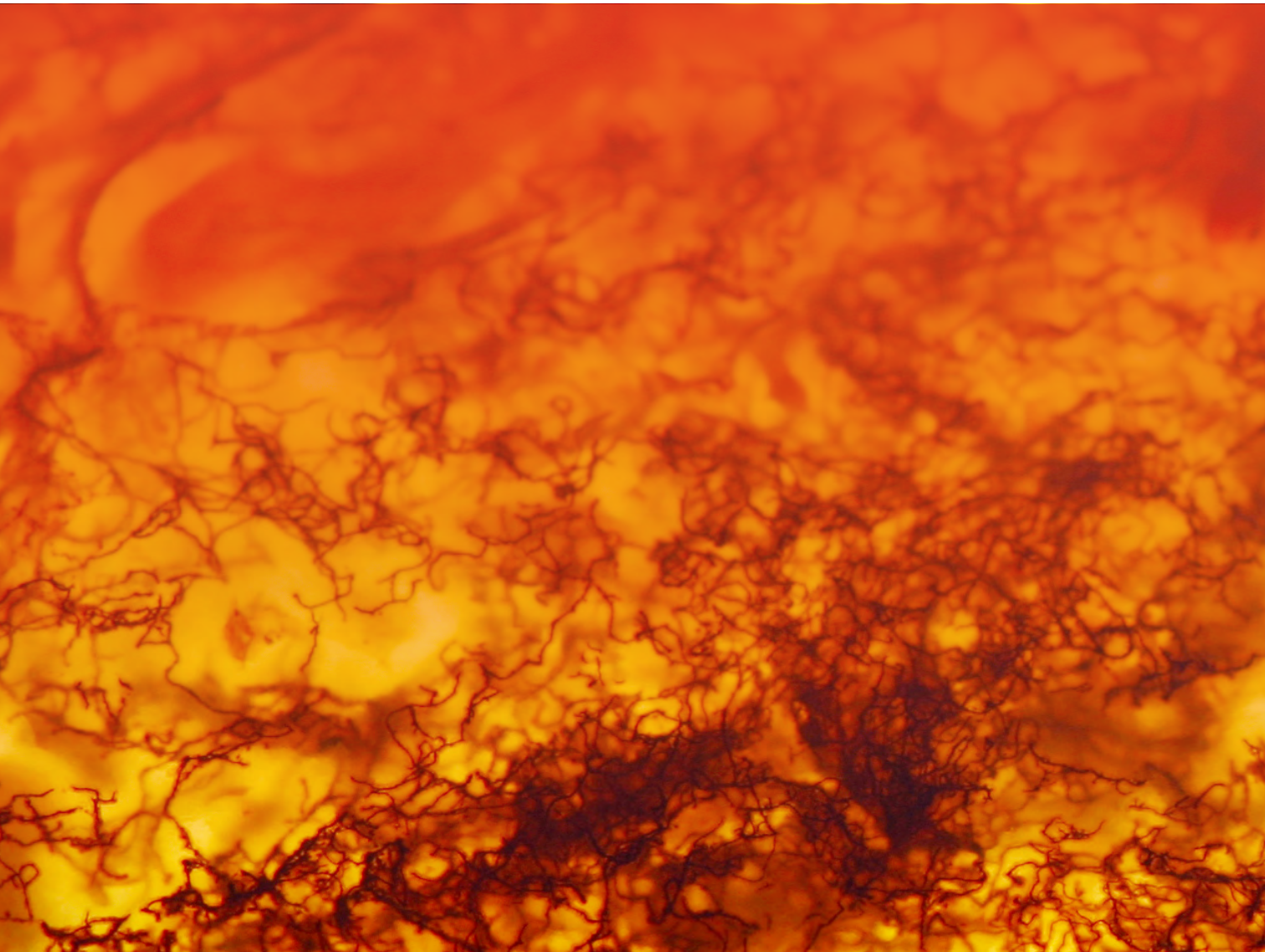


BURN INJURIES IN THE ASIA-PACIFIC REGION

Use of polyhexamethylene biguanide and betaine surfactant (PHMB-B) for wound bed preparation in children and adults



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Glossary of key terms

Antimicrobial resistance (AMR) The ability of microorganisms to survive exposure to drugs designed to kill them, often associated with chronic or biofilm-associated infections.

Asia-Pacific (APAC) region A broad geographic region encompassing East, South and Southeast Asia, and Oceania.

Betaine An amphoteric surfactant that reduces surface tension and assists removal of debris and biofilm.

Bioburden The number and types of microorganisms present on a wound surface; a high bioburden can impede healing and increase infection risk.

Biofilm A structured community of microorganisms encased in a self-produced adherent polymeric matrix. In wounds, biofilm formation contributes to infection persistence, delayed healing and antimicrobial resistance.

Burn injury Damage to skin or deeper tissues caused by heat, electricity, chemicals, radiation or friction. Severity is classified by depth and extent.

Chemical burn Skin or tissue injury caused by contact with corrosive substances such as acids or alkalis.

Contracture The permanent tightening of skin or underlying tissues after burn injury, leading to reduced mobility or deformity.

Debridement The removal of necrotic (dead) or contaminated tissue from a wound to promote healing. May be performed surgically, mechanically, enzymatically or with dressings.

Electrical burn Tissue injury caused by the passage of electrical current through the body, often associated with internal damage beyond the visible wound.

Epithelialisation The process by which new epithelial cells migrate and cover the wound surface during healing.

Exudate Fluid rich in protein and cellular debris that seeps from blood vessels during inflammation; excessive exudate may signal infection or delayed healing.

Flame burn Injury resulting from direct exposure to an open flame, often leading to deeper and more extensive tissue destruction.

Full-thickness burn A deep burn that destroys both the epidermis and dermis, often requiring surgical intervention such as grafting for closure.

Granulation tissue New connective tissue and capillaries that form on the surface of a healing wound, indicating progress towards closure.

High-viscosity (HV) gel A thicker topical formulation of PHMB-B designed for longer therapeutic contact with the wound surface, maintaining moisture and antimicrobial activity.

Hypertrophic scar A raised, thickened scar confined to the area of the original wound, resulting from excessive collagen deposition during healing.

Keloid scar A type of raised scar that extends beyond the original wound boundaries due to abnormal wound healing and fibroblast activity.

Moist wound healing A therapeutic principle that promotes healing by maintaining an optimally moist environment, which supports cellular migration and reduces pain.

Necrotic tissue Dead tissue within a wound, which delays healing and increases the risk of infection if not removed.

Negative pressure wound therapy (NPWT) A wound management technique that applies controlled suction to promote granulation, remove exudate and assist closure.

Partial-thickness burn A burn involving the epidermis and part of the dermis, typically characterised by pain, blistering and potential for spontaneous healing with appropriate care.

Polyhexamethylene biguanide (PHMB) A polymeric biguanide antiseptic with broad-spectrum antimicrobial and antibiofilm properties, used in wound irrigation and cleansing.

