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Albumin resuscitation in burns: a hybrid regime to mitigate fluid creep

Judith E Hunter[1,2], Peter J Drew[1], Tom S Potokar[1], William Dickson[1] and Sarah J Hemington-Gorse[1]

Abstract

Introduction: Globally, many burns units moved away from colloid resuscitation in response to the Cochrane review (1998). Recent literature has introduced the concept of fluid creep: patients receiving volumes far in excess of the upper limit of the Parkland formula. The Cochrane review has been widely criticised, however, and we continued to use 4.5% human albumin solution after 8 h of crystalloid as a hybrid of Parkland and Muir & Barclay's regime.

Methods: Adult patients ⩾15% TBSA were identified from data prospectively entered into our database over a 5-year period (2003–2008). Medical notes and intensive care charts were reviewed comparing volumes of fluids received with requirement estimates. Adverse events were also documented.

Results: A total of 72 cases with 34 sets of intensive care charts were analysed. Mean TBSA was 35.2% (range, 15–95%). A total of 75% survived; 3% were haemofiltered. Forty-one percent of patients were resuscitated using the Parkland formula alone, while 59% switched at 8 h post burn to the Muir and Barclay formula (Hybrid group). There was a significantly greater TBSA in the Hybrid group, but they received significantly less fluid volumes than the Parkland group ($P = 0.0363$; the Hybrid group received 1.36 times calculated need vs. 1.62 in the Parkland group).

Conclusion: Our patients still demonstrate fluid creep, but to a lesser extent than previously reported. Fluid creep has been mitigated but not eliminated through this strategy.

Keywords

Fluid resuscitation, fluid creep, burn resuscitation, colloid, crystalloid, fluid overload, albumin

Lay Summary

Burns patients are at risk of shock, which means they cannot maintain their blood pressure or circulation to their organs which can significantly disturb physiology and recovery, and at worst be fatal. Resuscitation is the term that describes treatment or prevention of shock, one of the most important features of which is restoring the circulation using fluids. This article describes the experience from the Welsh Burn Centre of fluid resuscitation incorporating Human Albumin, a blood-derived product. They reflect on their many years of experience with this regime, and find that amongst other potential benefits, it appears to limit excessive fluid administration.

[1]Welsh Centre for Burns and Plastic Surgery, Swansea, UK
[2]Imperial College Healthcare NHS Trust, London, UK

Corresponding author:
Judith E Hunter, Imperial College Healthcare NHS Trust, Charing Cross Hospital, Fulham Palace Road, London, W6 8RF, UK.
Email: missjudehunter@doctors.org.uk

Introduction

The Cochrane Injuries Group Albumin Reviewers (1998)[1] suggested a possible increased mortality rate in patients resuscitated with albumin and concluded that the 'use of human albumin in critically ill patients should be urgently reviewed'. Although criticised as flawed (leading to a revision and republication of the authors' conclusions[2]), the review is likely to have influenced many burns units as well as national and international associations (such as the British Burns Association) to move away from resuscitation based on the Muir and Barclay formula[3] in favour of the crystalloid as per the Parkland regime.[4] It is a recently observed trend that trauma patients often receive volumes of crystalloid far above the upper limit of estimated requirements; in the case of the burned patient this would equate to more than 4 mL/kg/total body surface area (TBSA) in the first 24 h. Pruitt has termed this phenomenon 'fluid creep'.[5] Fluid overload and the associated negative outcomes, such as worsening of burn oedema, conversion of superficial into deep burns, pulmonary oedema, and abdominal and peripheral compartment syndromes, may therefore be more likely.

The flaws in the Cochrane review[1] were due in part to the heterogeneous nature of the studies included (only three relating specifically to burns) and the inclusion of some studies in which both arms received colloid. Its conclusions have since been revised to 'there is no evidence from RCTs that resuscitation with colloids reduces the risk of death'.[2]

In our centre, which covers a population of 2.3 million, we have continued to routinely apply the Muir and Barclay formula, using 4.5% human albumin solution, from 8 h post burn (starting with the final 4-h period, and continuing with two 6-h periods and a final 12-h period). Prior to this 8-h period (and often prior to arrival at our centre) the Parkland formula (using 3–4 mL/kg/TBSA) is used.

Methods

Data relating to all patients treated at the Welsh Centre for Burns are prospectively entered into a computerised database ('Phoenix database') by a research assistant. Adult patients (defined as aged over 16 years) with 15% or more TBSA burns admitted to our centre in the 5-year period from January 2003 to January 2005 were identified from this database.

Table 1. Patient demographics.

Patients ⩾15% TBSA (n)	72
Mean TBSA (range) (%)	35.2 (15–95)
Mean age (years)	46
Deceased (n)	18

In addition to information from the database, medical notes and intensive care charts were reviewed. Data were tabulated using Microsoft Excel (Table 1 in electronic supplement). Actual fluid received during each resuscitation time period was recorded and compared to estimated requirements derived from the formula used to resuscitate the patient. Urine output was additionally recorded for each time period. Five time periods were used, which corresponded to the Muir and Barclay formula (0–8 h, 9–12 h, 13–18 h, 19–24 h and 25–36 h). If, however, the Parkland formula had been used throughout the resuscitation phase, data recording ended at 24 h.

Data were analysed using Student's T test.

