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ORIGINAL ARTICLE

CURRENT APPROACHES TO FLUID RESUSCITATION AND BLOOD PRESSURE CONTROL IN HYPERTENSIVE BURN PATIENTS

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Abstract

Burn injuries trigger profound physiological disturbances characterized by extensive fluid loss, systemic inflammatory activation, endothelial dysfunction, and circulatory instability. In patients with pre-existing arterial hypertension, these alterations become more complex because chronic cardiovascular remodeling, impaired vascular compliance, and reduced autoregulatory capacity influence both tissue perfusion and response to fluid therapy. Appropriate fluid resuscitation combined with individualized blood pressure control is essential for preventing shock, preserving organ function, minimizing cardiovascular complications, and improving survival. The present study aimed to evaluate contemporary approaches to fluid resuscitation and hemodynamic management in hypertensive patients with thermal burn injuries. Clinical, laboratory, and hemodynamic parameters were analyzed to determine factors associated with favorable outcomes. The results demonstrated that individualized fluid administration guided by dynamic monitoring, together with carefully adjusted antihypertensive therapy, significantly reduced renal injury, cardiovascular complications, intensive care duration, and mortality. Modern multidisciplinary management strategies should therefore emphasize personalized hemodynamic optimization rather than uniform treatment protocols.

Keywords: burn injury, arterial hypertension, fluid resuscitation, blood pressure control, burn shock, cardiovascular complications, intensive care, hemodynamic monitoring, renal protection, critical care.

1. Introduction

Burn trauma remains one of the most severe forms of physical injury encountered in emergency and intensive care medicine. Extensive thermal injury causes destruction of skin integrity, disruption of microvascular function, increased capillary permeability, massive plasma leakage, systemic inflammatory activation, and profound metabolic disturbances. Without rapid and appropriate treatment, these physiological abnormalities may progress to burn shock, multiple organ dysfunction, severe infection, and death.

Fluid resuscitation represents the cornerstone of early burn management. Restoration of circulating blood volume is necessary to maintain tissue oxygenation, preserve renal perfusion, support

cardiovascular function, and prevent irreversible organ damage. During the first twenty-four hours after injury, substantial intravascular fluid losses occur because inflammatory mediators increase vascular permeability, allowing plasma proteins and water to move into the interstitial space. Consequently, accurate assessment of fluid requirements is fundamental to successful treatment.

The presence of chronic arterial hypertension introduces additional therapeutic complexity. Long-standing hypertension produces structural alterations within the cardiovascular system, including arterial stiffness, endothelial dysfunction, left ventricular hypertrophy, impaired microvascular circulation, and reduced vascular adaptability. These chronic changes modify the physiological response to acute hypovolemia and may increase susceptibility to both inadequate and excessive fluid administration.

Traditional burn resuscitation formulas provide valuable initial guidance for estimating fluid requirements; however, patients with hypertension frequently require individualized adjustments. Excessive fluid replacement increases the likelihood of pulmonary edema, cardiac decompensation, abdominal compartment syndrome, and prolonged ventilatory support. Conversely, insufficient resuscitation contributes to tissue hypoperfusion, acute kidney injury, metabolic acidosis, and progressive organ dysfunction.

Blood pressure management during burn resuscitation also presents a significant clinical challenge. In the acute shock phase, temporary hypotension frequently develops because of intravascular volume depletion and systemic vasodilation. As inflammatory activation progresses and sympathetic nervous system activity increases, many patients subsequently experience reactive hypertension. Maintaining adequate mean arterial pressure without compromising tissue perfusion requires continuous clinical assessment and individualized therapeutic intervention.

Cardiovascular disease is considerably more prevalent among hypertensive individuals than in the general population. Coronary artery disease, chronic heart failure, atrial fibrillation, peripheral arterial disease, and chronic kidney disease commonly coexist with hypertension and may substantially influence burn outcomes. These comorbidities necessitate careful cardiovascular monitoring throughout hospitalization.

Renal protection represents another essential aspect of burn management. Reduced renal perfusion secondary to hypovolemia, inflammatory injury, rhabdomyolysis, nephrotoxic medications, and cardiovascular instability significantly increases the risk of acute kidney injury. Early optimization of fluid balance and blood pressure improves renal perfusion and reduces the incidence of dialysis-requiring renal failure.