Polyhexamethylene biguanide and betaine surfactant (PHMB-B) A combined antimicrobial cleansing preparation used in solutions, gels or high-viscosity gels to disrupt biofilm, reduce bioburden and support wound healing in burns and chronic wounds.

Pseudomonas aeruginosa* and *Acinetobacter baumannii Common bacterial pathogens in burn wounds, often associated with multidrug resistance and chronic infection.

Radiation burn (radiation dermatitis) Skin injury resulting from exposure to ionising radiation, often a complication of radiotherapy.

Scald burn Tissue damage caused by contact with hot liquids such as boiling water, oil or steam.

Silver dressing / silver foam A modern wound dressing containing ionic silver for sustained antimicrobial release, used to manage infected or high-risk wounds.

Silver sulfadiazine (SSD) A topical antimicrobial cream containing silver, traditionally used in burn management for infection control.

Slough Soft, yellow or white tissue composed of dead cells, fibrin and debris, typically requiring removal to prevent infection.

Split-thickness skin graft (STSG) A graft consisting of the epidermis and a portion of the dermis, harvested from a donor site to cover a burn or wound.

Total body surface area (TBSA) The percentage of the body affected by a burn injury. Used to estimate fluid requirements and clinical severity.

Wound bed preparation A systematic approach to removing devitalised tissue, reducing bioburden and optimising the wound environment to promote healing.

MA Healthcare

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Published by MA Healthcare Ltd

St Jude's Church, Dulwich Road,
London, SE24 0PB, UK
+44 (0)20 7738 6726
www.markallengroup.com

Produced by Mark Allen
Medical Communications
www.mamedcomms.com

Declaration of interest

All case study authors were paid for their contributions.

Sponsored by B. Braun

The views expressed in this publication are those of the authors and do not necessarily reflect those of B. Braun.

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Burn injuries in the Asia-Pacific region: use of polyhexamethylene biguanide and betaine surfactant (PHMB-B) for wound bed preparation in children and adults

Abstract

This case-series supplement serves as an educational resource for health professionals involved in the care of burn injuries. Drawing from clinical experiences across healthcare settings in the Asia-Pacific region, the supplement focuses on the use of polyhexamethylene biguanide and betaine surfactant (PHMB-B) solution, gel and high-viscosity gel, alone or in combination, in managing both thermal and non-thermal burns, including partial-thickness and full-thickness burns, in both paediatric and adult populations. In alignment with international guidance, this supplement reinforces the recommendation to integrate PHMB-B into routine practice. The broad-spectrum antimicrobial activity, low cytotoxicity and biofilm-disruptive properties of this combined solution is clinically appropriate for use in complex burn wounds, where infection control and optimal healing conditions are crucial to wound healing.

Introduction

Harikrishna KR Nair; Pornprom Muangman; Yan Liu; Kerrie Coleman

Panel

This case series supplement presents 12 case studies of polyhexamethylene biguanide and betaine surfactant (PHMB-B) solution, gel and/or high-viscosity (HV) gel used in burns across the Asia-Pacific (APAC) region. These case studies are equally divided between adult and paediatric patients, and they cover both thermal and non-thermal burns. Each case illustrates the role of cleansing with PHMB-B in wound bed preparation to prevent infection and biofilm regrowth, describing the impact on both patients' quality of life and overall healthcare costs.

In each case, PHMB-B solution, gel and/or HV gel were used per standard protocol and instructions for use. For example, PHMB-B solution, gel and/or HV gel were left in therapeutic contact with the wound until the next dressing change, rather than being rinsed off immediately after application.

The document is intended as a relevant and impactful educational resource for health professionals involved in the management of burn injuries. It aims to support evidence-based practice by

providing real-world case insights, treatment approaches and outcomes that can inform clinical decision-making and improve patient care standards.

This publication features cases submitted to the Excellence Case Sharing Award (ECSA) 2024, an initiative that invited independent health professionals from across the Asia-Pacific region to share their expertise in burn injury management. The award theme, 'Management of burn injuries: focusing on thermal and non-thermal stage 2a, 2b, and 3 in children and adults', underscored the importance of strategies that prevent infection, promote wound healing, preserve quality of life and ensure prudent resource use.

The present authors formed an expert panel to independently review all submitted abstracts and select the award winners, ensuring a transparent and unbiased selection process. The published cases were selected for inclusion by the expert panel and the *Journal of Wound Care* editorial team.

Panel affiliations

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Background

Burn injuries present a significant health burden in the APAC region, particularly in low- and middle-income countries. Burns occur when excessive heat is applied to the tissue, usually as a result of exposure to hot water, fire, electricity or radiation.¹ Unsafe work and social conditions contribute to the higher incidence of burns in the region.² A scoping review of burn care in Southeast Asia found that the most common cause of burns was flame (33%), followed by electrical injury (22%), spillage of hot water/beverages/oil (22%) and hot smoke inhalation (22%).¹ In addition to higher incidence, barriers exist that prevent people from accessing effective and timely care. These barriers include political conflict, limited access to affordable surgery and lack of resources in healthcare services.²

From 1990–2019, approximately 117 million burns were recorded in Asia.² In 2019 alone, the continent accounted for 46% of the global burden of burn injuries, 47% of burn-related mortality and 46% of disability-adjusted life years (DALYs).² South and Southeast Asia were the most affected subregions, contributing to 30–40% of all global cases, deaths and DALYs.² These figures are significantly higher than global averages, with 32% higher incidence, 22% higher death rate and 23% higher DALY rates.² While burn indicators have declined throughout the region since 1990, this has been outpaced by improvements seen in other parts of the world.

Regional challenges in care provision

Many countries within the APAC region experience barriers to providing high-quality and safe care to patients with burns. There is currently no standardisation in the surgical treatment or infection management of burns, making it challenging for clinicians across the region to consolidate practices and define the standard of care.³ In most APAC countries, people residing in rural areas have very limited access to specialist burn treatment centres. Transfers to larger burn centres can often be challenging, causing further delays and increasing the likelihood of infection. Additionally, the shortage of qualified burn surgeons and the general lack of specialised training significantly hinder the quality of care available to patients.³ There is a need for improved quality of care at all points of treatment, from pre-hospital to hospitalisation and rehabilitation.¹

Economic challenges present a significant barrier to the delivery of wound care in the APAC region. Most people are only able to access free, government-funded hospitals, where more advanced treatment options are limited.³ Although the prevalence of burns is highest in low- and middle-income countries, most data regarding the cost of wound care is from developed countries.⁴ Further research into the cost burden of burn care specifically in the APAC region would help to highlight the overall expenditure as well as inform policy makers on investment and access needs.

