

Preventing Shock and Airway Obstruction through Early Resuscitation in Moderate Burns with Suspected Inhalation Injury: A Clinical Case Report

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ABSTRACT

ARTICLE DETAILS

Introduction: Moderate to severe burns often result in complications such as hypovolemic shock and inhalation trauma. Both conditions contribute to mortality if not treated immediately. Proper fluid resuscitation and airway protection from the outset are key to preventing these complications. Moderate burns require precise early management to prevent hypovolemic shock and airway compromise.

Case Presentation: We report the case of a 52-year-old female with 17% TBSA burns and suspected inhalation injury, the patient was admitted conscious, GCS 15, with signs of burned hair, eyebrows, and nose hair, but without hoarseness or respiratory distress. Alongside a summary of 9 burn patients treated at Bali Mandara General Hospital (June 2023–June 2025) using EMSB protocols. Fluid resuscitation with Parkland formula and oxygen supplementation via a non-rebreathing mask, analgesia, prophylactic antibiotics, and close monitoring of urine output and hemodynamic status were performed. The wounds were treated with wound gel, gentamicin, and sterile dressings.

Discussion: Through titrated resuscitation (3 ml/kg/□) and vigilant airway monitoring, Ny. KS avoided intubation and shock. Within the 9-patient cohort, adherence to EMSB guidelines during the acute phase. The patient showed hemodynamic stability from the outset, with no signs of shock or respiratory failure. The urine output target was achieved (0.5–1 ml/kg/hour) while mitigating the risks of "fluid creep" and pulmonary edema. Serial Arterial Blood Gas monitoring providing an objective clinical basis for early oxygen tapering and the avoidance of prophylactic intubation. The patient underwent elective debridement, with good clinical outcome and progressive recovery.

Conclusion: Standardized EMSB protocols combined with individualized fluid titration are effective in preventing critical burn complications. Measured initial fluid resuscitation, combined with early detection of inhalation injury through close respiratory monitoring, proved effective in preventing shock and airway obstruction in cases of moderate burns. This case emphasizes the importance of an individualized approach, fluid titration based on physiological response, and readiness for airway protection within the first 24 hours.

KEYWORDS: Burns, Initial Fluid Resuscitation, Inhalation trauma, Shock

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I. INTRODUCTION

(Burn injuries represent a major public health challenge globally and are a significant cause of trauma-related disability and death. In Indonesia, data from the National Health Basic Research (Riskesdas) indicates a burn prevalence of approximately 0.7%, this affects millions of

people throughout the archipelago. The majority of these cases are domestic, often involving flame or scald injuries, and they disproportionately affect low-to-middle-income populations with limited access to specialized burn centers.

In the province of Bali, the incidence of burn injuries remains high, often linked to the unique intersection of

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tourism-related industrial accidents, domestic kitchen fires, and traditional ceremonial activities. As a primary tourism hub, Bali sees a variety of burn mechanisms ranging from electrical injuries in infrastructure to flame burns in residential areas. Bali Mandara General Hospital (BMGH), as a key regional provider, has become a pivotal center for managing these cases. Between June 2023 and June 2025, BMGH handled a significant cohort of burn patients, highlighting the need for standardized, high-quality emergency care. The management of a burn patient during the "Golden Hour" (the first few hours post-injury) is a delicate balancing act focused on two critical priorities: maintaining systemic perfusion to prevent hypovolemic shock and securing the airway against impending obstruction.

The immediate aftermath of a significant burn is characterized by a massive Systemic Inflammatory Response Syndrome (SIRS). This triggers a profound increase in capillary permeability often referred to as "capillary leak syndrome" which leads to the rapid shift of fluid, electrolytes, and plasma proteins from the intravascular space into the interstitium. If left untreated, this results in severe hypovolemic shock, organ malperfusion, and acute kidney injury. Modern guidelines now advocate for more conservative initial volumes (2–3 mL/kg/%TBSA) titrated strictly to physiological markers, primarily urine output (0.5–1.0 mL/kg/hour), to ensure organ survival while minimizing iatrogenic harm. However, recent studies (2020-2025) have highlighted the dangers of "fluid creep," where over-resuscitation leads to complications such as pulmonary edema, compartment syndrome, and prolonged mechanical ventilation.

