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Is supra-Baxter resuscitation in burn patients a new phenomenon?

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Abstract

Baxter described the use of 4 cm^3/kg/%TBSA as a guideline for fluid resuscitation after burns. However, recent studies have shown that, at the present time, patients generally receive greater than the "Baxter" formula. Pruitt has called this phenomenon "fluid creep," and it has the potential for significant consequences including abdominal and extremity compartment syndromes and severe pulmonary insults. The purpose of this paper is to determine if this supra-Baxter resuscitation is a new phenomenon. We performed a retrospective chart review with two cohorts of patients. Group 1 consisted of 11 patients admitted between 1975 and 1978 to our burn center. Group 2 consisted of 11 patients admitted to our burn center in 2000 who were matched for age, sex, and percent total body surface area burned. Group 1 received 3.6 ± 1.1 cm^3/kg/% TBSA of fluid in the first 24 h. Group 2 received 8.0 ± 2.5 cm^3/kg/% TBSA, which is 100% more than the Baxter formula. There was no difference in the median age, weight, or 24-h urine output between the two groups. Our data demonstrate that the "fluid creep" phenomenon is relatively new.

Keywords: Burn; Fluid; Resuscitation

1. Introduction

Since the late 1960s, when Charles Baxter [1–7] published objective criteria for resuscitation of the thermally injured patient, fluid replacement has become a prominent issue in the world of burn care. The "Baxter formula" itself has been dissected numerous times, and its application in everyday burn care has been repeatedly analyzed. Recent studies have examined burn resuscitation practices across the country. It has been found that fluid volumes much greater than Baxter's original resuscitation formula, which prescribed 4 cm^3 of crystalloid per kilogram of body weight per percent total body surface area burned (%TBSA), are being administered to injured patients [8]. Whereas, in subsequent writings after his original formula was published, Baxter concluded that only 12% of patients would require resuscitation amounts greater than 4.3 cm^3/kg/%TBSA, some recent reviews have shown that greater than 55% of patients receive fluid resuscitation in excess of 4.3 cm^3/kg/%TBSA [8]. The reasons for this phenomenon are unclear.

Intuition tells us that "more is better"—at first glance, large, aggressive fluid resuscitations do not appear to be more harmful, and the issue has not raised many concerns as yet. However, we are finding that resuscitation and over-resuscitation can pose formidable problems to the severely and multi-injured patient. Attendant problems include need for mechanical ventilation, prolongation of mechanical ventilation, anasarca, abdominal compartment syndrome, and potentially, prolongation of ICU, and hospital stay. Clearly, there is the possibility of significant morbidity associated with over-aggressive fluid resuscitation in the severely burned patient.

As a logical continuation of previous studies, which have shown larger resuscitation volumes administered than those prescribed by Baxter, we examined both the historical and current practices at our burn center to determine if this is a new phenomenon or have we always given more volume than prescribed by Baxter.

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2. Methods

The records of two cohorts of patients with majors burns admitted to the University of Washington Burn Center at Harborview Medical Center were retrospectively reviewed. Group 1 consisted of 11 patients admitted to the burn center between 1975 and 1978. Group 2 consisted of 11 age, sex, and %TBSA burned matched patients admitted to the burn center in 2000. This review was in accordance with and approved by the University of Washington Institutional Review Board. Demographic data and independent variables collected for each patient included dates of admission and discharge, age (years), gender, weight (kilograms), %TBSA, type of burn, total length of hospital stay in days (LOS), presence of inhalation injury, and need for intubation or escharotomy. Study data that were collected included total amount of fluid administered in the first 24-h period following injury, and urine output for the first 24 h after admission (five urine volumes were missing from the old records for Group 1). The resuscitation formula that has always been used at this center is 4 cm^3 of crystalloid per weight in kilograms per %TBSA burned (cm^3/kg/%TBSA).