Complications

Burns can present immediate and long-term complications, including pruritus, disfigurement and reduced quality of life. In extreme cases, burns can cause skin damage, electrolyte loss, infection, sepsis or respiratory failure.^{5–7} Additionally, burns can become infected, which is a significant factor for morbidity and mortality. Microbial contamination can lead to the formation of

biofilm, a process where microcolonies of bacteria grow on a surface, and pose a significant risk factor for hard-to-heal wounds.^{8–10} The presence of biofilm is associated with persistent infection, prolonged wound healing and antimicrobial resistance. Furthermore, biofilms contribute to 60% of global burn-related mortality.^{8,11,12} The health outcomes of biofilm formation ultimately lead to lengthened hospital stays, increased resource use and higher costs, presenting a significant burden to healthcare systems, particularly in low- and middle-income countries across the APAC region.

In the longer term, scarring and disfigurement are common concerns, and burns must be treated appropriately in order to avoid hypertrophic scarring, keloid scarring and contractures.³ In addition to reduced mobility, significant scarring can cause emotional distress, limit social activity and reduce overall quality of life.¹¹

Severe burns or hard-to-heal burn wounds result in greater healthcare resource use as well as significantly worsened patient quality of life. Chronic burn wounds are associated with prolonged healing times, increased risk of complications and treatment needs, which place a sustained burden on healthcare systems. A study examining resource use in the UK found that the annual cost of managing hard-to-heal wounds was £1.1 billion more expensive than wounds that healed within 1 year, with a 135% increase in individual patient care costs.¹³ Therefore, clinicians must ensure safe and effective management of burn wounds, including wound bed preparation and infection prevention, in order to limit the risk of chronic deterioration.

Therapeutic cleansing and infection prevention

International guidance recommends integrating antiseptic cleansing agents into routine practice.^{3,14,15} PHMB-B combines the broad-spectrum antimicrobial action of PHMB with the cleansing action of the amphoteric surfactant betaine, producing a synergistic effect that can break down biofilms and prevent infection.^{16,17} PHMB-B cleansing solution, gel and HV gel are used in the treatment of acute and chronic wounds to remove and impede biofilm, debris and slough, reducing the overall bioburden.^{9,17,18} Use of PHMB-B is often initiated in wounds that have failed to heal, especially as a result of infection.⁹ PHMB-B has broad-spectrum antimicrobial activity, low cytotoxicity and biofilm-disruptive properties that make it clinically appropriate for use in complex burn wounds, where infection control and optimal healing conditions are crucial to wound healing.

PHMB-B has shown promising results in the treatment of partial-thickness and full-thickness burn wounds in adults and children, with growing evidence supporting its potential for greater integration into standard burn care. PHMB-B gel compared with silver sulfadiazine in partial-thickness burns ($n=46$) showed a trend to faster healing (17.8 ± 2.2 vs 18.8 ± 2.1 days, $P=0.13$) and significantly lower pain at days 4–9 ($P<0.001$).¹⁹ PHMB-B products have been shown to be safe and tolerable in paediatric burns.²⁰ PHMB-B HV gel has proved efficacious, safe and well-tolerated in burns requiring split-thickness skin grafts.²¹ Other outcomes, including exudate, malodour and slough, have also reportedly improved following treatment with PHMB and betaine, indicating effective action against infection.⁹

Case 1. Improving quality of life in a paediatric partial-thickness burn

Wipawee Kanpuan, Plastic and Reconstructive Surgeon
Nakornping Hospital, Chiang Mai, Thailand

Presentation

A 1-year-old boy was admitted with partial-thickness scald burns covering 13% of his total body surface area (TBSA), with 5% on the anterior trunk and 8% on the left leg (*Figure 1*).

Intervention

The abdominal wound was treated every 3 days. It was cleansed with normal saline, followed by application of PHMB-B HV gel and a foam dressing, which was then secured with adhesive tape. Meanwhile, the leg wound was cleansed daily with saline then covered with silver sulfadiazine (SSD) cream and a gauze dressing. No antibiotics were used.

Outcomes

At day 4, there was around 5% TBSA slough, with 2% on the anterior trunk and 3% on the left leg. By day 7, devitalised tissue was absent on the abdominal wound (PHMB-B HV gel), but 1.5% TBSA of slough and pseudo-eschar were present on the leg wound (SSD cream). The cooling effect of PHMB-B HV gel also appeared to have reduced the patient's pain, based on assessment of his vocalisations, breathing and facial expressions.^{22,23}

By day 11, a greater percentage of the total area had epithelialised in the abdominal wound (PHMB-B HV gel) than in the leg wound (SSD cream).

By day 13, the abdominal wound (PHMB-B HV gel) had fully epithelialised, necessitating three dressing changes, while the leg wound (SSD cream) was 70% epithelialised and had not yet completely closed. There had been no signs of infection in either wound, and there was no staining in either wound.

Discussion

Compared with SSD cream, treatment with PHMB-B HV gel resulted in less devitalised tissue by percentage area, lower pain and a

Figure 1. Case 1, showing reduced slough and closure in 13 days



faster healing time, with a positive impact on quality of life. However, comparison should account for the original smaller size and lower slough coverage of the anterior trunk wound, as well as the general variability of wounds. Both interventions appeared to avoid wound infection. Pain reduction in the anterior trunk provided

relief during breathing inhalation. The reduced frequency of dressing changes with PHMB-B HV gel reduced potential pain and saved healthcare resources and nursing care time. The total cost of 2 weeks of care with PHMB-B HV gel of \$64 USD was less than half the cost of standard care with SSD for that time of \$155 USD.²⁴

Case 2. Navigating complexities of a major infected paediatric burn

Mohd Shahrul Suondoh, Plastic Surgeon; Salmi Mohamed Sukur, Plastic Surgeon
Kuala Lumpur General Hospital, Kuala Lumpur, Malaysia

Presentation

A 6-year-old boy presented with deep partial- and full-thickness scald burns, covering 50% of his TBSA over his anterior and posterior trunk and bilateral upper and lower limbs (Figure 2). The injury had been caused by hot soup. Presentation was delayed for 10 days, by which time malodour and greenish slough were present. Infection and sepsis were suspected, and tissue culture confirmed *Pseudomonas aeruginosa* and *Acinetobacter baumannii*.

Intervention

Daily wound-bed preparation included cleansing with PHMB-B solution, surgical debridement to remove necrotic tissue and application of PHMB-B HV gel. A month later, this was followed by advanced grafting, including Meek micrografting and split-thickness skin grafts, to cover the large wound areas and promote closure. The intravenous antibiotics ceftazidime and amikacin were targeted to sensitivity patterns. Throughout treatment, the patient also received comprehensive supportive care, including nutritional supplementation, physiotherapy to maintain mobility and psychological support to address the emotional impact of injury.²⁵

Outcomes

Over the course of 100 days in hospital, the patient demonstrated significant improvement. Within 1 month, the wound bed had been effectively prepared and infection was sufficiently controlled for successful graft integration. After achieving wound closure on major functional areas of the body, the residual burns were treated conservatively with continued use of PHMB-B solution and PHMB-B gel until complete healing was achieved by day 150. The patient demonstrated restored mobility and improved psychological wellbeing, as well as minimal scarring or contractures.

