OPEN ACCESS

Bromelain-Based Enzymatic Debridement in Major Burns: A Standardized Clinical Pathway and Nursing-Sensitive Management

Citation: Cecere, L., De Crescenzo, T., Falanga, A., Della Sala, M., Limonti, F., Abagnale, M., Gravante, F., Tomasello, A., Pota, V., & Villani, R. (2026). Bromelain-based enzymatic debridement in major burns: A standardized clinical pathway and nursing-sensitive management. *International Journal of Wound Research* 2(3): 251-259. DOI: https://doi.org/10.64115/w9gf6a66

Received: May 14, 2026

Revised: July 27, 2026

Just accepted: Septembr 26, 2026

Published: Septembr 26, 2026

Correspondence: Luciano Cecere - Department of Anesthesia and Resuscitation, Major Burn Intensive Care Unit, A.O.R.N. "Antonio Cardarelli", Via A. Cardarelli 9, 80131 Naples, Italy. Email: luciano.cecere@aocardarelli.it

Copyright: © The Author(s) 2026. This article is distributed under the terms of the Creative Commons Attribution 4.0 International (CC BY 4.0).

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Conflict of Interest: The author(s) declare(s) no conflict of interest.

Funding: This research received no external funding.

Luciano Cecere[1], Tonia De Crescenzo[1], Antonella Falanga[1], Marzia Della Sala[1], Francesco Limonti[2], Marco Abagnale[3], Francesco Gravante[4], Antonio Tomasello[1], Vincenzo Pota[5], Romolo Villani[1]

[1] Major Burn Intensive Care Unit, Department of Anesthesia and Resuscitation, A.O.R.N. "Antonio Cardarelli", Naples, Italy
[2] Department of Cardio-Thoracic and Vascular Sciences, A.O.U. "Arcispedale Sant'Anna", Ferrara, Italy
[3] Department of Critical Care, "Mauro Scarlato" Hospital, Local Health Authority Salerno, Scafati, Italy
[4] Department of Anesthesia and Resuscitation, "San Giuseppe Moscati" Hospital, Local Health Authority Caserta, Aversa, Italy
[5] Department of Woman, Child, General and Specialistic Surgery, University of Campania "Luigi Vanvitelli", Naples, Italy

Abstract

Introduction. Deep partial-thickness and full-thickness burns frequently require early eschar removal to reduce complications and support wound healing. Conventional surgical debridement, although effective, may result in blood loss, removal of viable tissue, and substantial resource use. Bromelain-based enzymatic debridement offers a selective, minimally invasive alternative that may preserve viable dermal structures while reducing the need for surgical excision.

Procedure or Intervention. This Procedure Update describes the standardized multidisciplinary clinical pathway adopted in a Major Burns Intensive Care Unit for bromelain-based enzymatic debridement using NexoBrid®. The pathway integrates plastic surgeons, anesthesiologist-intensivists, and nursing staff and encompasses patient assessment, environmental and sterile field preparation, wound preparation, product preparation and application, continuous monitoring during treatment, product removal, post-treatment wound management, and clinical

documentation.
Key Updates. The pathway defines the sequence of care, professional responsibilities, safety measures, and nursing competencies required throughout the procedure. Particular emphasis is placed on multiparametric monitoring, pain assessment and management, maintenance of aseptic technique, protection of perilesional skin, surveillance for bleeding, and accurate procedural traceability. Proposed nursing-sensitive quality indicators are also presented to support future evaluation of care processes and outcomes.
Clinical Implications. Standardizing the procedure may support consistency, safety, and multidisciplinary coordination in enzymatic burn wound debridement. Clearly defined nursing competencies and structured training are essential for appropriate implementation and ongoing quality improvement.
Conclusions. A structured multidisciplinary pathway provides a practical framework for the safe and standardized delivery of bromelain-based enzymatic debridement in major burn care. Prospective multicenter studies and formal quality audits are needed to evaluate its clinical, organizational, and nursing-sensitive outcomes.

Keyword: Burn Care, Burn Nursing, Nursing Clinical Pathway, Bromelain-based Debridement, Enzymatic Debridement

Introduction

Burns are traumatic injuries affecting the skin or other tissues, caused by thermal, chemical, electrical, or radiation exposure (American Burn Association, 2012; Hussain & Dunn, 2013; Porter et al., 2016; Sheridan, 2001). They are classified according to the depth of the lesion as follows: epidermal (first degree), partial-thickness (second degree, which may be either superficial or deep), and full-thickness (third degree), as well as by the percentage of total body surface area involved (TBSA) (American Burn Association, 2012; Hussain & Dunn, 2013; Kagan et al., 2009; Porter et al., 2016; Sheridan, 2001). Burn depth is a key determinant of both mortality and the long-term morphological and functional outcomes in patients (Kagan et al., 2009; Orgill, 2009; Sheridan, 2001).