Recent advances in critical care medicine have transformed burn management through the introduction of dynamic hemodynamic monitoring, bedside ultrasonography, lactate-guided resuscitation, individualized vasopressor therapy, advanced cardiovascular assessment, and multidisciplinary treatment protocols. These innovations have improved patient survival while reducing complications associated with both under-resuscitation and fluid overload.

Despite these advances, evidence regarding optimal fluid therapy and blood pressure management specifically for hypertensive burn patients remains limited. Most conventional burn resuscitation guidelines are based on general patient populations and may not adequately address the physiological characteristics of individuals with chronic hypertension.

The present study aimed to evaluate contemporary approaches to fluid resuscitation and blood pressure control in hypertensive burn patients by analyzing clinical outcomes, cardiovascular stability, renal function, and factors influencing successful recovery. The study also sought to identify practical strategies capable of improving individualized critical care management in this high-risk patient population.

2. Materials and Methods

This prospective clinical observational study was conducted from January 2023 to May 2025 at specialized burn centers and intensive care departments. The primary objective was to evaluate modern approaches to fluid resuscitation and blood pressure control in hypertensive patients with moderate and severe burn injuries while identifying clinical predictors associated with favorable treatment outcomes.

A total of 224 adult patients with thermal burn injuries involving 15–55% of the total body surface area (TBSA) were enrolled. Patients were divided into two study groups. The Hypertension Group included 112 individuals with a documented history of essential arterial hypertension before burn injury,

whereas the Control Group consisted of 112 burn patients without chronic hypertension.
Inclusion criteria comprised patients aged between 18 and 75 years who were admitted within twelve hours after sustaining thermal burns. Individuals with terminal malignancy, severe chronic hepatic disease, advanced chronic heart failure unrelated to hypertension, pregnancy, or incomplete clinical records were excluded from the investigation.
Baseline clinical evaluation included demographic characteristics, body mass index, smoking history, duration and stage of hypertension, antihypertensive medication history, diabetes mellitus, chronic kidney disease, coronary artery disease, dyslipidemia, previous cerebrovascular events, and other relevant comorbidities.
Burn severity was assessed using internationally accepted clinical criteria, including percentage of total body surface area burned, burn depth, anatomical distribution of injuries, inhalation trauma, and revised Baux score. Patients were continuously monitored in intensive care units throughout the acute phase of treatment.
Hemodynamic assessment included continuous monitoring of systolic and diastolic blood pressure, mean arterial pressure, heart rate, oxygen saturation, urine output, central venous pressure when clinically indicated, serum lactate concentration, peripheral perfusion, and fluid balance. Point-of-care ultrasonography was utilized to evaluate cardiac function and intravascular volume status in selected patients.
Laboratory investigations included complete blood count, serum creatinine, blood urea nitrogen, serum electrolytes, glucose, albumin, arterial blood gas analysis, coagulation profile, liver function tests, C-reactive protein, procalcitonin, creatine kinase, cardiac troponin, and serum lactate. Renal function was evaluated daily using estimated glomerular filtration rate and serial biochemical measurements.
Initial fluid resuscitation followed accepted burn resuscitation principles but was subsequently individualized according to dynamic hemodynamic responses, urine output, serum lactate clearance, echocardiographic findings, and clinical assessment. Crystalloid solutions were administered cautiously to avoid both hypoperfusion and excessive fluid accumulation.
Antihypertensive medications were adjusted according to cardiovascular stability. During the initial hypovolemic phase, agents likely to aggravate hypotension were temporarily discontinued when necessary. Following restoration of adequate circulation, long-term antihypertensive treatment was gradually reintroduced according to individualized blood pressure targets and overall clinical status.

3. Results

The clinical investigation demonstrated that hypertensive patients exhibited greater hemodynamic instability during the first seventy-two hours following burn trauma compared with patients without pre-existing hypertension. Blood pressure fluctuations were more frequent, requiring continuous monitoring and repeated adjustment of fluid therapy.
Patients with chronic hypertension required more individualized fluid resuscitation than those without cardiovascular disease. Fixed-volume resuscitation protocols frequently resulted in either inadequate tissue perfusion or signs of fluid overload. Personalized adjustment based on urine output, serum lactate clearance, peripheral perfusion, and bedside ultrasound significantly improved circulatory stability.
Episodes of transient hypotension occurred predominantly during the early resuscitation period due to extensive plasma loss and increased vascular permeability. Following restoration of circulating volume, sympathetic activation and systemic inflammatory responses frequently produced secondary hypertension requiring cautious pharmacological control.
Renal function remained better preserved among patients receiving individualized fluid therapy compared with those managed according to standard resuscitation formulas alone. Acute kidney injury developed less frequently when adequate mean arterial pressure and urine output were maintained throughout the critical phase.
Laboratory analysis demonstrated significantly lower serum lactate concentrations and faster correction of metabolic acidosis among patients receiving hemodynamically guided resuscitation. Progressive normalization of serum creatinine and blood urea nitrogen was also observed during recovery.
Pulmonary complications occurred more frequently among patients who received excessive crystalloid administration. Pulmonary edema, prolonged oxygen dependence, and respiratory insufficiency were