Discussion

Wound-bed preparation effectively disrupted biofilm and eradicated multi drug-resistant microorganisms to reduce bacterial load, control infection and create a healthy wound environment conducive to

Figure 2. Case 2, showing reduction in signs of infection and successful graft integration



healing. The prepared wounds were also made suitable for successful graft integration, despite limited availability of donor skin. The multidisciplinary team comprised plastic surgeons, infectious disease experts, rehabilitation physicians, physiotherapists, occupational therapists, dietitians and psychologists. This comprehensive collaborative multidisciplinary approach ensured all aspects of the patient's physical and emotional health were addressed, improving his quality of life, minimising

long-term complications and helping him achieve a full recovery.²⁶

Use of advanced innovative wound-healing techniques also proved cost-effective and sustainable for the institution. Cost efficiencies included accelerated healing that shortened hospital stays, as well as risk of complications, such as sepsis or contractures significant disability, and consequent need for prolonged, repeated or more expensive treatments and rehabilitation.

Case 3. Reducing pain and improving outcomes in a paediatric partial-thickness burn

Anchan Ketmek, RN; Suttipong Tianwattanatada, Physician; Suchada Kittidacha, RN; Orapin Taengthet, RN
Siriraj Hospital, Bangkok, Thailand

Figure 3. Case 3, showing decreased devitalised tissue and closure in 20 days



Presentation

A 10-month-old boy presented with scalding from accidental exposure to hot water 3 hours before admission (*Figure 3*). The injuries ranged from superficial to deep partial-thickness burns, assessed to be affecting approximately 18% of the TBSA, partially covered with devitalised tissue. The Neonatal Infant Pain Scale (NIPS) score was 7/7, the maximum value, indicating severe distress and emotional impact on the patient.²³

Intervention

The patient was initially treated according to standard wound care protocol, involving cleansing with normal saline solution and application of 1% SSD cream for antiseptics. Initial treatment also included appropriate pain management provided by paediatricians, as well as daily dressing changes to monitor wound progression closely during the critical initial phase.

Over the following days, the patient displayed significant signs of distress, including anxiety, screaming, crying, vomiting and muscle tension. Despite gentle handling and pain control efforts, the NIPS score remained 7/7. Heavy wound exudate further aggravated discomfort, and slough formed due to the wet wound environment.

On day 5, when the patient had stabilised, it was decided to modify the wound care regimen to ensure infection control, promote healing and improve quality of life. This began with cleansing the wound with PHMB-B solution to reduce bacterial load for 10–15 minutes. Antimicrobial silver alginate dressings were then applied to cover the wounds, promote a moist environment and minimise risk of infection. This was performed at a reduced frequency of every 3 days for a total of six dressing changes. The emotional and physical conditions of the patient were continuously monitored throughout. No antibiotics were used.

Outcomes

After changing treatment regimen, devitalised tissue decreased, and the wounds rapidly epithelialised. Epithelial tissue reached 30% on day 10 and 80% on day 16, when there was a marked decrease in exudate. The wound had fully healed by day 20. No signs of infection were observed. The patient's emotional status improved as pain and fear diminished, leading to better adherence to treatment and improved enteral nutrition. The overall positive emotional state likely contributed to faster healing. At discharge, the wounds were fully healed, and the patient displayed a stress-free demeanour, with a NIPS score of 0/7.

Discussion

Implementation of PHMB-B cleansing and antimicrobial absorptive dressings with less-frequent dressing changes appeared to be successful at maintaining infection control and promoting moist wound healing. Compared to the standard protocol, this approach enhanced healing outcomes, alleviated pain and improved emotional wellbeing and quality of life.

A holistic approach to burn wound care is essential, particularly in paediatric patients. Successful treatment requires addressing both physical and emotional needs, as young patients may retain negative memories of painful care experiences.²⁵

The estimated dressing cost for the 20-day stay was \$340 USD, compared with an estimated \$230 USD for the standard protocol.²⁶ Antimicrobial absorbent dressings cost more per dressing change than conventional methods, but this was outweighed by the less-frequent changes. The overall treatment cost, including expenses such as admission fees, medical equipment, analgesics and nursing services, was comparable with an estimated \$525 USD for standard wound dressings and \$478 USD in advanced wound dressings.²⁶

Case 4. Improving compliance and quality of life in a paediatric burn

Wen Liang Wang, Chief Nurse; Min Gao, Resident Physician; Zong Qi Yin, Attending Doctor; Yi Dou, Deputy Chief Physician; Jia Jun Zhu, Attending Doctor

Ruijin Hospital, affiliated with Shanghai Jiao Tong University School of Medicine, Shanghai, China

Presentation

A 19-month-old boy was admitted to hospital 6 days after sustaining accidental scalds on multiple areas of the body, including the face, neck, torso and left arm, from hot soup (Figure 4). The partial-thickness burn covered 20% of his TBSA. The patient was in pain,²³ and there were signs of infection, including malodour.

Intervention

The burns were cleansed with PHMB-B solution, followed application of PHMB-B gel to impede biofilm reformation and reduce pain and malodour. The patient was also treated with the antibiotic teicoplanin. Dressing changes were infrequent. During this period, the patient also received fluid replacement and nutritional support, in combination with laboratory tests, until his circulation and vital signs stabilised.

Outcomes

The patient was tolerant of the treatment and showed improved comfort. After 1 week, there were significant improvements in several key areas, with signs of healing in 80% of the wounds, decreased pain and absence of odour. The hospital stay was relatively short. Hypertrophic scarring was minimal, with no long-term complications.

Discussion

Observed benefits included reduced signs of infection and rapid healing, which were likely driven by the antimicrobial action of PHMB-B solution and gel. Moreover, the reduced pain and improved comfort were likely attributable to the cooling effect of PHMB-B gel.

Infrequent dressing changes and a short hospital stay reduced associated patient distress and treatment costs, as well as facilitating cooperation and compliance. Absence of long-term complications and minimal scarring improved quality of life and avoided long-term care costs.

Figure 4. Case 4, showing signs of healing over 11 days



Case 5. Large infected paediatric burn

Chenlu Song, Surgeon; Gai Zhang, Surgeon; Xuechuan Li, Surgeon; Huizhong Yang, Surgeon

Ruijin Hospital, affiliated with Shanghai Jiao Tong University School of Medicine, Shanghai, China

Presentation

A 1-year-old boy was transferred to the burn unit with burns covering 15% of his total body surface area, caused by scalding from hot water 15 days earlier (Figure 5). The burns spanned his anterior and posterior trunk (8%), right arm (5%) and face (2%), and while some areas were superficial, others, largely the trunk and upper limbs, were deep partial-thickness burns. He had been experiencing intermittent high fever, and the dressings were removed to reveal signs of infection, with increased exudate, malodour and delayed healing, accompanied by redness and swelling of the periwound skin. Approximately 20% of the wound surface was covered with devitalised tissue, with a small amount of exudate. Wound culture showed *Enterococcus faecalis*.

