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Capillary Leak Syndrome in Trauma

What is it and What are the Consequences?

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Keywords
• Capillary leak syndrome • Traumatic injury • Compartment syndrome
• Systemic inflammation

Key Points
- TICS is a complex multifactorial disease in the traumatically injured patient.
- The mainstay of therapy for TICS is prevention and attenuation of its effects.
- Newer resuscitation strategies and prompt are currently the best available strategies to combat TICS.

INTRODUCTION

Largely considered a component of the systemic inflammatory response syndrome (SIRS), capillary leak syndrome (CLS) is poorly defined. Described as increased endovascular or microvascular permeability, CLS is known to occur in a variety of disease states. Although most widely reported in the setting of sepsis and septic shock, following traumatic injury CLS is also frequently seen. There are several features of traumatic disease that allow the injured patient to be uniquely susceptible to CLS. Inflammation plays a prominent role in the sequela of both systemic injury and organ-specific injury and is central to the development of trauma-induced capillary leak syndrome (TICS). Large-volume crystalloid administration, a mainstay of resuscitation strategies following trauma, also contributes significantly to the development of TICS. In addition, hypoproteinemia caused by systemic catabolic states following tissue injury plays a significant role in the development and worsening of capillary leak and tissue edema.

Direct tissue destruction due to dynamic forces applied across tissues directly causes local tissue edema and increased capillary permeability, precipitating more widespread systemic inflammation and amplifying the SIRS response to

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injury. Postcapillary hypertension due to direct lymphatic or venous injury may cause localized CLSs in affected areas. These more localized edematous states then subsequently also worsen the overall TICS due to the systemic response to local injury. CLS causes organ dysfunction and failure, which contributes to both morbidity and mortality after critical injury. Although no specific therapy is widely used to combat the effects of capillary leak, there are strategies that may be used to minimize its occurrence and attenuate its effects once it occurs. These strategies include hemostatic resuscitation and more goal-directed therapies following severe trauma. This review focuses on the development of TICS and the strategies that may be used to combat its effects following trauma.

EPIDEMIOLOGY

The leading cause of death following injury is traumatic brain injury (TBI), followed by acute hemorrhage [1]. Deaths from these diseases typically occur within the first hours to days after injury. For those who survive these acute insults, sepsis and the attendant multiple organ dysfunction syndrome (MODS) and multiple organ failure (MOF) are the leading causes of death and typically occur at approximately 2 weeks after injury. MODS and MOF account for more than 10% of injury-related deaths, [1] and mortality following the development of MODS and MOF is as high as 70% [2,3]. Following trauma, CLS plays an integral role in the development of organ dysfunction not only as part of a systemic inflammatory process but also as a direct result of both the traumatic injury itself and the treatments applied to combat its effects.

TICS is poorly described in the literature. In unpublished data from the authors' institution, the authors found TICS in as many as 21% of injured patients admitted to the intensive care unit (ICU) [4]. Once TICS occurs, mortality rate is exceptionally high, with a 10-fold increase in the risk of death. In patients with the most severe form of the disease, as defined by a serum albumin level of up to1 mg/dL, mortality rate was 70%. Failure of albumin levels to improve over a period of 72 hours after admission resulted in a 91% positive predictive value for death. One study which used the levels of microalbuminuria to define CLS, found that levels of microalbuminuria also predicted mortality in critically ill trauma, burn, and surgical patients in adjusted analysis [5]. Because of the lack of any consensus as to the definition of TICS, population-based incidence rates following traumatic injury are currently unavailable.

DIAGNOSIS

There is currently no established definition of CLS in the setting of trauma or other disease processes. CLS has been described in several diseases aside from trauma, namely sepsis [6] and burns [7,8]. An idiopathic version called systemic capillary leak syndrome or Clarkson disease also exists [9,10]. Positive fluid balance/edema is listed as one of the suggested criteria for the definition of sepsis in a consensus conference [11], but as a syndrome that is largely considered part of the SIRS/sepsis continuum. One review article describes "… increased microvascular permeability and capillary leakage which, in turn, result in interstitial fluid