

Fluid Creep and Over-resuscitation

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KEYWORDS

• Burns • Fluid resuscitation • Fluid creep • Colloid

KEY POINTS

- Fluid creep occurs when a patient requires more resuscitation fluid than is predicted by standard formulas.
- Fluid creep is reported in 30% to 90% of patients with major burns; the incidence increases with burn size.
- Excessive fluid given in the initial hours after injury predisposes to fluid creep.
- Complications of fluid creep include extremity and abdominal compartment syndromes, respiratory failure, and ocular hypertension. Resuscitations that require 6 mL/kg/% total body surface area or a total fluid of 250 mL/kg should prompt measures to correct fluid creep.
- Strategies to prevent or treat fluid creep include careful budgeting of fluids, use of colloid as a routine or rescue, hypertonic saline resuscitation, vitamin C infusions, and plasmapheresis.

INTRODUCTION

In 2000, Dr Basil Pruitt¹ coined the term fluid creep to characterize recent disturbing reports that many burn patients were receiving much more resuscitation fluid than predicted by widely accepted formulas. Not coincidentally, this insidious trend was preceded by widespread reports of the abdominal compartment syndrome (ACS)² and other serious complications. Pruitt called for clinicians to “push the pendulum back” by reassessing their resuscitation practices.

Reports of fluid creep have been widespread^{3–23}; in response, clinicians have re-examined both the physiologic basis of burn shock and the historical underpinnings of revered resuscitation guidelines. The result has been enhanced appreciation of the complexities of burn resuscitation and several approaches for managing difficult patients through the critical period of initial burn treatment.

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HISTORICAL CONTEXT

Clinicians have recognized and treated burn shock for almost a century. As experience and knowledge accumulated, progressively better formulas for fluid resuscitation were developed that dramatically reduced early burn mortality. Formula-guided resuscitation is now a cornerstone of modern care and the formulas themselves have become almost sacrosanct in the burn community. Foremost among these is Baxter's⁴ Parkland formula, which originally called for lactated Ringer (LR) solution at a total dose of 4 mL/kg/% total body surface area (TBSA) burned, half given in the first 8 hours after injury, the rest over the next 16 hours. Importantly, he also emphasized that an infusion of plasma given during a fourth 8-hour period was essential to restore extracellular fluid volume and cardiac output. He reported that more than 79% of adults and 98% of children were successfully resuscitated with 3.7 to 4.3 mL/kg/% TBSA of LR. The earlier Brooke and Evans formulas also called for combinations of crystalloid and colloid.²⁴

As these formulas became widely used, they were simplified and, ultimately, oversimplified. In 1979, the recommendations of a conference sponsored by the National Institutes of Health on burn care blended the crystalloid requirements of the most popular formulas, calling for initial resuscitation with LR at a total dose of 2 to 4 mL/kg/% TBSA, titrated to maintain urine output of 30 to 50 mL per hour, and omitting any routine use of colloids.²⁵ This became the consensus for burn resuscitation for over 25 years, and probably set the stage for the occurrence of fluid creep.

FLUID CREEP BEGINS

The Parkland formula was largely effective but not universally so. Even in the original reports, patient groups were noted who regularly required increased fluid volumes. Foremost among these were patients with inhalation injuries or high-voltage electrical injuries, and those in whom resuscitation was delayed. Subsequently, patients suffering multiple traumatic injuries, and those with acute alcohol or drug use, have been recognized to need extra fluid.²⁶

Table 1 summarizes several clinical reports of burn resuscitation in a variety of circumstances. Several initial studies confirmed that fluid requirements were increased from 37% to 65% in the presence of inhalation injury, even with the addition of colloid.²⁷

Fluid Creep: The New Normal?

In contrast to specific situations such as inhalation injury, more recent reports have described fluid creep in 30% to more than 80% of unselected patients without known complicating conditions. In many of these patients, fluid creep has a characteristic presentation: a patient arrives at the burn center having received substantially more crystalloid than required. Parkland resuscitation is begun and continues fairly smoothly until 8 to 12 hours after the burn injury. At that time, instead of decreasing, fluid requirements actually begin to escalate, ranging further and further from predictions. As this continues, problems with edema-related complications may become more obvious. Requirements for large quantities of crystalloid may continue unchecked despite efforts to reduce them and taper only very slowly, often requiring more than 24 hours to resolve.

As noted by Pruitt¹, the magnitude and frequency of this scenario seems to be a distinctly modern problem. Friedrich and colleagues¹⁴ compared a small group of patients treated during 2000 with similar patients treated 25 years earlier and found that resuscitation requirements had doubled.¹⁵ As possible explanations, the investigators

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