Intervention

Every 2 days, the wound was cleansed with saline and PHMB-B solution, before being debrided with forceps. Subsequently, the wound bed was covered with PHMB-B gel followed by a silver foam dressing, used synergistically for their combined antimicrobial action and the dressing's absorptive capacity. These interventions were intended to tackle bacterial proliferation and biofilm formation to promote wound healing. Intravenous ceftazidime was given.

Outcomes

Over the following days, the patient was in a stable condition. After two debridements, cultures were negative, and ceftazidime was discontinued. By day 17 of hospitalisation with the new treatment protocol (day 32 since admission), the patient had no fever, and his wound had significantly reduced in size and nearly completely healed, and so he was discharged.

Conclusion

PHMB-B solution and gel, alongside silver foam, provided an effective approach to improve the healing of large, infected burn wounds in an infant patient who had been experiencing intermittent high fever. After only two rounds of cleansing with PHMB-B solution, negative cultures allowed for

Figure 5. Case 5, showing significant reduction in wound size



discontinuation of antibiotics and thus avoidance of the associated cost and antibiotic-resistance burden. Dressing changes every 2 days was fairly infrequent, contributing to patient comfort.

In this case, use of PHMB-B solution and gel likely contributed to reduced antibiotic use and a relatively short hospital stay, consequently reducing nursing workload and overall care costs.

Case 6. Partial- and full-thickness burns in a paediatric patient with multiple allergies

Duong Van Phu, Medical Doctor; Nguyen Hai An, Department Head
Le Huu Trac National Burn Hospital, Hanoi, Vietnam

Presentation

A 10-month-old boy presented with partial- and full-thickness scald burns caused by direct exposure to boiling water (*Figure 6*). The injury covered 7% of his TBSA, affecting the face, chest and both arms.

Intervention

The burned area was divided into two equal parts: one part was treated daily with 5 ml PHMB-B HV gel (area A), and the other was treated daily with 5 ml povidone-iodine 10% solution (area B), to compare the effectiveness of these treatments. The entire burn area was then covered with two pieces of an adhesive antimicrobial silver nanocellulose dressing to provide protection, retain moisture and reduce bacterial contamination, thus helping to reduce pain and accelerate healing. Oral antibiotics (150 mg) and vitamins (5 ml) were administered daily for 10 days to prevent infection and support immune function. Daily observations were made to document the progression of both areas, focusing on redness, swelling and granulation.

Outcomes

After approximately 10 days of intensive treatment, the patient's wounds showed significant improvement. The burns appeared light pink, indicating the start of epithelialisation. There were no signs of infection or purulent exudate. By the time of discharge, the burns had developed new skin with no exudate. Compared to povidone-iodine, PHMB-B HV gel appeared to be more effective in promoting epithelialisation, resulting in a smoother and improved wound surface post-healing.

Discussion

The absence of signs of infection can be attributed to the antimicrobial efficacy of PHMB-B HV gel, alongside silver dressings

Figure 6. Case 6, showing epithelialisation in 11 days



and antibiotics. This case highlights the effectiveness of using PHMB-B HV gel as part of holistic treatment for scald burns in infants. This approach not only aids in controlling infection but also promotes epithelialisation, minimises scarring and

accelerates recovery. Effective resource use reduced the duration of hospitalisation from the predicted 15 days to 12 days, which reduced accommodation costs, complication risks and need for rehabilitative care.

Case 7. Full-thickness thermal burn with Achilles tendon reconstruction

Claudine Rosario B Lukban, Medical Doctor; Gerald Marion M Abesamis, Plastic Surgeon; Ralf V Santamaria, Orthopedic Surgeon; Fernando A Acance, Orthopedic Surgeon
Philippine General Hospital, Manila, the Philippines

Figure 7. Case 7, showing granulation and good graft take



Presentation

A 42-year-old man presented with a full-thickness thermal burn on his right ankle from contact with a motorcycle exhaust 22 days earlier. The wound measured 9x8 cm, with a desiccated Achilles tendon (Figure 7). The wound bed appeared infected, with adherent eschar and malodorous purulent exudate. Wound cultures yielded *Pseudomonas aeruginosa*. The patient had limited dorsiflexion and significant pain on ambulation. He was able to move all his toes, but with a negative Thompson test.²⁷

Intervention

Wound care involved soaking the wound bed in PHMB-B solution for 10 minutes, followed by surgical debridement and application of PHMB-B HV gel and a non-adherent dressing. Negative pressure wound therapy was introduced on day 4.²⁸

The patient was initially on subcutaneous ampicillin-sulbactam 3 g every 6 hours, then was moved to ciprofloxacin 750 mg IV every 12 hours. The multidisciplinary treatment plan also involved strengthening exercises and psychosocial care, and it was developed by multiple specialties (burns, orthopedics, infectious diseases, rehabilitation, pain and social services).

Outcomes

On day 2 after admission, the Achilles tendon was found to be non-viable and was excised.

The patient achieved negative cultures and a viable wound bed by day 20 post-admission, when reconstruction was performed. The Achilles tendon was surgically reconstructed using the flexor hallucis longus (FHL) tendon and peroneal artery perforator propeller (PAPP) flap for coverage. This involved careful dissection and flap rotation to ensure proper alignment and function.²⁹

Postoperatively, the patient was closely monitored for flap viability and graft take. During this period, neither flap congestion nor necrosis were observed, and all areas with skin grafts showed good granulation and graft take. At week 3, the patient was discharged as an outpatient with continued coordinated efforts from comanaging clinical services. At 1 month, he demonstrated increased dorsiflexion and ambulation without assistance. At 6 months, he reported excellent functional outcomes and return to work and leisure activities

Discussion

Successful reconstruction was likely facilitated by wound-bed preparation. Cleansing with PHMB-B solution, debridement and topical antiseptics, including PHMB-B gel, all would have helped break down biofilm and optimise the wound for graft take.

Achilles tendon reconstruction presents a multifaceted challenge, requiring robust

functional recovery, viable vascularity and optimal wound coverage. Reconstruction following a full-thickness burn requires consideration of complications including compromised skin and subcutaneous tissue; poor skin elasticity; compromised blood supply; tendon necrosis and loss of tendon continuity; and scarring that impairs function.³⁰ Wound infection is one of several reasons why flaps or grafts can fail, emphasising the importance of antimicrobial agents, such as PHMB-B solution and gel, in preparing wounds for reconstruction. In this case, use of the FHL tendon and PAPP flap augmented rehabilitation and facilitated early mobilisation and restoration of function, and definitive reconstruction achieved excellent functional and aesthetic outcomes, with minimal donor-site morbidity.

