Monitoring End Points of Burn Resuscitation

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KEYWORDS

• Burn resuscitation • End points • Burn shock • End points of resuscitation

KEY POINTS

- Burn care is best provided in a regional burn center that has the expertise and experience in caring for a unique population of critically ill patients.
- Although burn resuscitation is monitored and administered using the methodology as seen in medical/surgical intensive care settings, special consideration for excessive edema formation, metabolic derangements and frequent operative interventions must be considered.
- End points of burn resuscitation must be able to consider these factors and provide reliable starting and stopping points.

INTRODUCTION

Shock and Burn Shock

Described in the nineteenth century by Gross,[1] shock was believed to be a "manifestation of the crude unhinging of the machinery of life." Years later, shock was noted by Blalock[2] to be "a peripheral circulatory failure, resulting from a discrepancy in the size of the vascular bed and the volume of the intravascular fluid." In present day, the 2006 International Consensus Conference and American College of Surgeons Advanced Trauma Life Support defined shock by using degrees of derangements in physiologic parameters, such as heart rate, urine output, and blood pressure.[3] These efforts yielded the current definition of shock as "an abnormality of the circulatory system that results in inadequate organ perfusion and tissue oxygenation"; failure of a person's oxygen supply to meet their tissue metabolic demands.[4]

Burn shock is the significant loss of fluids described as a combination of hypovolemic and distributive shock.[5–10] Although shock states often require significant fluid administration, burn resuscitation often requires supertherapeutic fluid administration to maintain adequate perfusion and ultimately restore fluid balance. Unfortunately, fluid administration in the burn shock state is easier said than done. Systemic capillary

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leak from the microcirculation causes protein (decreasing osmotic pressure) and fluid loss from the vascular system.[5,9,11,12] Excessive fluid movement occurs into the interstitium resulting in a decrease in plasma volume, hemoconcentration, global edema, low urine output, and increasing systemic vascular resistance.[7,13] Coupled with the grave fluid losses is the release of tumor necrosis factor-α, which acts directly on the cardiac myocardium to decrease contractility and cardiac output (CO).[7,14,15] Next, edema formation, although stated to be maximal at 24 hours post burn injury, often continues for 48 to 72 hours resulting in tissue hypoxia, increased tissue pressure, and possible compartment syndromes.[5,9,11] To restore the plasma volume the extracellular space must be expanded but in doing so may actually worsen the edema.[9,16,17]

Goals of Burn Resuscitation and Monitoring

Resuscitation is the restoration of a body's normal physiology, primarily at the cellular level. Although normal physiologic values may be obtained, persistent hypoxemia, anaerobic acidosis, and lactic acidosis may still be present. Thus, many burn practitioners have noted that the ideal burn resuscitation protocol would prevent rather than treat burn shock.[18–20] These same clinicians argue that resuscitation of burn shock cannot achieve complete normalization of physiologic parameters because of the burn injury, subsequent operative treatment, and ongoing cellular and hormonal responses. Among burn physicians there is considerable variability in determining the type and amount of fluids to be administered and how to monitor and ultimately cease resuscitation efforts. Thus burn resuscitation is an area of clinical practice driven primarily by local custom of treating burn units than by evidence-based medicine.[21] More sophisticated physiologic markers, also known as end points of resuscitation, have been sought to better guide resuscitative efforts in patients undergoing shock.

END POINTS OF BURN RESUSCITATION

First-Line Monitoring

Even though burn physicians are aware of the limitations of monitoring resuscitation using heart rate and urine output, Latenser[21] noted that these parameters are still the primary modalities, although their use in patients with large burns is not supported by data. Most burn physicians use the standard that a pulse rate less than 110 beats/min in adults usually indicates adequate volume, with rates greater than 120 beats/min usually indicating hypovolemia. Narrowed pulse pressure provides an earlier indication of shock than systolic blood pressure alone.[5] Furthermore, noninvasive blood pressure measurements by cuff are rendered inaccurate because of the interference of tissue edema.[12] Therefore, arterial catheter placement is recommended. However restoration of blood pressure to the normal range, although the most common method of resuscitation, demonstrates great variability in terms of the accuracy of systolic and diastolic pressures. Most often, clinicians rely on mean arterial blood pressure (MAP) has a more accurate blood pressure measurement.

When MAP is normalized it is termed an end point of resuscitation, all be it controversial. In 2001, Rivers and colleagues[22] reported the substantial benefits of using MAP in early goal-directed therapy. They demonstrated that a significant mortality decrease was possible in patients with sepsis treated with an algorithm including MAP, central venous pressure (CVP), and mixed venous oxygen saturation (SvO_2). However, Donnino and colleagues[23] later reported that despite normalization of MAP, a significant number of patients were still exhibiting signs of global hypoxia