encompass all DRSL in neonates, addressing a broader spectrum of skin damage associated

with neonatal care. Additionally, unlike Nie⁴⁵, our study employs a rigorous validation process through expert consensus using the Delphi methodology, ensuring a high level of agreement on each recommendation. Furthermore, our analysis incorporates the Content Validity Index (CVI) to assess the clarity, relevance, ambiguity, and simplicity of each item, providing a quantitative measure of the decalogue's robustness. Another notable distinction is our strong emphasis on family-centered care and skin-to-skin contact as key preventive strategies, which are not as prominently discussed in the compared study. These differences highlight the need for validated, consensus-based guidelines tailored to neonatal care, ensuring their clinical applicability and effectiveness in preventing DRSL.

Various scientific societies, both in the wound care field (SEHER, GNEAUPP, EPUAP, EWMA, Upppediatria) and in neonatal care (Sociedad Española de Enfermería Neonatal, Association of Women's Health, Obstetric and Neonatal Nursing, Società Italiana di Neonatologia Infermieristica), are making significant efforts to compile and disseminate the most current scientific evidence on the prevention of neonatal skin lesions. However, this information is often scattered across guidelines and consensus documents, which hinders rapid and effective access to key recommendations. The creation of simplified compilations, such as the prevention decalogue validated by experts, could facilitate intensive and continuous training of healthcare professionals in neonatal skin care. As supported by the scientific community, such resources would allow professionals to recognize, understand, and correctly implement prevention strategies, ultimately reducing the incidence of skin lesions.^{6,46–50}

This study presents certain limitations that should be considered when interpreting the results. First, the expert panel was composed primarily of professionals affiliated with scientific societies and working groups specializing in neonatal care, which may have biased responses towards recommendations with stronger consensus within these groups. Additionally, although robust in reaching a consensus, the Delphi methodology relies heavily on active participation, and a reduction in the number of experts across rounds could limit the diversity of opinions.

Another important limitation is that the

decatalogue's validation was based exclusively on expert opinions, without preliminary clinical trials to assess its real impact on DRSL prevention. Furthermore, as August highlighted in his review, terminology inconsistencies regarding neonatal skin lesions complicate unified diagnoses and treatment approaches, representing another challenge in achieving consensus.

Despite these limitations, the decatalogue offers a practical and applicable guide for healthcare professionals working in neonatal care units. Its high scores in relevance, clarity, ambiguity, and simplicity criteria support its implementation in different clinical contexts. The recommendations provided align with current evidence and are designed to be adaptable according to the specific needs of each neonatal center. Additionally, the decatalogue serves as an educational tool for training new professionals and promoting standardized neonatal skin care practices at a national level.

This study establishes a foundation for future research in several areas. First, multicenter clinical studies are necessary to assess whether the integration of the decatalogue into continuous education programs and its dissemination among healthcare professionals contribute to a reduction in neonatal DRSL incidence. These studies should incorporate clinical indicators, such as skin lesion prevalence, as well as patient- and family-centered outcomes, including pain levels and length of hospitalization.

Furthermore, the economic impact of implementing the decatalogue in neonatal units could be investigated. Finally, the development of digital tools to facilitate the application, monitoring, and documentation of the decatalogue's recommendations could represent a promising area for further research.

Clinical Implications

This validated decatalogue will facilitate that training interventions to prevent dependency-related skin lesions in newborns aimed at health professionals contain the ten basic key points validated by a panel of experts.

Conclusions

This study facilitated the design and validation of a decatalogue for the prevention of dependency-related skin lesions (DRSL) in neonates through a Delphi process with experts. The results

show a high level of consensus regarding the relevance, clarity, applicability, and simplicity of the included recommendations. The decatalogue serves as a practical guide that can support healthcare professionals in enhancing neonatal care quality and reducing the incidence of DRSL.