The treatment strategy demonstrated economic value. The hospital stay was markedly shorter than could be expected for a complex reconstructive case, which often extend due to complications. Rapid recovery reduced the need for extensive medical supplies, which are often limited in developing countries. Moreover, this approach minimised long-term disability risks, enhancing the patient's potential to return to work sooner, thereby reducing the socioeconomic impact of lost wages and dependence on ongoing medical care. This economic efficiency was of particular value in a resource-limited setting.

Case 8. Burns complicated by severe coagulopathy and a heart defect

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Presentation

A 45-year-old man presented with thermal burns covering 15% of his TBSA, which were sustained due to a gas leak at home (Figure 8). There were individual burn wounds, varying in depth between superficial, partial-thickness and full-thickness.

Around 10% of the patient's TBSA was covered with full-thickness burns with devitalised tissue. This was complicated by disseminated intravascular coagulation (DIC) and perimembranous ventricular septal defect (VSD). Both DIC (severe coagulopathy causing intermittent bleeding) and VSD (a congenital heart defect) are complex, high-risk, systemic comorbidities that pose significant challenges to wound healing and infection control. In DIC, poor perfusion and repeated bleeding episodes can significantly delay granulation tissue formation and re-epithelialisation. In VSD, mixing of oxygenated and deoxygenated blood can result in hypoxia, which impairs key wound healing phases, especially angiogenesis and collagen synthesis.

Intervention

Wound care was performed three times every 3 days. The wound bed was cleansed with PHMB-B solution, before being debrided and dressed according to standard care protocols. Pain was controlled with intravenous opioids, and prophylactic antibiotics were given. DIC was closely monitored and proactively managed with blood transfusions and antifibrinolytic therapy for intermittent bleeding.

Outcomes

By day 7, there was a marked reduction in slough and necrotic tissue across several wound sites (arms, shoulders, knees and legs), with early granulation and minimal exudate. Pain had improved, reducing opioid requirements.

By day 10, the wounds appeared partially re-epithelialised across most affected areas, with 0.5% of his TBSA remaining

Figure 8. Case 8, showing granulation and epithelialisation



unepithelialised (distributed as small residual patches, mainly on the lower limbs).

After the third treatment with PHMB-B on day 10, some of the wounds were treated with skin grafts and covered with tulle containing framycetin sulfate. By day 14, significant re-epithelialisation had occurred, particularly in partial-thickness burn areas, with no signs of infection. By day 22, the wound had fully healed, with complete re-epithelialisation, restored skin integrity and no signs of infection or complications. Despite the underlying coagulopathy, the patient remained clinically stable, with no active bleeding or haematoma formation.

Throughout the treatment course, there were no clinical signs of wound infection, with no erythema, purulent exudate, malodour or systemic evidence of sepsis.

Discussion

This case demonstrated rapid healing even in the presence of DIC and VSD. That progression is best explained by regular antimicrobial cleansing with PHMB-B and serial debridement. This comprehensive, tailored wound-management strategy, plus supportive antibiotics, sufficiently controlled bacterial bioburden to maintain a favourable healing environment and effective infection control throughout the treatment course.

Wound care integrating PHMB-B cost around \$4976 USD, alongside anticipated use of blood products. This proved cost-effective compared with the estimated \$5878–\$10982 USD total care cost for treating these wounds without PHMB-B,³¹ which could be expected to require more aggressive surgical debridement, sustained opioid use and longer hospital stay, due to slower healing.

Case 9. Enhancing healing and cost efficiency in a partial-thickness acid burn

Chamath Sachindra Angulugaha, Registrar in General Surgery; **Gayan Ekanayake**, Consultant Plastic and Reconstructive Surgeon; **SVP Wimalarathna**, Registered Nursing Officer, Dialysis Unit
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Presentation

A 49-year-old man presented with a partial-thickness (second-degree) occupational sulphuric based chemical acid burn on his back, covering 16% of his TBSA (Figure 9). The patient presented within 24 hours. The affected areas exhibited patchy devitalised tissue, particularly in regions with deeper involvement. The wound showed moderate amount of serosanguinous exudate, reflecting the ongoing inflammatory tissue breakdown. The patient reported a 7/10 on the pain scale.

Intervention

The patient received routine wound care every other day for 30 days. The wound was cleansed and hydrated with PHMB-B, using either 10 ml gel or 150 ml wound irrigation solution rotationally. This was followed by application of sterile dressings to maintain an optimal healing environment. Pain was managed with subcutaneous morphine.

A multidisciplinary team of doctors, nurses, healthcare assistants, physiotherapists and occupational therapists provided comprehensive, integrated, person-centred care, addressed patient comfort and monitored wound healing. No antibiotics were used.

Outcomes

By day 30, the patient demonstrated significant visible improvement, with substantial development of granulation tissue covering approximately 80% of the affected 16% TBSA, along with marked reduction in wound surface area and depth. Complete wound healing was achieved by day 42, with near complete epithelialisation. The patient's discomfort decreased to 3/10 with ongoing treatment, allowing for gradual tapering of morphine.

Figure 9. Case 9, showing substantial granulation and closure in 4 weeks



Discussion

Wound care with PHMB-B was clinically effective at upholding hygiene standards and preventing contamination, thus facilitating rapid tissue regeneration, enhancing healing outcomes and avoiding any complications that might have required prolonged or intensive care. The

patient's swift recovery led to a shorter-than-anticipated length of stay. Moreover, the targeted resource-allocation protocol focussed on essential supplies to reduce reliance on supplementary products and ensure cost-efficiency. This efficient approach reduced total care costs by around 15%.

Case 10. Treating burn wounds in difficult anatomical locations

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Presentation

A 63-year-old woman presented with a deep partial-thickness to full-thickness burn injury, caused by a flame incident 20 days before referral to the burn unit (Figure 10). The burns covered 50% of her TBSA, including the anterior and posterior trunk, bilateral upper and lower limbs and gluteal regions. Her condition was further complicated with underlying chronic lung infection. The wounds showed slough and necrotic tissue with signs of infection, and swab culture confirmed *Pseudomonas aeruginosa* colonisation.

Intervention

All wounds received daily wound bed preparation, including cleansing with PHMB-B solution, surgical debridement and application of PHMB-B HV gel. Easily accessible areas underwent grafting to restore lost tissue, while difficult anatomical locations of the bilateral gluteal wounds were treated conservatively with daily paraffin gauze dressings, as well as PHMB-B HV gel. Antibiotic medication (intravenous ceftazidime) was targeted to *P. aeruginosa*. Comprehensive treatment also included physiotherapy and occupational therapy to enhance limb function, prevent complications such as hypertrophic scarring and promote overall recovery.³²

Outcomes

By day 30, the gluteal wounds healed completely, without need for surgical intervention. By day 40, all the wounds had healed, and the patient had recovered limb function. Grafts on the trunk and limbs demonstrated a take rate of 95–100%. She was discharged with substantial improvements in mobility, functionality and independence.