The presence of inhalation injury acts as a significant multiplier of mortality, increasing the risk of death by up to 20% compared to cutaneous burns alone. Inhalation injury is bipartite: thermal injury typically affects the upper airway (above the glottis), causing rapid mucosal edema that can lead to total obstruction within minutes to hours, while chemical injury from smoke toxins (such as carbon monoxide and cyanide) damages the lower respiratory tract and lung parenchyma. This chemical insult triggers a cascade of inflammatory cytokines and nitric oxide release, leading to impaired mucociliary clearance, surfactant inactivation, and potentially Acute Respiratory Distress Syndrome (ARDS).

One of the most debated topics in current burn care is the threshold for prophylactic intubation. Traditional teaching suggested that clinical signs such as facial burns, singed nasal hair, or soot in the oral cavity were definitive indications for early endotracheal intubation. However, contemporary literature (2023 – 2025) reveals that 30 – 40% of such intubations may be unnecessary, exposing patients to the risks of ventilator-associated pneumonia, tracheal stenosis, and sedation-related complications. The current

trend shifts toward "vigilant observation" for patients who are hemodynamically stable and lack signs of true respiratory distress (e.g., hoarseness, stridor, or accessory muscle use), provided they are monitored in a specialized setting.

This case report describes the management of a 52 year old female with moderate (17% TBSA) flame burns and classic markers of suspected inhalation injury. It serves as a critical clinical example of how a physiology driven approach prioritizing individualized fluid titration and non-invasive respiratory support can successfully navigate the acute phase of burn trauma. By avoiding "fluid creep" and unnecessary invasive airway management, the clinical team achieved hemodynamic stability and prevented airway obstruction, offering valuable insights into the efficacy of conservative but rigorous early resuscitation.

II. CASE PRESENTATION

Between June 2023 and June 2025, Bali Mandara General Hospital treated 9 patients with moderate to severe burns using the EMSB framework.

Table 1: Clinical Characteristics of moderate to severe Burn Patients at Bali Mandara General Hospital (n=9)

Patient No.	Age/Sex	TBSA (%)	Etiology	Suspected Inhalation	Resuscitation Method	Outcome (Acute Phase)
1.	31 (M)	15-30%	Scald	Yes	EMSB / Modified Parkland	Recovered
2.	32 (M)	15%	Flame	Yes	EMSB / Modified Parkland	Recovered
3.	24 (F)	44%	Flame	Yes	EMSB / Modified Parkland	Stable
4.	28 (M)	6% (full thickness)	Unknown	No	EMSB / Modified Parkland	Stable
5.	33 (M)	10%	Flame	No	EMSB / Modified Parkland	Recovered
6.	1 (M)	40%	Scald	No	EMSB / Modified Parkland	Stable
7.	31 (M)	5%	Scald	Yes	EMSB / Modified Parkland	Recovered
8.	19 (F)	10%	Scald	No	EMSB / Modified Parkland	Recovered
9.	52 (F) Ny. KS	17%	Flame	Yes	EMSB / Parkland (3mL)	Recovered

A 52-year-old female (85 kg) was brought to the emergency department at Bali Mandara General Hospital via

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ambulance 2.5 hours after being struck by a flame while cooking in her 3x2.5m kitchen. The incident occurred in a semi-enclosed space with windows and doors open. The patient had applied aloe vera gel to the wounds as first aid. She had no prior history of hypertension, diabetes, or allergies. (Primary Survey) Airway: C-spine stable; facial burns, singed hair, eyebrows, and nasal hair were present. "Fish mouth" appearance was noted, but no laryngeal edema or hyperesthesia. Breathing: Spontaneous; RR 20x, SpO₂ 99% on 15 LPM Non-Rebreathing Mask (NRM). No hoarseness, respiratory distress, or carbonaceous sputum. Circulation: Stable; BP 158/72 mmHg, HR 71 bpm, CRT < 2 second. Disability: GCS 15 (E4V5M6), pupils isochoric. Exposure: Total Burn Surface Area (TBSA) calculated at 17%. The patient was diagnosed with superficial to deep dermal burns (17% TBSA) involving the facial-coli region (6%), bilateral upper extremities (9%), and bilateral lower extremities (2.5%), with suspected inhalation injury. Diagnostic evaluation through follow-up tests, including X-rays and laboratory tests. Initial chest X-ray showed cardiomegaly with clear lung fields and no signs of pulmonary congestion. Initial arterial blood gas (ABG) analysis confirmed adequate oxygenation on 15 LPM NRM. Repeat X-ray and ABG on Day 1 showed stable findings, supporting the continuation of conservative management despite the patient's cardiac status.