Despite its limitations, the decatalogue is presented as a valuable tool for standardizing best practices across neonatal units, whether critical, intermediate, or basic care settings. Its implementation and assessment in real clinical environments are strongly recommended, alongside further studies to validate its effectiveness and long-term applicability.

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Nursing's Role in Prevention Interventions and Therapeutic Education for Patients with Critical Limb-Threatening Ischemia: a Scoping Review Protocol

Citation: Colella R, Zanetti C, De Mola A, Cardilicchia A, Macchitella C, Testa G, Longobucco Y, Zanini E, Scotti V, Di Stasio G, Rossi M, Bellingeri A. "Nursing's Role in Prevention Interventions and Therapeutic Education for Patients with Critical Limb-Threatening Ischemia: a Scoping Review Protocol" (2025) *International Journal of Wound Research* 1(1) 1(1): 47-52. DOI: 10.64115/ijwr-2025-6

Received: April 26, 2025

Revised: June 9, 2025

Just accepted online: June 30, 2025

Published: June 30, 2025

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Data Availability Statement: All relevant data are within the paper and its Supporting Information files. This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination, and proofreading process, which may lead to differences between this

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Abstract

Introduction. Chronic Limb-Threatening Ischemia (CLTI) represents the advanced stage of Peripheral Artery Disease (PAD), a condition with increasing prevalence worldwide due to the rising burden of risk factors and comorbidities, and consequently, escalating healthcare costs. CLTI is a highly morbid condition, often leading to limb loss, chronic pain, and significantly impaired health-related quality of life. Despite its severe consequences, CLTI remains underrecognized. Patients often realise the severity of the disease at a late stage, when revascularisation attempts may no longer be useful. Primary prevention interventions are essential for early diagnosis and correct patient pathway. The trained nurse could have an important role in the community in identifying and managing this disease. This scoping review aims to evaluate the literature

version and the Version of Record.

Competing Interests: The author(s) declare(s) no conflict of interest.

on knowledge of nurses about preventive interventions and therapeutic education, and how, and raising awareness of this disease among professionals and individuals from a community medicine perspective, this topic can be developed using the potential of nurses in the team.

Methods. The Joanna Briggs Institute Reviewers' Manual and the framework developed by Arksey and O'Malley were used as the guidelines for the scoping review that is suggested in this protocol. Accordingly, the PCC (Population, Concept, Context) model was adopted. The Preferred Reporting Items for Systematic and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) will be followed for reporting the research and the results. The databases will include MEDLINE/ PubMed, Cochrane, CINAHL and grey literature sources.

Expected results. The main expected results will be the mapping of available evidence and the implementation of knowledge regarding available nursing interventions as well as improved adherence to educational interventions.

Keyword: Chronic Limb Ischemia, CLTI, Nursing, Prevention, Education Health

Introduction

Critical ischemia of the lower limbs (CLI), defined as ischemic pain at rest or non-healing injury resulting from arterial insufficiency, is the most serious and life-threatening peripheral arterial disease condition of the lower limbs and affects adults, on average, over 60 years of age.¹

The global prevalence of PAD is 1.52%; it increases with age and is higher in females than in males (18.03% vs. 10.56% in the same age group). PAD prevalence rose by 72% from 1990 to 2019, considering a 45% growth rate in the world population.² Globally, Chronic Limb-Threatening Ischemia (CLTI) is estimated to affect approximately 1–2% of the adult population.¹ CLTI affects more than 2 million people in the United States and has an estimated mortality risk of 24% within the first year of diagnosis and 60% over 5 years.³

In Italy, it is estimated that approximately 26 700 new cases of critical limb ischemia (CLI) occur each year, corresponding to 468 new patients per million inhabitants.⁴

Despite its severe consequences, CLTI remains underrecognized, often diagnosed late, leaving patients at risk of ulcers, emergency admissions, limb amputation, and life-threatening complications.