The Mann–Whitney *U* test was used to test for potential differences between continuous variables, and the Pearson's chi-square or Fisher's (two-tailed) exact tests were used to analyze for potential differences in proportions between categorical variables of the two groups. Results are reported as mean ± standard deviation. A P-value < 0.05 was considered statistically significant. Statistical analyses were performed using Stata 6.0 software (StataCorp, College Station, TX) and SPSS 11.0.1 (SPSS Inc., Chicago, IL).

3. Results

Demographic data for Groups 1 and 2 were similar (Table 1).

Table 1
Demographics

	Group 1	Group 2
Age (year)	35 ± 15	33 ± 13
Range	16–66	13–56
Male sex, no. (%)	8 (72%)	8 (72%)
Weight (kg)	81 ± 21	74 ± 20
Range	54–117	44–103
%TBSA: second + third degree	58 ± 17	48 ± 15
Range	22–85	27–76
Type of burn		
Flame, no. (%)	9 (82%)	11 (100%)
Tar/grease, no. (%)	2 (18%)	0 (0%)
Smoke inhalation injury, no. (%)	3 (27%)	5 (45%)
Intubated, no. (%)	6 (55%)	9 (82%)
Escharotomy	4 (36%)	5 (45%)

Table 2
Fluid and urine volumes

	Group 1	Group 2	P
Total fluids, first 24 h (cm^3/kg/%TBSA)	3.6 ± 1.1	8.0 ± 2.5	<0.01
Total fluids, first 24 h (cm^3)	15600 ± 7433	27367 ± 10064	<0.05
Range	7000–32000	10647–46850	
Urine output, first 24 h (cm^3)	1857 ± 1475	1730 ± 841	
Range	427–4160	759–3258	
Urine output, first 24 h (cm^3/kg/h)	0.9 ± 0.6	1.1 ± 0.6	

The fluid input (including prehospital fluids) and urine output for the two groups are summarized in Table 2. The patients in Group 1 received 3.6 ± 1.1 cm^3/kg/%TBSA burned in the first 24 h following injury while the patients in Group 2 received 8.0 ± 2.5 cm^3/kg/%TBSA burned. The resuscitation in Group 2 is 100% greater than that prescribed by Baxter and the difference between the two groups was significant ($P < 0.001$). There was no statistical difference in urine output either with the incomplete pairs included or excluded.

4. Discussion

At our institution, supra-Baxter resuscitation is a new phenomenon. The field of burn care has made numerous significant advancements since Baxter first determined guidelines for fluid resuscitation of the thermally injured patient. There is no doubt that lives have been saved as a result of his work. However, in more recent years, some have described a sharp increase in the volume of total resuscitation and our data confirm this. In a recent editorial, Pruitt termed this phenomenon of increasing resuscitation volumes "fluid creep," and argues that burn care providers would be wise to find ways of "pushing the pendulum back" [9].

In looking at the data for fluid resuscitation of burned patients at our institution, we were amazed at the degree to which we exceeded the Baxter formula. Intuitively, we suspected that our patients were receiving more than the prescribed formula, but we were surprised to find that it was double what Baxter recommended and what we administered 25 years ago.

This study simply asked the question "Is this phenomenon new?" and found the answer to be "yes." We did not study whether present day patients suffer or benefit from these large fluid resuscitation volumes. Nor did we study the reason for the increased volumes. We can, however, speculate on both.

It is known that fluid volumes contribute to abdominal and extremity compartment syndromes and to pulmonary complications [10–15]. It is possible that the incidence of

these has increased and should be compared to the incidence of one or two decades ago.

As to why we are administering more fluids, we have previously asked [8], do we administer the Baxter formula poorly? We need to re-examine our implementation of the formula. It is possible that the nature of burns has changed. Methamphetamine burns are recent and require very large volumes [16]. These burns may require a new formula. The care of burns may have changed. Invasive monitoring is now common and may lead to increased fluids. Finally, perhaps the use of increased doses of opioids results in the need for fluids in excess of the Baxter formula. All of these possibilities warrant further investigation.

In conclusion, we have demonstrated that supra-Baxter resuscitation is a new phenomenon. It seems prudent for the burn community to determine why is this the case and what, if any, are the benefits and risks of this supra-Baxter resuscitation.

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