More severe burns can result in clinically significant morbidity and, if not adequately treated, may lead to serious cicatricial sequelae (Sheridan, 2001). Major burns elicit a profound systemic response with long-term effects on the patient. Inadequate or particularly delayed management can lead to a rapid and progressive course of organ failure culminating in death (Porter et al., 2016). A recent systematic review of the literature highlights that both age and TBSA are strong predictors of outcomes among those commonly used in burn care (Hussain & Dunn, 2013). Data reported by the United States National Burn Registry indicate that the overall mortality rate increases from 0.6% in cases involving less than 10% TBSA to 2.9% in cases involving 10-19.9% TBSA (American Burn Association, 2012). Deep partial-thickness and full-thickness burns are typically characterized by the presence of necrotic tissue (commonly referred to as eschar), which hinders accurate assessment of injury depth and contributes to the development of local and systemic complications (Kagan et al., 2009; Orgill, 2009; Sheridan, 2001). Early eschar removal, followed by autografting, represents the cornerstone of modern burn care, as it reduces the incidence of both early and late complications, particularly pathological scarring (Kagan et al., 2009; Orgill, 2009; Sheridan, 2001). Following patient admission, the majority of deep burns

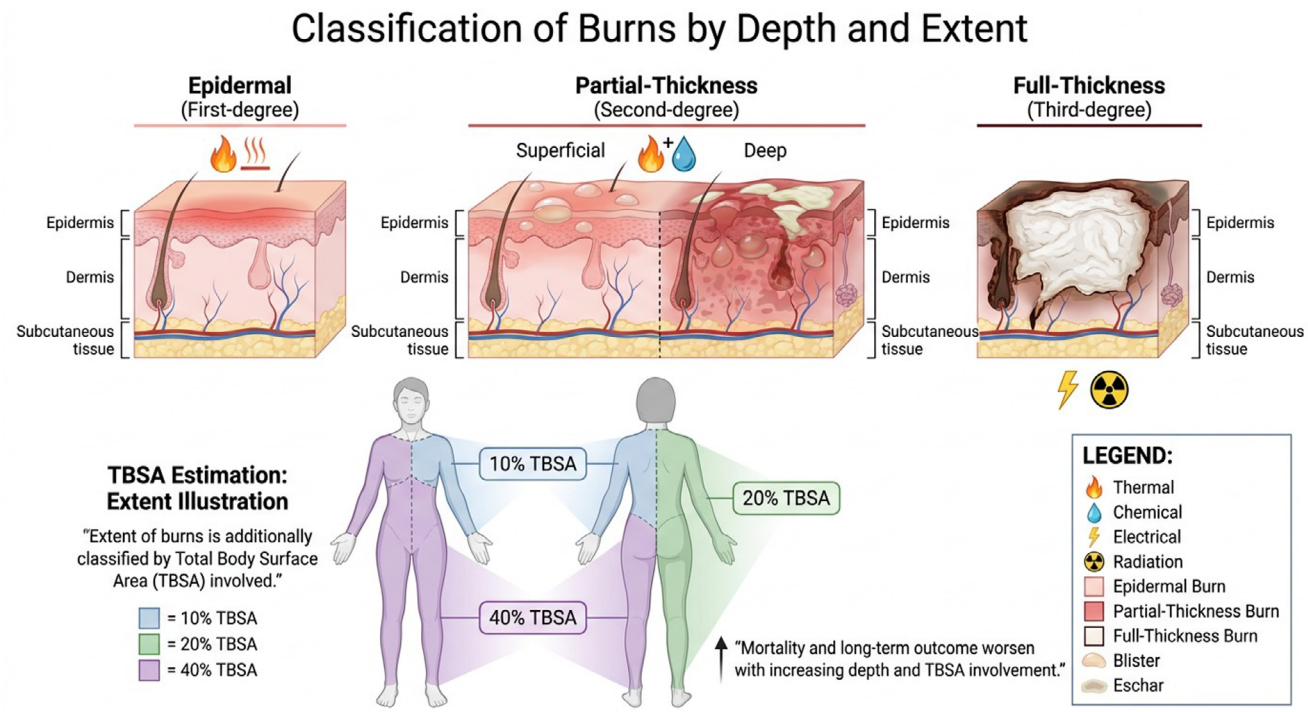

Figure 1. Classification of burns by depth and extent.