The term Critical Limb Ischaemia (CLI) was first introduced in 1982. Its definition has long been debated, as it could include a broad group of patients at risk of amputation, considering various degrees of ischaemia based on classification systems such as WIFI^{3,4}, GLASS⁵, Fontaine-Leriche classification—many of which are still in use today. The 2019 Global Vascular Guideline (GVG) defined CLTI to include a broader and more heterogeneous group of patients with varying degrees of ischaemia, which can delay wound healing and increase the risk of amputation.¹

Epidemiological data show that PAD prevalence varies across contexts: men are more affected in high-income countries (HICs), whereas women show a higher prevalence in low- and middle-income countries (LMICs). As global life expectancy rises, the burden of PAD is expected to increase, particularly in LMICs, with a substantial number of cases occurring in individuals under 55 years old.⁵

The scientific literature reiterates the importance of teams consisting of nurses, podiatrists, and vascular surgeons in the management and prevention of CLTI, but we found little literature regarding the interventions and potential of nurses in the community to foster greater awareness in primary prevention.^{6,7} Most articles focused on management and treatment,

but few addressed nursing interventions in primary prevention, the identification of signs and symptoms by nurses to foster early diagnosis, or the role of health education in increasing this awareness.^{8,9}

Aware of the potential that nurses, podiatrists, and primary care physicians in the community could have to foster early diagnosis, this review aims to deepen and systematically investigate the literature on nursing interventions in this area.

The aim of this scoping review is to investigate and review the existing literature on prevention and therapeutic education interventions carried out by nurses. The research question is: “Which nursing interventions for education and prevention of CLTI have been described in the literature?” The research question is structured as follows:

- Population: patients with suspected CLTI / patients at risk of CLTI;
- Concept: literature mapping of therapeutic-education interventions and thus prevention of CLTI in non-hospitalized patients carried out by nurses;
- Context: community/home care.

In the context of modern, community-based healthcare systems, increasing awareness and early recognition of conditions like CLTI could play a key role in preventing severe patient outcomes and reducing healthcare-system strain. Scoping reviews are a valuable method for addressing broad research questions and mapping existing prevention strategies for CLTI, including those based on health education and physical-activity programs.

Methods

This protocol was developed in accordance with the methodological guidance provided by the Joanna Briggs Institute (JBI), with the aim of rigorously defining the objectives of the review and ensuring methodological transparency throughout the process.^{10,11} The protocol was prospectively registered and made publicly available on the Open Science Framework (OSF) registry (<https://osf.io/w2b39/>) prior to the commencement of data collection.

The forthcoming scoping review will be conducted in alignment with the JBI Manual for Evidence Synthesis and, accordingly, will utilize the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist.^{3,12} The scoping review methodology is considered

the most appropriate approach for this study, as it allows for comprehensive mapping of the existing literature, facilitates the clarification of key concepts and definitions, and supports an in-depth examination of how research in this field has been designed and conducted.

The methodological framework will follow the recommended structure, focusing on the elements of Population, Concept, and Context (PCC), and will proceed through five key stages:

1. identification of the research question,
2. identification of relevant studies,
3. selection of studies,
4. charting of the data,
5. collation and summarization of the results.

An initial exploratory search of the databases was conducted prior to the formal systematic search, which was carried out up to September 2024. Following this, data analysis is currently ongoing, with progression through the subsequent phases of the review, including study selection, data extraction, synthesis of findings, and preparation of the manuscript. The systematic database search was initiated after registration of the protocol.

Eligibility criteria

Considering the Population, Concept, and Context described earlier, the following inclusion criteria were established:

- Patients over the age of 18
- Patients with suspected CLI or at risk of CLI, evaluated using the Leriche-Fontaine classification
- Patients residing in the community/territory
- Studies addressing therapeutic education or prevention of CLI
- Articles written in English or Italian
- Published within the last 5 years
- Patients with a diagnosis of PAD

The exclusion criteria are as follows:

- Paediatric patients
- Hospitalized patients
- Patients with ischemic leg ulcers

The authors aim to investigate the literature on nursing interventions for the early recognition and management of individuals in the initial phase of Chronic Limb-Threatening Ischemia (CLTI). This scoping review does not focus on the treatment of skin ulcers, hospitalized patients, or individuals in the advanced stages of the disease.