Table 2. Serial ABG & Electrolytes Monitoring (June 9 – 10, 2025)

Parameter	Unit	Admission (June 9, 2025)	Day 1 (June 10, 2025)	Normal Range
pH	-	7.553 (High)	7.456 (High)	7.35 – 7.45
pO ₂	mmHg	163 (High)	188 (High)	80 – 100
pCO ₂	mmHg	22.2 (Low)	30.6 (Low)	35 – 45
HCO ₃	mmol/L	19.6 (Low)	21.4 (Low)	22 – 26
SO ₂	%	100	100	95 – 100
Base Excess	mmol/L	-3 (Low)	-2	(-2) – (+2)
Sodium (Na)	mmol/L	137 (Normal)	134 (Low)	136 – 145
Albumin	g/dL	3.9 (Normal)	3.3 (Low)	3.5 – 5.2

Upon admission on June 9, 2025, the initial arterial blood gas analysis revealed a state of respiratory alkalosis with partial metabolic compensation, characterized by a pH of 7.553 and a decreased pCO₂ of 22.2 mmHg. Despite the suspected inhalation injury, oxygenation remained excellent with an SO₂ of 100% and a pO₂ of 163 mmHg while on a 15 LPM Non-Rebreathing Mask. By June 10, the pH had trended toward normal (7.456), and the pCO₂ improved to

30.6 mmHg, indicating stabilized respiratory effort. Laboratory findings on the second day also showed mild hyponatremia (134 mmol/L) and hypoalbuminemia (3.3 g/dL), likely secondary to the capillary leak syndrome associated with burn-induced Systemic Inflammatory Response Syndrome (SIRS). These findings supported the decision to transition the patient to more conservative respiratory support and continue individualized fluid titration.

Therapeutic Intervention with fluid resuscitation: Parkland Formula was initiated ($3 \text{ ml} \times 85 \text{ kg} \times 17\% = 4,335 \text{ ml}$) of Ringer's Lactate (RL) over 24 hours. First 8 hours, 2167 ml (approx. 270 ml/hour). Next 16 hours, 2167 ml (approx. 135 ml/hour), titrated based on urine output. The infusion rate was not static but actively titrated every 1–2 hours based on urine output.

Table 3. Therapeutic Intervention, Fluid Resuscitation Monitoring (June 10 – 11, 2025)

Time Interval	Fluid Intake (mL)	Urine Output (mL)	Clinical Notes
15:00 – 19:00	1,570	1,080	Initial Resuscitation Phase
20:00 – 00:00	790	1,040	Rate titrated down as target UO was met.
01:00 – 06:00	870	1,050	Consistent titration between 100–200 mL/hr.
07:00 – 15:00	1,263	2,500	RL tapered further; Albumin 5% added.
00:00 – 21:00	Maintenance	3,700 (cumulative)	Ringer's Lactate (RL) was maintained at a very low restrictive rate of 15 mL/hour
TOTAL (Acute Phase)	5,493	5,700	Clear yellow urine

The fluid regimen was actively titrated based on hourly physiological response. While the Parkland formula provided a baseline, the infusion rate was adjusted hourly to maintain a urine output of 0.5–1 mL/kg/hr. The urine remained consistently "clear yellow" indicating adequate renal perfusion without signs of myoglobinuria. By the second day, the RL rate was significantly reduced to 15 mL/hour to prevent over-resuscitation.

For the wound care a bullectomy was performed followed by wound gel, gentamicin ointment, and sterile dressings. Target urine output was set at 0.5–1 mL/kg/hour (42.5 – 85 mL/hour). The patient was initially stabilized with a 15 LPM Non-Rebreathing Mask (NRM) due to suspected inhalation injury. As respiratory distress remained absent and SpO₂ remained stable at 99 – 100%, oxygen was successfully tapered to a Nasal Cannula (2 LPM) by the second day. The patient underwent elective debridement on days – 5 and 10 . By day – 10, significant re-epithelialization was observed in the facial region.

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Figure 1. The clinical description of patients with burns encompasses a total surface area of 6% of the facial-coli.



Figure 2. The clinical description of patients with burns encompasses a total surface area of 9% of the bilateral upper extremities.