undergo surgical debridement in the operating room. This is typically performed through sequential tangential excision of thin layers of necrotic tissue until viable, bleeding tissue is reached. The primary objective is to prevent complications such as compartment syndrome, a severe pathophysiological condition that compromises the function of a limb or specific anatomical region. Compartment syndrome results from increased tissue pressure within an osteofascial compartment and occurs when tissue pressure exceeds perfusion pressure, leading to ischemia (Hartsock et al., 1998). Although effective, excisional debridement is traumatic for the patient, involving loss of viable tissue, blood, and heat, and it requires trained personnel and highly specialized surgical facilities. Moreover, it is often delayed until an accurate assessment of burn depth confirms the need for surgical intervention (Kagan et al., 2009; Orgill, 2009; Sheridan, 2001; Silver et al., 2007). To overcome the limitations associated with this technique, several alternative methods for eschar removal have been developed over the years, including enzymatic debridement (Edmondson et al., 2018; Hyland et al., 2015; Kagan et al., 2013; Schulz, Perbix, et al., 2017). NexoBrid®, an enzymatic debridement agent based on bromelain in gel formulation, has become widely adopted in recent years. Several studies in the literature have evaluated its efficacy and safety in burn wounds management (Rosenberg et al., 2014; Rosenberg et al., 2015; Schulz, Fuchs, et al., 2017; Schulz, Perbix, et al., 2017; Schulz, Shoham, et al., 2017). Reported advantages include reductions in surgical morbidity and blood loss, length of hospital stay, infection rates, need for skin grafting, and overall costs (Giudice et al., 2017; Kern et al., 2018), as well as enabling eschar removal without sacrificing viable or healthy tissue, thereby preserving viable dermal and subcutaneous structures. Bromelain is known to be an extract derived from pineapple, present in both the fruit and the stem; it is a compound consisting of proteolytic enzymes and non-enzymatic components, whose anti-edematous, anti-inflammatory, antithrombotic, analgesic, and keratolytic properties have been widely validated by the scientific community (Aguirrezabala et al., 2022; Pertea et al., 2021; Snyder et al., 2024).

Aim

This Procedure Update aims to describe the standardized multidisciplinary clinical pathway adopted for bromelain-based enzymatic debridement using NexoBrid® in the Major Burns Intensive Care Unit of the "Antonio

Cardarelli" Hospital in Naples. Particular attention is given to the procedural and organizational components of the pathway, with a specific focus on the role, responsibilities, and core competencies of nursing staff within the multidisciplinary team. The paper also outlines the training requirements and operational considerations supporting the safe, appropriate, and standardized implementation of this procedure in clinical practice.

Clinical Setting And Pathway Overview

The operational phase begins with a multidisciplinary pre-procedural briefing involving the plastic surgeon as consultant, the anesthesiologist-intensivist, and the nursing staff. This phase is focused on patient identification (in accordance with institutional safety procedures), assessment of eligibility for treatment and any contraindications (Hirche et al., 2020), assessment of the extent and location of the treatment area and identification of any pre-existing conditions, such as renal and/or hepatic impairment. Given the limited data available in the literature regarding the use of the product in burn patient populations (Agenzia Italiana del Farmaco, 2020; European Medicines Agency, 2020), such patients are closely monitored through instrumental assessments and laboratory investigations. In our clinical experience, the instrumental diagnostic modalities prescribed and subsequently performed to evaluate potential pre-existing renal impairment include renal and urinary tract ultrasound, renal color Doppler ultrasonography, and abdominal computed tomography (CT). Concurrently, laboratory investigations conducted on our patients encompass the assessment of serum creatinine, estimated glomerular filtration rate (eGFR), cystatin C, blood urea nitrogen (BUN), lactate, and procalcitonin levels, alongside a standardized panel of routine emergency blood tests. This predefined panel specifically integrates indicators of hepatic cytolysis (aspartate aminotransferase [AST], alanine aminotransferase [ALT], and lactate dehydrogenase [LDH]), markers of cholestasis (alkaline phosphatase, gamma-glutamyl transferase [γ-GT], and both total and fractionated bilirubin), and measures of hepatic synthetic function (prothrombin time/ international normalized ratio [PT/INR]) to comprehensively screen for acute liver injury. The updated European consensus guidelines (Hirche et al., 2020) define the different timing strategies for enzymatic debridement as outlined in table 1. Based on these established criteria and the clinical timing of product application, our center systematically aligns with the second category (Early intervention) of this international classification framework.