Expected outcomes

The main expected outcomes will include the following:

1. Nurses' knowledge of CLTI prevention in community settings.

Secondary outcomes:

1. Adherence to therapeutic education

- interventions, as measured by the incidence of new injuries.
2. Management of pain in patients with CLTI.
3. Improvement in personal autonomy.
4. Improvement in health-related quality of life.

Strengths and limitations of this study

Scoping reviews represent a valid methodological approach for addressing broad research questions and, as such, are well suited to provide an overview of CLTI prevention programmes focused on health education, including physical activity interventions. A rigorous search strategy was developed in collaboration with a librarian experienced in systematic and scoping review methodologies. This review will include studies published in English and Italian. Articles published in other languages will be excluded due to the unavailability of adequate translation resources. Given the exploratory nature of the scoping review, a critical appraisal of study quality and risk of bias will not be undertaken.

Information sources and search strategy

The authors conducted searches in the following electronic bibliographic databases up to September 2024, including randomized studies, observational studies, controlled studies, guidelines, and published systematic reviews: PubMed, EMBASE, Cochrane Library, and CINAHL. Additional bibliographic sources for grey literature were also consulted: Google Scholar (titles from the first 10 pages of search results were screened, as a stopping rule), Open Access Theses and Dissertations, GreySource, Web of Science, the US National Institutes of

Health Trials Register (<https://clinicaltrials.gov/>), and the WHO International Clinical Trials Registry Platform (<https://trialsearch.who.int/>).

The bibliographic search strategy was initially developed for PubMed. The translated search strategies will be reviewed for accuracy and then adapted to each of the additional databases, including EMBASE, CINAHL, and the Cochrane Library (see Table 1).

The searches will be conducted at the scientific library of the San Matteo Polyclinic in Pavia, with the support of an experienced librarian.

Source selection and data charting process

All records will be deduplicated by one author using Rayyan. Additional manual checks for duplicates will be performed prior to initiating the review process. Titles and/or abstracts of studies retrieved through the search strategy, as well as those identified from additional sources, will be independently screened by two reviewers using Rayyan to identify studies that potentially meet the inclusion criteria described above. The full texts of potentially eligible studies will be retrieved and independently assessed for eligibility by both reviewers. Any disagreements regarding the inclusion of specific studies will be resolved through discussion with a third reviewer.

Studies excluded during this phase will be recorded in a PRISMA flow diagram, along with the corresponding reasons for exclusion. Discrepancies will be discussed and resolved through consensus with a third reviewer.

Following the screening process, data will be extracted and entered into a structured Excel-based data extraction tool. Data extraction will be performed independently by two reviewers using a customized extraction form. The extraction protocol will be piloted on the first five included studies to ensure consistency in the process; any necessary modifications to the data extraction form will be made and documented accordingly. Subsequently, each reviewer will independently extract data from half of the included articles.

Data to be extracted will include the following domains: publication details, participant characteristics, description of interventions, comparison groups (if applicable), and study results.

Data extracted from each article will include:

- Study details (e.g. name of first author, year of publication, country, funding source, setting);
- Description of the study population and participant demographics, including baseline characteristics;
- Study design and methodology;
- Information on the intervention(s);
- Details of any comparison group(s);

Table 1. Data charting form. Items considered for data extraction.