Figure 3. The clinical description of patients with burns encompasses a total surface area of 2.5% of the bilateral lower extremities.

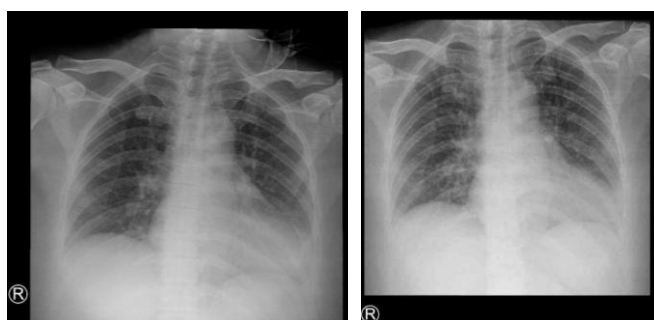


Figure 4. Chest X-ray comparison (A) Admission: Cardiomegaly with clear lungs. (B) Day 1: Stable pulmonary status after 24 hours of resuscitation.

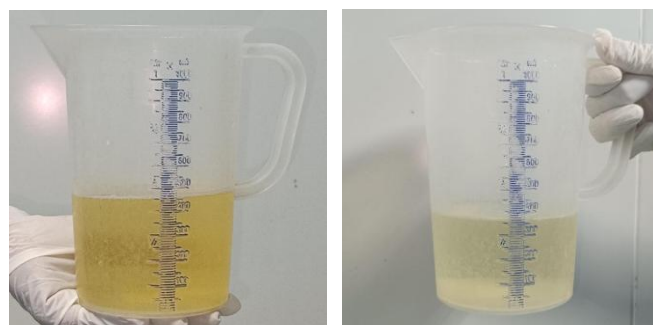


Figure 5. Urine Output Monitoring (A) Initial urine: 450ml, clear and straw-colored. (B) Urine remained clear and straw-colored throughout the first 48 hours, indicating adequate renal perfusion and the absence of significant myoglobinuria.

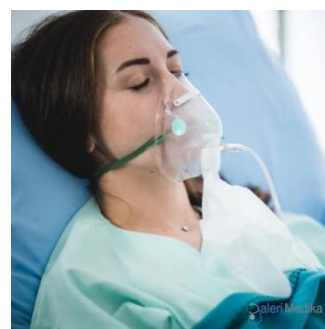


Figure 6. The patient was maintained on a 15 LPM Non-Rebreathing Mask (NRM) to maximize oxygen delivery during the peak inflammatory phase. (Figure: Illustration of NRM placement and head-of-bed elevation 30°).

After bullectomy, dressing is applied using the moist wound healing principle to facilitate re-epithelialization and prevent infection. Apply wound gel and Gentamicin eye ointment thickly to the face and neck area to maintain extreme moisture. Use of tulle as the primary layer to prevent mechanical trauma during dressing changes, followed by a transparent dressing. The wound is covered with sterile gauze and fixed using an elastic bandage. All four extremities are continuously elevated to minimize dependent oedema, which can worsen tissue perfusion.

During the ten days treatment period, the patient underwent two debridement procedures in the operating room (OK IBSA): Debridement I (Day – 3): Dead tissue was removed and the wound depth was re-evaluated. At this stage, oxygen supplementation was gradually reduced to a nasal cannula at 2 LPM as the patient's respiratory condition improved. Debridement II (Day – 8): Focused on cleaning the extremities that still had eschar.

Serial debridement on days – 3 and 8 revealed progressive healing. By Day – 10, the face and neck showed 6% epithelialization, with the remaining burns exhibiting healthy granulation. Despite the initial depth (superficial to deep dermal), a split-thickness skin graft (STSG) was not required. The use of moist wound healing with gentamicin and wound gel, combined with adequate systemic perfusion, prevented 'burn wound conversion'. This allowed the wounds to heal through spontaneous re-epithelialization by

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Day – 10. The patient was discharged with a good clinical outcome.



Figure 7. By the evaluation on Day – 10, the facial and neck regions showed nearly complete re-epithelialization.



Figure 8. By the evaluation on Day – 10, the bilateral upper extremities regions showed nearly complete re-epithelialization.



Figure 9. By the evaluation on Day – 10, the bilateral lower extremities regions showed nearly complete re-epithelialization.