Pre-Procedural Assessment And Multidisciplinary Roles

At the conclusion of the briefing, the anesthesiologist-intensivist determines the type of pre-procedural analgesia and anesthesia, assesses the presence of coagulopathies, allergies, or known contraindications, verifies the availability of laboratory test results, and ensures that informed consent has been

Table 1. Timing strategies for enzymatic debridement according to european consensus guidelines.

Timing Strategy	Window from Injury	Burn Wound Characteristics & Clinical Rationale	Required Pre-treatments/ Technical Considerations
Very Early/ Immediate	<12 hours	Burns are typically still moist; performed during the initial admission process. Serves as an alternative to surgical escharotomy to prevent burn-induced compartment syndrome in patients undergoing active fluid resuscitation with increasing edema	No pre-soaking required
Early (Gold Standard)	12-72 hours	Maximizes the principal therapeutic benefits of selective enzymatic debridement	Applied strictly according to the manufacturer's recommendations
Delayed	>72 hours	Feasible, but the wound bed is often dry or covered with crusts	Requires prolonged pre-treatment (e.g., pre-soaking) and potential mechanical removal of crusts or dry debris

properly obtained. The nursing team, on the other hand, is responsible for preparing the environment, assembling all necessary materials for the procedure, and setting up the sterile field (Greenhalgh, 2019; Hirche et al., 2020; World Health Organization, 2018). The following table summarizes the clinical pathway developed at our institution for enzymatic burn wound debridement, detailing the operational sequences, specific protocols, and healthcare competencies required for each operational phase.

Environment, Equipment, And Procedural Preparation

The application of NexoBrid® is performed in a controlled environment within our intensive care unit for major burn patients. Patients are accommodated in single rooms, within which, thanks to continuous restocking by support staff, all necessary equipment and devices are available (with the exception of medicinal products). To guarantee patient safety during bromelain-based enzymatic debridement in major burns, a standardized clinical pathway framework is required. This specific procedure, while effective for eschar removal, involves intense metabolic and physiological stimuli. Consequently, the integration of targeted nursing management is important to mitigate risks and monitor patient responses. Table 2 outlines the core nursing-sensitive outcomes, established quality indicators, and specific nursing interventions with their scientific rationales. Continuous multiparametric monitoring is used during the four-hour dwell time to maintain hemodynamic stability and assess fluid balance. To preserve tissue integrity, precise demarcation of the wound perimeter is executed using sterile paraffin-impregnated gauzes, preventing damage to perilesional healthy skin. Pain control is systematically addressed through regular assessments using the Visual Analogue Scale or Numerical Rating Scale, ensuring timely analgesic administration. Finally, constant surveillance of the treated area is maintained during and after gel application to minimize the incidence of post-procedural bleeding and ensure overall safety. This framework serves as a standard reference within the clinical pathway to optimize burn care results. More details in Table 2.

Implications For Clinical Practice And Future Challenges

Drawing from the institutional experience and consolidated clinical practice of our Major Burn Intensive Care Unit, rather than from a formal audit or structured data collection, several future challenges and professional implications have emerged. These primarily concern the monitoring of the learning curve associated with the procedure, the personalization of pain management, and the analysis of economic sustainability. In particular, tracking the nursing staff's learning curve regarding NexoBrid® application and enzymatic eschar removal represents a critical factor for optimizing procedural efficiency and ensuring therapeutic safety. Although these observations are currently grounded in our center's day-to-day clinical experience, they provide a valuable foundation for future prospective studies aimed at objectively quantifying competency development and its direct impact on patient outcomes. The phases of specific competency acquisition for NexoBrid® application reflect the Dreyfus Model (Dreyfus & Dreyfus, 1980), progressing from rigid protocol adherence to intuitive and adaptive management. In the initiation phase, the nurse focuses on the theoretical understanding of the proteolytic mechanism of action. Key competencies involve the preparation of the enzymatic gel, maintaining its stability, and managing preventive procedural analgosedation. Critical issues at this stage include the risk of underestimating burn depth or inadequate site preparation (concerning the removal of keratinized tissues). Subsequently, the consolidation phase emphasizes technical-practical skills through supervised applications. This phase aims to ensure precision in gel application (uniform distribution at a thickness of 1.5-3 mm (Agenzia Italiana del Farmaco, 2020)) and rigorous monitoring, specifically the early recognition of local edema, management of fluid and electrolyte balance related to skin barrier loss during treatment, and control of potential bleeding. The final step is the autonomy phase, characterized by the development of expertise in assessing the post-treatment wound bed. Based on these considerations, it is advisable to implement specific training programs, particularly for newly hired staff, as this method is currently learned primarily through on-the-job training in our center. Furthermore, the creation of an ad hoc monitoring tool to evaluate

Table 2. Clinical Pathway.