ITEMS CONSIDERED	COMMENTS
Authors	
Years	
Title	
DOI	
Population	Patient with CLTI and PAD
Concept	Concept or aim of the study
Context	Community or Hospital
Type of study	Case study, observational study, review, trial, other...
Results	The primary and additional outcomes being measured in the study
Role of nurses in prevention of CLT	In specific information about nurses' intervention in CLTI prevention
Notes	Additional comment or notes

- Study recruitment and completion rates;
- Reported outcomes and timing of measurements;
- Description of the prevention interventions implemented;
- Information relevant to risk of bias assessment.

Corresponding authors will be contacted to provide clarification in cases of missing or unclear data, when appropriate. Authors who do not respond after three follow-up emails will be classified as non-responders.

Data items

This scoping review aims to address the following questions:

- What research has been conducted in this field?
- What gaps exist in the current literature?
- Which populations have been studied?
- What progress has been made in the field?
- How have policies evolved over time?
- What are the key concepts and terminology used in this area of research?
- How is research typically conducted in this field?
- Is the existing literature sufficient to support a systematic review?

Ethics and dissemination

Ethical approval is not required for this scoping review, as it involves the analysis of previously published studies and does not include any primary data collection involving human participants. The authors intend to disseminate the findings of this review through presentations at scientific conferences and publication in peer-reviewed journals.

Expected results

Despite ongoing efforts to promote public health awareness and education regarding the prevalence of peripheral arterial disease (PAD), the ischemic limb at risk remains underrecognized in a significant proportion of patients with critical limb ischemia (CLI). Broader implementation and development of both primary and secondary prevention strategies are needed, alongside improved dissemination of guideline recommendations to healthcare professionals and patients with PAD and CLI.

This scoping review aims to increase awareness of the condition among both healthcare professionals and the general public. It also seeks to examine and evaluate the existing literature in order to enhance prevention strategies, particularly within community and territorial healthcare settings.

The findings will be synthesized and presented through tables and conceptual maps.

Patient and public involvement

We plan to disseminate the results of the scoping review through conference presentations and peer-reviewed publications. The objective is to support stakeholder engagement and raise awareness among key audiences, including nurses, general practitioners, physiotherapists, patients, and caregivers.

Authors' contributions

RC, as the project lead, contributed to the formation of the research team and the development of the protocol, and collaborated with CZ on its reporting. YL and GT were responsible for the methodological components of the study, with GT also managing the use of Rayyan. VS, an expert librarian at the Scientific Library of San Matteo Hospital, Pavia, Italy, supported the literature search strategy.

CM, ADM, AC, EZ, CZ, and RC composed the review team, contributing to data extraction and manuscript preparation. Two authors with methodological expertise supervised the assessment of methodological quality. Six authors, organized into three independent pairs, conducted article screening and analysis. In the case of disagreements, the project lead intervened to facilitate resolution.

All authors contributed to and approved the final version of the manuscript.

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Omega-3 Fatty Acids and Wound Healing: Enhancing Recovery in Chronic Ulcers

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Wound healing is a complex biological process involving a cascade of cellular and molecular mechanisms aimed at repairing damaged tissue. Nutrition plays a crucial role in influencing the body's ability to modulate inflammation, promote cell regeneration, and enhance immune function. In recent years, Omega-3 fatty acids have gained attention as powerful allies in managing chronic wounds, such as pressure ulcers, diabetic foot ulcers, and venous ulcers. These essential fatty acids, predominantly found in oily fish (salmon, mackerel, sardines), flaxseeds, walnuts, and fish oil, exert profound effects on inflammation resolution and tissue repair. The two most bioactive components of this group, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are well known for their potent anti-inflammatory properties and their ability to modulate cellular processes involved in wound healing.¹

The wound healing process occurs in three overlapping yet distinct phases: inflammation, proliferation, and remodeling. The initial inflammatory response is critical for removing pathogens and necrotic debris. Leukocytes, including neutrophils and macrophages, infiltrate the wound site, releasing pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF- α) and interleukin-6 (IL-6), which help coordinate immune responses.²