Discussion

The patient responded positively to the wound management regimen, and the pace of healing and recovery was notable, given the severity of the burns and

Figure 10. Case 10, showing improvement in wound condition by 30 days of conservative treatment



complicated comorbidities. Wound-bed preparation with combined use of PHMB-B solution and gel, alongside antibiotic medication, likely played a crucial role in removing biofilm, eradicating *P. aeruginosa* and creating an optimal environment for healing. This also may have allowed for successful graft take. Conservative therapies, such as daily dressings and biofilm management, were effective in areas where surgery was not viable. A multidisciplinary, patient-centred, holistic approach, with a focus on physiotherapy and occupational therapy for functional rehabilitation, helped the patient regain mobility and enhanced her quality of life.^{33,34}

The wound management techniques employed were not only clinically effective, but they also resulted in significant cost savings by minimising the need for costly interventions like extra surgeries or prolonged antibiotic use. Likewise, fast healing times and short hospital stays directly lowered expenses. The outcomes from this case study support the broader implementation of these approaches within the institution, contributing to more sustainable and higher quality care for future burn patients. The institution has since re-evaluated its wound care pathways and integrated these innovative tools into standard protocols to enhance patient care and sustainability.

Case 11. Cleansing protocol for acute radiation dermatitis

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Figure 11. Case 11, showing reduced wound area and removal of necrotic tissue in 29 days



Presentation

A 43-year-old woman presented with acute radiation dermatitis involving approximately 7% of the deep dermis over the right chest wall, axilla and shoulder (*Figure 11*). The patient was a stage III breast cancer survivor who had previously completed adjuvant chemotherapy, and the wounds developed following adjuvant radiation therapy. The affected area demonstrated confluent moist desquamation, ulceration and haemorrhagic changes, with approximately 2% necrotic tissue. The patient reported severe pain, score 9/10.

Intervention

The treatment regimen included cleansing the affected area with normal saline followed by soaking with PHMB-B solution. Mechanical debridement of necrotic tissue

was performed using a gentle swabbing technique. PHMB-B HV gel was then applied to the ulcerated regions, which were subsequently covered with an absorbent, non-adherent foam secondary dressing. Linovera oil was used to moisturise the superficial burn areas. Dressings were changed every 3 days for the first 2 weeks, and subsequently once weekly. No antibiotics were given.

Outcomes

By day 18, wound area had significantly reduced by 60%; her pain score had decreased from 9/10 to 3/10;^{35,4} and areas of necrotic tissue had been replaced with new healthy tissue. After day 18, the treatment regimen was simplified to twice-daily applications of Linovera oil until day 28.

Discussion

The treatment protocol of PHMB-B solution, PHMB-B HV gel and Linovera oil appeared to have effectively promoted wound healing in acute radiation dermatitis, resulting in rapid tissue regeneration and pain relief. The extent of skin damage was analogous to a full-thickness burn, despite a different aetiology. Regarding resource utilisation, the weekly direct wound care costs of \$37 USD were less than half of the \$86 USD weekly cost of daily wound dressing, alongside the indirect cost savings of daily rather than weekly transportation (\$6 USD per day or \$30 USD for the whole treatment).³⁶

Case 12. Optimising burn management in a patient with heart failure

Amarmend Ganbat, Burn and Reconstructive Surgeon

National Trauma & Orthopedic Research Center of Mongolia, Ulaanbaatar, Mongolia

Presentation

A 70-year-old man presented with a deep partial- or full-thickness burn affecting 5–6% of his TBSA (Figure 12). The burn was located on the right posterior side of the lower trunk and the right thigh, sparing the groin area. The injury occurred after accidentally sitting on a hot stove. Despite the brief exposure, the high temperature caused extensive tissue damage. The wound was entirely covered with necrotic tissue, accompanied by pain and malodour, with well-defined edges and minimal exudate. The patient's chronic heart failure and impaired peripheral circulation precluded surgical intervention, negatively impacting healing potential. Laboratory results confirmed the presence of *Acinetobacter baumannii*, and biofilm presence was suspected.

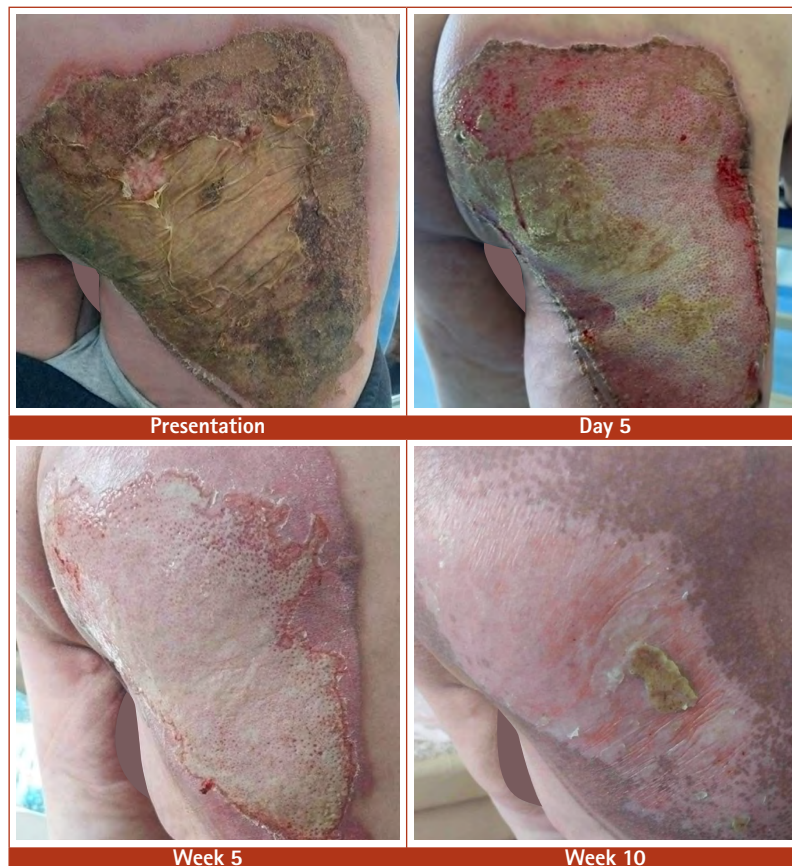
Intervention

The wound was soaked with PHMB-B solution for 10 minutes. A cleansing cloth was then used to mechanically debride any loosened devitalised tissue on the wound bed. PHMB-B gel was then applied, followed by a paraffin gauze dressing. This routine was carried out five times (every 2 days) during the patient's 10-day hospitalisation, and it was continued at an outpatient ambulatory service. The patient also received antibiotics (levofloxacin, ceftriaxone and ceftazidime) and nutritional supplementation. This approach aimed to promote healing; reduce infection and other complications; and avoid risks associated with surgical intervention.