Phase	Description	Healthcare worker
Preliminary product verification	The verification is performed by a nurse. Prior to preparation, the batch number, expiration date, and integrity of the NexoBrid® packaging are checked. These data are recorded in the operating register and subsequently in the electronic medical record (with both physician and nurse completing their respective sections).	ICU nurse Physician (plastic surgeon)
Environment, material and sterile field preparation	This organizational model is designed to prevent any form of cross-contamination between patients and to reduce the risk of healthcare-associated infections. Subsequently, a dedicated ICU nurse: • verifies the availability and proper functioning of monitoring, suction, and ventilation equipment (both invasive and non-invasive); • prepares all materials required for multiparametric patient monitoring and airway management, including: • electrocardiographic monitoring electrodes; • a pulse oximeter with disposable adhesive sensor; • a temperature probe; • a non-invasive blood pressure cuff, or alternatively if the patient's condition is unstable and clinically indicated, a kit for invasive blood pressure monitoring; • a non-self-inflating resuscitation bag ("Mapleson-type"); • a self-inflating AMBU bag; • face masks of various sizes for ventilation; • an oxygen source; • Guedel airways of different sizes; • low-flow nasal cannulas; • high-flow nasal cannulas with the corresponding delivery system. A recent literature review conducted by our working group highlighted the potential benefits of HFNC use in adult patients with severe burns and inhalation injury in improving respiratory outcomes (Cecere et al., 2026; Napolitano et al., 2024), thereby representing a valid non-invasive respiratory support that can also be employed during enzymatic debridement procedures; • prepares medications according to medical prescription and the devices required for anesthesia administration.	ICU nurse
Preparation of the sterile trolley	This phase involves two nurses: one opens the material packages using an aseptic technique, while the other operates under sterile conditions. Specifically, this intervention is conducted as an aseptic procedure with a sterile field. The nurse working in the sterile field performs antiseptic hand scrub and dons appropriate personal protective equipment (impermeable gown, correctly sized sterile gloves, surgical mask, cap, and either a face shield or protective goggles) (Italia, 2008). A dedicated sterile instrument trolley is then set up, containing: • a kidney dish; • an anatomical forceps and a surgical forceps; • a plate and radiofrequency electrosurgical unit for cauterization and coagulation of any bleeding; • sterile laparotomy gauzes (45×70cm), both dry and soaked in 0.9% NaCl solution; • sterile laparotomy gauzes (45×70cm) soaked in a sodium hypochlorite based disinfectant; • paraffin-impregnated gauzes to delineate wound margins, transparent polyurethane film dressings (waterproof and breathable); • elastic bandages; • a sterile disposable tongue depressor used as an applicator spatula for the product; • a sterile draping set; Containers for hazardous healthcare waste at risk of infection are also prepared.	ICU nurse
Patient preparation	Prior to product application, with the patient already under strict multiparametric monitoring, vital signs are recorded by a dedicated nurse (responsible for assessing the electrocardiographic trace and heart rate, oxygen saturation, respiratory rate, body temperature, blood pressure, and hourly urine output), who also assists the anesthesiologist-intensivist during the induction, maintenance, and recovery phases at the end of the procedure. Following induction, and under continuous close supervision by the team, a sterile operative field is established. A nurse initially performs thorough wound cleansing using sterile 0.9% NaCl, carefully removing superficial necrotic debris and blisters formed as a result of the burn injury. The area is gently dried with sterile gauze and, upon indication from the plastic surgeon, sterile laparotomy gauzes soaked in a sodium hypochlorite-based disinfectant are applied and left in place for approximately 10 minutes. Subsequently, the area is dried again, and sterile paraffin-impregnated gauzes are applied along the wound perimeter to delineate the area for product application, while the surrounding healthy skin is protected with sterile protective dressings. At the end of the procedure, waste is disposed of in containers designated for hazardous healthcare waste with infectious risk.	ICU nurse Physician
Product preparation and application	Nurse operating under sterile conditions mixes the bromelain powder with the carrier gel as indicated in the package insert, using a sterile disposable tongue depressor as a spatula, until a homogeneous mixture is obtained; NexoBrid® is applied within 15 minutes of preparation (Agenzia Italiana del Farmaco, 2020; European Medicines Agency, 2020; Hirche et al., 2020), ensuring uniform distribution of the gel at a thickness of approximately 1.5-3 mm, so that the entire eschar is fully covered; at the end of the application, the nurse covers the area with one or more transparent polyurethane film dressings, securing them to the paraffin barrier, and wraps with sterile gauze in a non-compressive manner; the product is left in place for approximately 4 hours (unless otherwise indicated by the physician); following application, the nurse responsible for patient preparation reassesses vital signs; throughout the dwell time of NexoBrid®, in addition to monitoring vital parameters, the presence of bleeding (including potentially massive hemorrhage) is assessed, and pain is continuously evaluated using VAS or NRS.	ICU nurse
Product removal and post-treatment dressing	Pre-Procedural Pain Management & Monitoring: reassess patient pain levels using validated scales and concurrently administer prescribed analgesic therapy. Maintain strict observation and continuous multiparametric vital signs monitoring, assisting the anesthesiologist-intensivist throughout the anesthesia phases. Sterile Field & Equipment Setup: execute an antiseptic hand scrub and don all personal protective equipment. Conduct the setup as an aseptic procedure with a sterile field, utilizing two nurses (one operating under sterile conditions and one circulating) to prepare all sterile materials on a dedicated instrument trolley. Enzymatic Gel Removal: under the direct supervision of the plastic surgeon and anesthesiologist-intensivist, remove the occlusive polyurethane film. Gently scrape away the remaining enzymatic treatment residues using a sterile disposable tongue depressor as a spatula. Wound Cleansing & Post-Treatment Dressing: perform thorough cleansing of the treated wound bed using sterile gauzes soaked in 0.9% NaCl, followed by gentle drying of the area. Apply the final post-treatment wound dressing in strict accordance with the plastic surgeon's clinical indications.	ICU nurse Physician
End of procedure and documentation	Waste Management & Disposal: immediately upon completion of the procedure, systematically dispose of all used materials, consumables, and contaminated equipment into dedicated, clearly labeled containers for hazardous healthcare waste with infectious risk, in strict accordance with biohazard protocols. Clinical Documentation & Register Logging: accurately document the completed procedure within both the surgical/operating register and the patient's EMR, ensuring both the attending physician and the primary nurse independently finalize their respective clinical sections. Mandatory Data Tracking: verify that the following mandatory procedural parameters are comprehensively recorded in the EMR: • exact date and time of the enzymatic treatment initiation and completion; • precise anatomical location and the specific percentage of TBSA treated; • type of pre-procedural anesthesia and analgesia administered; • formal confirmation of procedural checklist completion; • product traceability data, including the specific batch/lot number and expiration date of the NexoBrid® gel utilized; • full names and roles of all medical and nursing personnel actively involved in the intervention; • detailed reporting of any intra-procedural or immediate post-procedural complications, or a formal note stating their absence.	ICU nurse Physician