However, in chronic wounds, this inflammatory phase can become prolonged, preventing progression to subsequent healing stages. Omega-3 fatty acids intervene by promoting the resolution of inflammation rather than merely

suppressing it. EPA and DHA serve as precursors for specialized pro-resolving lipid mediators (SPMs), including resolvins, protectins, and maresins. These molecules actively signal the termination of inflammation by limiting neutrophil infiltration, enhancing macrophage-mediated clearance of cellular debris, and shifting macrophages from a pro-inflammatory (M1) to an anti-inflammatory (M2) phenotype.³ This transition is essential for allowing tissue repair mechanisms to take over.

Beyond their role in inflammation resolution, Omega-3 fatty acids significantly contribute to cellular proliferation, migration, and extracellular matrix remodeling. Fibroblasts, key players in wound healing, are stimulated by EPA and DHA to enhance their proliferative and migratory capacity, promoting the formation of granulation tissue.⁴ Additionally, keratinocytes, the main epithelial cells responsible for re-epithelialization, show increased mobility and adhesion in the presence of Omega-3, accelerating wound closure.⁵

Collagen synthesis, another crucial aspect of wound healing, is also positively influenced by Omega-3 fatty acids. Collagen provides structural integrity and tensile strength to newly formed tissue. Studies have demonstrated that EPA and DHA increase the expression of genes involved in collagen deposition and decrease matrix metalloproteinases (MMPs), enzymes that degrade the extracellular matrix and contribute to excessive tissue breakdown in chronic wounds.⁶

Another critical factor in chronic wound healing is impaired microcirculation, which limits oxygen and nutrient delivery to the affected area. Patients with diabetes or vascular disorders often exhibit endothelial dysfunction, which further exacerbates poor wound healing. Omega-3 fatty acids have been shown to improve endothelial function by increasing nitric oxide (NO) bioavailability, reducing oxidative stress, and improving blood flow.⁷ These effects enhance oxygenation and nutrient supply to the wound site, fostering an optimal environment for cell proliferation and tissue repair.

Several clinical studies have highlighted the potential benefits of Omega-3 supplementation in chronic wound management. Research has demonstrated that patients receiving Omega-3-rich diets or supplementation exhibit improved wound closure rates, reduced inflammation, and enhanced collagen deposition compared to those without Omega-3 intake.⁴ In diabetic patients, Omega-3 supplementation has been associated with reduced oxidative stress and improved glycemic control, both of which contribute to better wound healing outcomes.⁵

To harness the benefits of Omega-3 fatty acids, dietary incorporation of Omega-3-rich foods is essential. Fatty fish such as salmon, mackerel, and herring are the most potent natural sources. For individuals following plant-based diets, flaxseeds, chia seeds, walnuts, and algae-based supplements offer viable alternatives. However, it is important to balance Omega-3 intake with other crucial nutrients involved in wound healing:

- **Vitamin C:** Essential for collagen synthesis and angiogenesis, vitamin C deficiency can impair healing and increase susceptibility to infection.
- **Protein:** A vital component for tissue repair and immune function; inadequate protein intake can delay wound healing.
- **Zinc:** Plays a fundamental role in protein and collagen synthesis; its deficiency can slow down tissue regeneration.
- **Arginine:** An amino acid that contributes to structural protein formation and supports immune function, ultimately improving the tensile strength of healed tissues.

Omega-3 fatty acids play a key role in wound healing, not only by modulating inflammation but also by promoting tissue regeneration, enhancing vascular function, and improving

collagen synthesis. Their supplementation is an active strategy in the management of chronic wounds, particularly in individuals with reduced healing capacity due to diabetes, vascular disease, or aging. By incorporating Omega-3-rich foods into the daily diet and ensuring an adequate intake of complementary nutrients, the healing process can be optimized, improving clinical outcomes and quality of life.

This update is published for informative and editorial purposes only. It is not indexed and has not been assigned a DOI.

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