Outcomes

By day 10, the wound was actively progressing, with significantly less devitalised tissue observed. Laboratory results showed no bacterial growth, and the patient was transferred from inpatient to outpatient care. The wound showed continuous improvement, with marked reductions in pain and odour and no

Figure 12. Case 12, showing devitalised tissue and closure in 10 weeks



evidence of reinfection or inflammation, achieving complete healing by week 10.

Discussion

Cleansing and debridement with a PHMB-B-soaked cloth involved minimal pain or discomfort, making it significantly easier and faster than comparable treatments. Given the severity and complexity of the burn and the patient's age and overall health, the wound healing process was smooth, with no instances of reinfection, hypertrophic scarring or contractures, and it avoided the need for surgical intervention. Throughout the treatment course, the patient's physical function and mental wellbeing were well preserved. Moreover, rapid healing of a

full-thickness burn reduced the risk of scarring.

Compared with standard protocol and antibiotics, treatment with PHMB-B solution, PHMB-B gel and antibiotics was broadly estimated to have shortened the patient's hospital stay by 50%, reducing the risk of hospital-acquired reinfection. It also reduced the frequency of dressing changes, saving on the overall quantity of dressing materials and associated medical therapy costs. Together, this was estimated to have reduced hospital costs (e.g., accommodation, nursing care and use of hospital facilities) by 80% and treatment costs (e.g., medications, wound care products and medical procedures) by 30%.

Conclusion

Harikrishna KR Nair; Pornprom Muangman; Yan Liu; Kerrie Coleman

Panel

The case studies in this document consistently demonstrate both the clinical efficacy and the cost efficiency of using PHMB-B solution, gel and HV gel in adult and paediatric patients with partial-thickness and full-thickness burns. Positive outcomes include reductions in pain, odour and infection risk, as well as rapid epithelialisation and recovery. Such outcomes are of great value in burn wounds, which are susceptible to bacterial, fungal and viral infections, as well as associated with morbidity, disability, disfigurement and mortality.^{37–40}

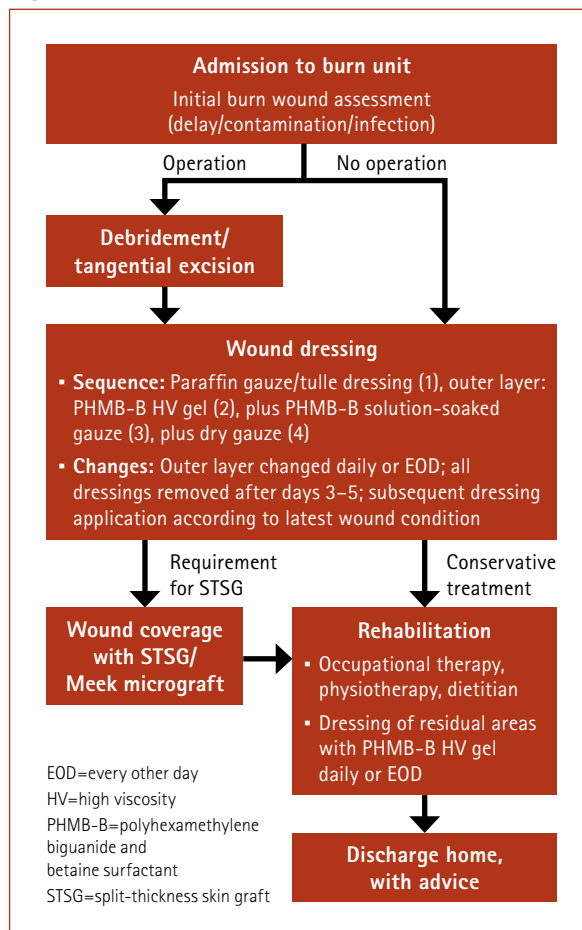
The cases show how cleansing and soaking with PHMB-B solution can disrupt biofilm and control infection, in line with evidence on the antimicrobial efficacy of PHMB-B products.^{41,42} In each case, PHMB-B products were used as part of a wider antimicrobial wound-bed preparation, typically including debridement, and sometimes involving antibiotics or other topical antimicrobials. Moreover, several cases demonstrated how the cooling effect of PHMB-B gel and HV gel can alleviate burn-related pain, which can be particularly difficult to manage and a source of considerable anxiety for patients.⁴³ Quality-of-life outcomes such as fewer dressing changes, faster recovery of functional mobility and reduced complications reflect general quality-of-life improvements seen in PHMB-B products in other wound types.⁴⁴ Overall, the clinical outcomes of the cases reflect further evidence on PHMB-B products in burns^{8,18–21} and other wounds.^{9,16–18,45}

Moreover, use of PHMB-B products likely reduced the overall cost of care through resource savings and complication prevention. These products consistently facilitated accelerated healing, enabling shorter hospital stays (by as much as 50% in some cases) and reducing the frequency of dressing changes. These factors directly lowered costs related to hospital accommodation, nursing time, dressing materials, analgesics, antibiotic use and surgical interventions. In one estimated comparison, treatment with PHMB-B solution cost less than half of standard care protocols, while one case reported an 80% reduction in total care costs through efficient supply use and reduced procedural intensity.

This aligns with evidence on the cost-effectiveness of PHMB-B products in other wound types. In a Brazilian systematic literature review, cleansing hard-to-heal wounds with PHMB-B solution instead of saline lowered overall treatment costs.⁴⁶ In a South Korean study using a price-of-therapy model, cleansing infectious hard-to-heal wounds with PHMB-B solution instead of sterile saline was found to reduce the total cost of wound healing by 63.6%, including an 83.3% lower antibiotic cost.⁴⁷ In a UK study using a Markov model, treating venous leg ulcers with PHMB-B solution and HV gel instead of saline was found to save £867.87 and gain 0.0087 quality-adjusted life years (QALYs) per patient.⁴⁸

These cases are marked by absence of complications, such as infection and sepsis, which often necessitate extended or repeated treatments, rehabilitation or long-term disability support. By avoiding such outcomes, PHMB-B products can minimise long-term healthcare burdens and support sustainability in burn care.

Figure 13. Pathway for care of burn wounds



Throughout these cases, direct wound care was embedded within a person-centred burn-management strategy. This resulted in improved mobility, reduced pain and enhanced quality of life, as well as upholding hygiene standards and promoting better patient compliance with interventions. Combining PHMB-B products with holistic care can reduce the psychosocial and economic impact of burns on patients and families, including minimising the burden of travel and dressing changes.

The results of the case studies prompted some centres to update their pathways to incorporate PHMB-B, such as the pathway from Kuala Lumpur General Hospital, Malaysia, developed by plastic surgeons Mohd Shahrul Suondoh and Salmi Mohamed Sukur (Figure 13).

The integration of PHMB-B solution, gel and HV gel into patient-focused burn care protocols represents a clinically sound and cost-effective innovation. Its adoption has the potential to drive systemic improvements in burn management by delivering high-quality outcomes with lower resource demands, aligning with best practices in sustainable, value-based healthcare.

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