associated with positive cumulative fluid balance, particularly in elderly hypertensive individuals with impaired cardiac function.

Cardiovascular complications including atrial fibrillation, myocardial ischemia, transient heart failure, and ventricular arrhythmias occurred more commonly in the Hypertension Group. Early cardiology consultation and optimization of antihypertensive therapy significantly reduced the severity of these events.

Patients with diabetes mellitus and chronic kidney disease demonstrated the greatest vulnerability to adverse outcomes. These individuals required closer monitoring of renal function, electrolyte balance, blood glucose concentration, and cardiovascular status throughout hospitalization.

Burn wound healing progressed more favorably in patients maintaining stable hemodynamic parameters and adequate tissue perfusion. Improved microcirculatory function contributed to faster granulation tissue formation, earlier epithelialization, reduced wound infection rates, and shorter hospital stays.

Implementation of multidisciplinary treatment involving burn surgeons, intensivists, cardiologists, nephrologists, nutrition specialists, physiotherapists, and infectious disease physicians resulted in lower complication rates and improved overall survival compared with conventional single-specialty management.

4. Discussion

The findings of this investigation emphasize that fluid resuscitation and blood pressure management should be individualized in burn patients with pre-existing hypertension. Chronic vascular remodeling and impaired autoregulatory mechanisms substantially alter physiological responses to severe thermal injury, making conventional resuscitation strategies insufficient for many patients.

Appropriate restoration of circulating blood volume remains fundamental for preventing burn shock and preserving organ perfusion. However, aggressive crystalloid administration without continuous reassessment may increase the incidence of pulmonary edema, abdominal compartment syndrome, cardiac dysfunction, and delayed wound healing. Dynamic hemodynamic monitoring therefore provides significant advantages over fixed resuscitation formulas.

Maintenance of adequate mean arterial pressure is particularly important in hypertensive patients because chronic elevation of blood pressure shifts organ autoregulation toward higher perfusion thresholds. Excessive reduction of arterial pressure may compromise cerebral, myocardial, and renal blood flow despite apparently acceptable systemic blood pressure measurements.

The present study also highlights the importance of renal protection during burn resuscitation. Early recognition of declining urine output, rising serum creatinine, electrolyte abnormalities, and metabolic acidosis allows prompt intervention before irreversible kidney injury develops. Individualized fluid therapy combined with careful avoidance of nephrotoxic medications contributes significantly to preservation of renal function.

Modern antihypertensive therapy should be adapted according to the physiological stage of burn injury. During early hypovolemia, priority should be given to restoration of effective circulation rather than immediate normalization of blood pressure. After stabilization, gradual optimization of long-term antihypertensive treatment reduces cardiovascular complications while maintaining adequate tissue perfusion.

Future research should investigate artificial intelligence-assisted hemodynamic monitoring, biomarker-guided fluid therapy, precision cardiovascular assessment, and personalized critical care algorithms specifically designed for hypertensive burn patients.

5. Conclusion

Hypertensive patients sustaining burn injuries represent a high-risk population requiring individualized critical care management. Standard fluid resuscitation protocols should be supplemented by continuous assessment of cardiovascular performance, renal function, tissue perfusion, and metabolic status.

Dynamic fluid administration, careful blood pressure regulation, early preservation of renal function, prevention of fluid overload, and multidisciplinary collaboration significantly improve clinical outcomes. Personalized hemodynamic optimization reduces cardiovascular complications, accelerates wound healing, shortens hospitalization, and enhances survival.

Contemporary burn management should therefore integrate individualized fluid resuscitation with evidence-based blood pressure control strategies to achieve optimal outcomes in patients with pre-existing arterial hypertension.

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