DISCUSSION

The management of moderate burn injuries involving the face and suspected inhalation trauma presents a significant clinical challenge, requiring a precise balance between aggressive resuscitation and the prevention of secondary complications. This case highlights several key areas where modern evidence-based practices (2020–2025) diverge from or refine traditional protocols.

Fluid Resuscitation: Parkland vs. Restricted Strategies

Historically, the Parkland formula (4 mL/kg/TBSA) was the definitive standard. However, recent literature (Kahn et al., 2025; StatPearls, 2025) has identified a growing trend of "fluid creep" the administration of excessive fluids beyond calculated needs which is associated with pulmonary oedema, abdominal compartment syndrome, and increased mortality. In this case, the medical team utilized a more

conservative ratio of 3 mL/kg/TBSA. For Ny. KS, who presented with cardiomegaly on imaging, this restricted approach was vital. Studies from 2023–2025 suggest that in patients with underlying cardiac risks or moderate burns (15–20% TBSA), lower initial volumes (2–3 mL) titrated strictly to a urine output of 0.5–1.0 mL/kg/hour result in better outcomes and fewer days on ventilatory support. The patient's hemodynamic stability and the achievement of target urine output (42.5 – 85 mL/hour) without signs of heart failure confirm the efficacy of this individualized, physiology-driven titration.

Management of Suspected Inhalation Injury

The presence of facial burns, singed nasal hair, and a history of injury in a semi-enclosed space strongly suggested inhalation trauma. Traditionally, such markers often triggered "prophylactic" intubation. However, recent multicentre reviews (2024–2025) argue against automatic invasive airway management in the absence of active respiratory distress (hoarseness, stridor, or O₂ desaturation). The decision to utilize High-Flow Oxygen (15 LPM NRM) and close monitoring (every 3 hours) in Ny. KS allowed for the avoidance of ventilator-associated risks. This is supported by 2024 guidelines emphasizing that upper airway oedema typically peaks at 12–24 hours; if a patient can be managed through this window with non-invasive support and "head-of-bed elevation (30°)" the overall prognosis improves significantly.

The patient's respiratory management was characterized by a cautious yet proactive tapering of oxygen supplementation. Although initial clinical markers (facial burns and singed nasal hair) suggested a high risk of inhalation injury, serial Arterial Blood Gas (ABG) analyses provided the physiological justification for a non-invasive approach. On admission, the ABG showed a high pO₂ of 163 mmHg while the patient was on a 15 LPM Non-Rebreathing Mask (NRM). This hyperoxic state, combined with the absence of clinical distress, indicated that the patient had a significant respiratory reserve despite the suspected thermal insult to the upper airway. By the following day, the pO₂ remained elevated at 188 mmHg. These supra-physiological oxygen levels confirmed that the 15 LPM NRM was no longer necessary. Consequently, the team successfully transitioned the patient to a 2 LPM nasal cannula, maintaining an SO₂ of 100%. This data-driven decision prevented the complications associated with prolonged high-flow oxygen therapy and unnecessary prophylactic intubation (Deutch. C. J., et al., 2025) and (American Burn Association, 2023).

Adjunctive Therapies and Wound Care and the Prevention of Burn Wound Conversion

The use of Dexamethasone in this case, while controversial in some older burn protocols due to infection risks, has seen a resurgence in specific contexts for reducing

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acute laryngeal oedema in suspected inhalation injury. When combined with prophylactic antibiotics (Ceftriaxone) and meticulous wound care (Gentamicin and Wound Gel), the patient remained infection-free.

The avoidance of a split-thickness skin graft (STSG) in this patient underscores the efficacy of targeted conservative wound management. A critical challenge in the acute phase of moderate to severe thermal injuries is the prevention of burn wound conversion a pathophysiological cascade where an initial partial-thickness burn deepens into a full-thickness injury, thereby mandating surgical excision and grafting.

According to recent pathophysiological reviews, burn wound conversion occurs primarily within the zone of stasis during the first 48 to 72 hours post-injury (Popowicz et al., 2025). This zone is highly vulnerable to three primary destructive forces: local tissue ischemia, cellular desiccation, and microbial colonization (Popowicz et al., 2025). In this case, early and adequate fluid resuscitation starting on June 9, 2025, addressed the systemic ischemic component, while the local wound microenvironment was aggressively managed using the principles of Moist Wound Healing.