Legend: ICU=Intensive Care Unit, AMBU=Auxiliary Manual Breathing Unit, HFNC=High-Flow Nasal Cannulas, NaCl=Sodium Chloride, VAS=Visual Analogue Scale, NRS=Numerical Rating Scale, EMR=Electronic Medical Record, TBSA=Total Body Surface Area.

Table 3. Nursing-Sensitive outcomes.

Outcome	Quality Indicator	Nursing Intervention & Rationale
Hemodynamic Stability	Absence of significant fluctuations in vital signs during the 4-hour dwell time	Continuous multiparametric monitoring (electrocardiographic trace and HR, NIBP or IBP, SpO2, RR, body temperature) and fluid balance assessment
Tissue Integrity	Preservation of perilesional healthy skin	Precise demarcation of the wound perimeter with sterile paraffin-impregnated gauzes
Pain Control	Reduction or stability of post-procedural pain scores (VAS/NRS)	Regular pain assessment and timely administration of prescribed analgesics
Safety and Complications	Incidence of post-procedural or massive bleeding	Constant surveillance of the treated area during and after gel application

Legend: HR=Heart Rate, NIBP=Non Invasive Blood Pressure, IBP=Invasive Blood Pressure, SpO2=Oxygen Saturation, RR=Respiratory Rate, VAS=Visual Analogue Scale, NRS= Numerical Rating Scale.

the training process and the learning curve is essential. This would ensure not only treatment efficacy but also the optimization of drug utilization to avoid waste, a crucial factor given the high cost of the medicinal product and the principles of pharmacoeconomics.

A further challenge of a complex nature is represented by the concept of sustainability: balancing the high acquisition cost of the medicinal product with savings derived from reduced hospital stays, minimized waste of consumables, and a decreased requirement for skin grafting. Based on our institutional experience and day-to-day clinical practice, future research should formally document these factors to rigorously evaluate the hypothesized added value of specialized nursing care in achieving such clinical and operational efficiencies.