The application of an amorphous wound gel (hydrogel) played a pivotal role in preventing cellular desiccation. Contemporary literature demonstrates that hydrogel-based dressings maintain an optimal fluid balance at the wound bed, which prevents the drying of exposed dermal collagen and the subsequent necrosis of surviving keratinocytes and hair follicle stem cells (Surgical Critical Care, 2025). Furthermore, this moist environment facilitates autolytic debridement and accelerates the migration of epithelial cells across the wound surface (Popowicz et al., 2025). By preserving the viability of the dermal appendages in the zone of stasis, the wound gel directly arrested the progression of the burn depth.

Equally important was the control of local bioburden to prevent infection-driven conversion. The inflammatory response triggered by bacterial colonization can cause microvascular thrombosis in the delicate dermal capillary plexus, rapidly deepening the wound (Popowicz et al., 2025). The topical application of Gentamicin provided targeted antimicrobial coverage against common hospital-acquired and burn-specific pathogens, such as *Pseudomonas aeruginosa* and *Staphylococcus aureus*. Recent clinical guidelines emphasize that while prophylactic systemic antibiotics are generally discouraged in burns, targeted topical antimicrobials combined with moisture-retentive dressings significantly reduce local infection rates without impeding re-epithelialization (Cartotto et al., 2023; Surgical Critical Care, 2025).

Ultimately, the synergistic effect of preventing desiccation via wound gel and controlling bacterial colonization via Gentamicin successfully salvaged the zone of stasis. This halted burn wound conversion and allowed

the superficial and deep dermal burns to heal via spontaneous re-epithelialization within 10 days, entirely sparing the patient from the morbidity, donor-site pain, and prolonged recovery associated with surgical skin grafting.

Clinical Implication and Uniqueness

The uniqueness of this case lies in the successful management of a "high-risk" geriatric-adjacent patient (52 years old) with cardiomegaly and markers of inhalation trauma through non-invasive means. It proves that early resuscitation within the "Golden Period" (2.5 hours post-injury) and strict adherence to physiological targets can mitigate the need for aggressive interventions that carry their own set of morbidities.

CONCLUSIONS AND LIMITATION

This case demonstrates that measured fluid resuscitation specifically using a 3 mL/kg/%TBSA calculation is highly effective in preventing both hypovolemic shock and "fluid creep" complications in moderate burns. Furthermore, clinical signs of inhalation injury do not necessitate immediate intubation if the patient remains respiratorily stable under vigilant monitoring. The key educational lesson is the importance of individualized titration: treating the patient's physiological response (urine output and breath sounds) rather than strictly following static formulas.

Furthermore, the integration of serial Arterial Blood Gas (ABG) monitoring proved vital in respiratory management (Surgical Critical Care, 2025). The presence of supra-physiological oxygen levels (pO₂ of 163 – 188 mmHg) provided objective evidence that the patient remained respiratorily stable. This evidence allowed for a safe and early transition from a 15 LPM Non-Rebreathing Mask to a 2 LPM nasal cannula, successfully avoiding the risks associated with unnecessary prophylactic intubation (Kahn et al., 2025; Surgical Critical Care, 2025).

The primary clinical lesson is that early detection of inhalation injury markers does not mandate invasive intervention if the patient remains hemodynamically and respiratorily stable under vigilant observation. Ultimately, treating the patient's individualized physiological response rather than strictly adhering to static formulas is the key to optimizing outcomes and preventing burn wound conversion in acute burn care (Popowicz et al., 2025).

Despite the significant improvements observed in this case, several limitations must be considered: lack of generalizability as a single-case report (n=1), the findings are specific to this patient's physiological response and cannot be generalized to a broader population with different age groups, comorbidities, or more extensive Total Body Surface Area (TBSA) burns; short term follow-up, consequently long-term outcomes such as hypertrophic scarring, functional contractures, or late-stage respiratory

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complications were not evaluated; A notable limitation of this study is that the management was conducted at Bali Mandara General Hospital, which currently lacks a specialized burn center or a Burn Intensive Care Unit (BICU). Although the patient was successfully treated and the absence of a multidisciplinary burn team including specialized burn nurses, dedicated burn therapists, and specialized nutritionists may affect the applicability of this conservative protocol in more complex or higher-TBSA (Total Body Surface Area) cases.

ETHICS APPROVAL

Informed consent has been acquired from the patient. The patient written informed consent to be published as a case report.

COMPLETING INTERESTS

All the authors declare that there are no conflicts of interest

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