Conclusions

The experience gained at our Major Burns Intensive Care Unit confirms that enzymatic debridement using bromelain represents a valid and safe alternative to traditional surgical debridement in the management of burn patients. Based on our institutional experience and day-to-day clinical practice, the structured organization of this care pathway, grounded in a multidisciplinary approach and standardized operating protocols, is perceived to support high standards of safety, appropriateness, and quality of care. While these operational benefits are currently reflected in our routine clinical consensus rather than through formal quality indicators or empirical measurement, they demonstrate the practical viability of the framework and offer a valuable baseline for future clinical audits aimed at objectively quantifying safety and quality outcomes. Within this context, the central role of the nurse emerges clearly, not only in the technical management of the procedure but also in continuous clinical monitoring, prevention of complications, and overall patient support. Clinical pathway described in this paper further highlights how continuous and specialized training of healthcare personnel is an essential element for the effective implementation of innovative technologies and for the optimization of clinical outcomes. However, despite the promising clinical trends observed in our daily institutional practice and the encouraging data reported in the current literature, further prospective, multicenter studies remain essential. Such future research is necessary to strengthen the available evidence, more precisely define patient selection criteria, and objectively evaluate long-term functional and aesthetic outcomes.

© The Author(s) 2026. This article is published by iEditore and distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0).

References

- Agenzia Italiana del Farmaco. (2020). *NexoBrid: Riassunto delle caratteristiche del prodotto*. AIFA.
- Aguirrezabala, J. A., Aguilera-Sáez, J., Illa-Boixaderas, M., Serracanta, J., Monte-Soldado, A., Rivas-Nicolls, D., et al. (2022). Response of a single European burn center to Centelles mass casualty burn disaster: Enzymatic debridement utility. *Int J Burns Trauma*, 12(6), 224–231.
- American Burn Association. (2012). *National Burn Repository 2012 report.* American Burn Association.
- Cecere, L., Anastasi, G., Pota, V., Villani, R., Abagnale, M., Limonti, F., et al. (2026). Respiratory outcomes during the use of the high flow nasal cannula in severe burn patients with inhalation injury: A systematic review. *Scenario*, 43(1). https://doi.org/10.4081/scenario.2026.656
- Dreyfus, S. E., & Dreyfus, H. L. (1980). *A five-stage model of the mental activities involved in directed skill acquisition.* California University Berkeley Operations Research Center. https://www.researchgate.net/publication/235125013_A_FiveStage_Model_of_the_Mental_Activities_Involved_in_Directed_Skill_Acquisition
- Edmondson, S. J., Jumabhoy, I. A., & Murray, A. (2018). Time to start putting down the knife: A systematic review of burns excision tools of randomised and non-randomised trials. *Burns*, 44, 1721–1737. https://doi.org/10.1016/j.burns.2018.01.012
- European Medicines Agency. (2020). *NexoBrid: Summary of product characteristics.* EMA.
- Giudice, G., Filoni, A., Maggio, G., Bonamonte, D., & Vestita, M. (2017). Cost analysis of a novel enzymatic debriding agent for management of burn wounds. *Biomed Res Int*, 2017, 9567498. https://doi.org/10.1155/2017/9567498
- Greenhalgh, D. G. (2019). Management of burns. *N Engl J Med*, 380(24), 2349–2359.
- Hartsock, L. A., O'Farrell, D., Seaber, A. V., et al. (1998). Effect of increased compartment pressure on the microcirculation of skeletal muscle. *Microsurgery*, 18, 67–71.
- Hirche, C., Almeland, S. K., Dheansa, B., Fuchs, P., Governa, M., Hoeksema, H., et al. (2020). Eschar removal by bromelain-based enzymatic debridement (NexoBrid) in burns: European consensus guidelines update. *Burns*, 46(4), 782–796.
- Hussain, A., & Dunn, K. W. (2013). Predicting length of stay in thermal burns: A systematic review of prognostic factors. *Burns*, 39(7), 1331–1340.
- Hyland, E. J., D'Cruz, R., Menon, S., Chan, Q., Harvey, J. G., Lawrence, T., et al. (2015). Prospective, randomised controlled trial comparing Versajet hydrosurgery and conventional debridement of partial thickness paediatric burns. *Burns*, 41, 700–707. https://doi.org/10.1016/j.burns.2015.02.001
- Italia. (2008). *Decreto Legislativo 9 aprile 2008, n. 81*. Gazzetta Ufficiale della Repubblica Italiana.
- Kagan, R. J., Arenholtz, D. H., Hickerson, W. L., Holmes, J. H., Korentager, R. A., Kraatz, J. J., et al. (2009). *Surgical management of the burn wound and use of skin substitutes: An American Burn Association white paper.*
- Kagan, R. J., Peck, M. D., Ahrenholz, D. H., Hickerson, W. L., Holmes, J. H., Korentager, R., et al. (2013). Surgical management of the burn wound and use of skin substitutes: An expert panel white paper. *J Burn Care Res*, 34, e60–e79. https://doi.org/10.1097/BCR.0b013e31827039a6
- Kern, M. A., Depka, N., Schackert, C., Henkel, W., & Hirche, C. R. (2018). Enzymatic burn wound debridement with NexoBrid: Cost simulations and investigations on cost efficiency. *Gesundheitsökonomie Qualitätsmanagement*, 23, 21–28. https://doi.org/10.1055/s-0043-109520
- Napolitano, G., Gravante, F., Gravante, A., De Rosa, F., Coletta, F., Tomasello, A., et al. (2024). Confronto tra cannule nasali ad alto flusso e ventilazione non invasiva nei pazienti critici gravemente ustionati affetti da insufficienza respiratoria acuta: Un protocollo di revisione della letteratura. *Scenario*, 41(3), 600. https://doi.org/10.4081/scenario.2024.600
- Orgill, D. P. (2009). Excision and skin grafting of thermal burns. *N Engl J Med*, 360(9), 893–901.
- Pertea, M., Poroch, V., Ciobanu, P., Filip, A., Velenciuc, N., Lunca, S., et al. (2021). Efficiency of bromelain-enriched enzyme mixture (NexoBrid) in the treatment of burn wounds. *Appl Sci*, 11, 8134. https://doi.org/10.3390/app11178134
- Porter, C., Tompkins, R. G., Finnerty, C. C., Sidossis, L. S., Suman, O. E., & Herndon, D. N. (2016). The metabolic stress response to burn trauma: Current understanding and therapies. *Lancet*, 388, 1417–1426.
- Rosenberg, L., Krieger, Y., Bogdanov-Berezovski, A., Silberstein, E., Shoham, Y., & Singer, A. J. (2014). A novel rapid and selective enzymatic debridement agent for burn wound management: A multicenter randomized controlled trial. *Burns*, 40, 466–474. https://doi.org/10.1016/j.burns.2013.08.013
- Rosenberg, L., Shoham, Y., Krieger, Y., Rubin, G., Sander, F., Koller, J., et al. (2015). Minimally invasive burn care: A review of seven clinical studies of rapid and selective debridement using a bromelain-based debriding enzyme (NexoBrid). *Ann Burns Fire Disasters*, 28, 264–274.
- Schulz, A., Perbix, W., Shoham, Y., Daali, S., Charalampaki, C., Fuchs, P. C., et al. (2017). Our initial learning curve in the enzymatic debridement of severely burned hands: Management and pitfalls of initial

treatments and development of a post-debridement wound treatment algorithm. *Burns,* 43, 326–336. https://doi.org/10.1016/j.burns.2016.08.009
- Schulz, A., Fuchs, P. C., Rothermund, I., Hoffmann, A., Rosenberg, L., Shoham, Y., et al. (2017). Enzymatic debridement of deeply burned faces: Healing and early scarring based on tissue preservation compared to traditional surgical debridement. *Burns,* 43, 1233–1243. https://doi.org/10.1016/j.burns.2017.02.016
- Schulz, A., Shoham, Y., Rosenberg, L., Rothermund, I., Perbix, W., Fuchs, P. C., et al. (2017). Enzymatic versus traditional surgical debridement of severely burned hands: A comparison of selectivity, efficacy, healing time, and three-month scar quality. *J Burn Care Res,* 38, e745–e755. https://doi.org/10.1097/BCR.0000000000000478
- Sheridan, R. L. (2001). Comprehensive treatment of burns. *Curr Probl Surg,* 38(9), 657–756.
- Silver, G. M., Klein, M. B., Herndon, D. N., Gamelli, R. L., Gibran, N. S., Altstein, L., et al. (2007). Standard operating procedures for the clinical management of patients enrolled in a prospective study of inflammation and the host response to thermal injury. *J Burn Care Res,* 28(2), 222–230.
- Snyder, R. J., Hoffmeister, T., Ead, J. K., Nass, A., Klinger, E., David-Zarbiv, K., et al. (2024). Bromelain-based enzymatic debridement: Mechanism of action in the wound environment. *Wounds,* 36(12), 429–436. https://doi.org/10.25270/wnds/24100
- World Health Organization. (2018). *Burn prevention and management.* WHO Press.