Results

Data retrieved

Between 2003 and 2008, 72 adults were admitted to the burns centre with 15% or more TBSA burns. Data were available on all 72 via the database; 61 sets of medical notes were available for review (85%). Of these, 34 intensive care charts were obtained for detailed calculation of fluids received (56%).

Patient demographics

Mean age, TBSA and number of deaths are shown in Table 1, derived from all 72 patients.

Distribution of burn size

TBSA was recorded for all 72 patients; 56% of patients had burns in the range of 15–30% TBSA; however, as can be seen from Figure 1, there was a range of burn size up to 95%.

Mode of burn

As shown in Figure 2, the majority of burns were either flame, flash or scalding injuries.

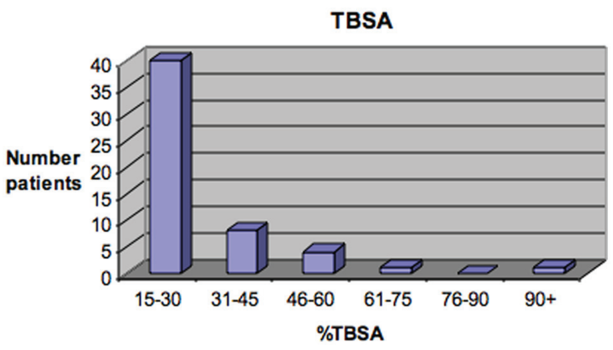

Figure 1. Distribution of burn size.

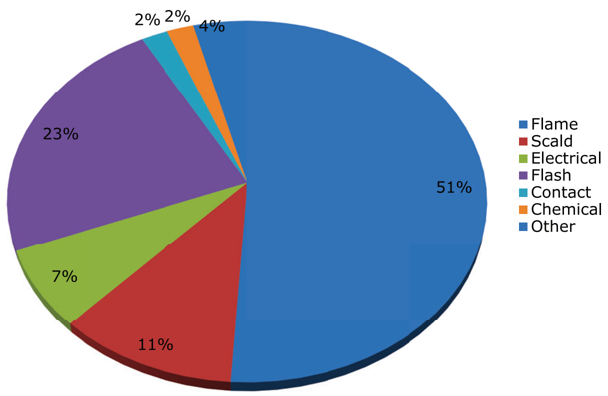

Figure 2. Mode of burn.

Type of fluid resuscitation formula used

Data were available for the 34 patients that had intensive care charts available; as shown in Figure 3, 41% were resuscitated following the Parkland formula only while 59% were switched after 8 h, as per protocol, to the Muir and Barclay formula. There were, however, significant differences between these groups in terms of age and TBSA, as shown in Table 2. The Parkland-only resuscitated patients were significantly younger and had significantly smaller burns compared to those that were switched to the Muir and Barclay formula.

Comparison of actual fluid received versus estimated need – Parkland only group

For those that were resuscitated using the Parkland formula only, in the 24-h resuscitation phase patients received overall a mean of 1.62 times more fluid than calculated by the formula. This equated to a mean of 6.5 mL/kg/TBSA, with a range of 3.3–8.8 mL/kg/TBSA. As can be seen in Figure 4, in the first 8 h, the amount of fluid received was about in line with the calculated need, but peaked to over 2.5 times that estimate in the 13–18-h period.

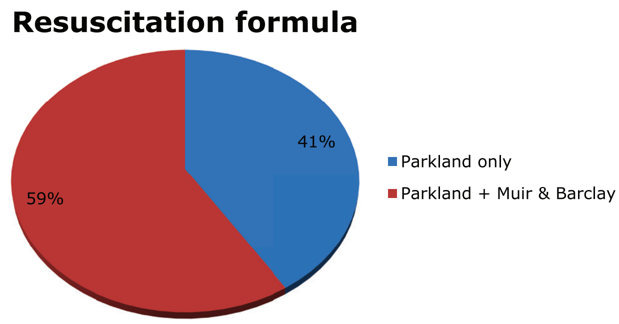

Figure 3. Resuscitation formula used.

Table 2. Differences in Parkland and Muir and Barclay resuscitated groups.

	Parkland only	Switched to Muir and Barclay	*P* value
Mean age (years)	39	53	0.0211
Mean TBSA (%)	20.4	32.8	0.0096

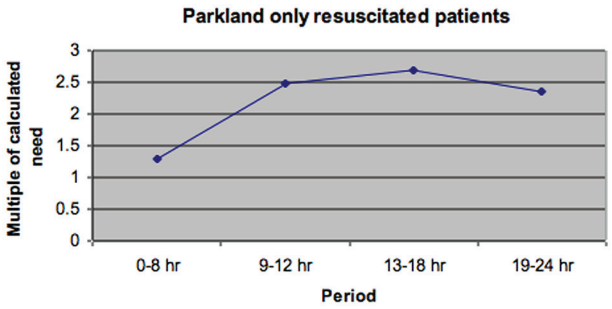

Figure 4. Volume of fluid received per time period expressed as a multiple of that estimated to be required by the Parkland formula.

Comparison of actual fluid received versus estimated need – Muir and Barclay group

For those that received Parkland formula fluids for the first eight hours and were then switched to the Muir & Barclay formula, in the 36 hour resuscitation phase patients received a mean of 1.36 times more fluid than their calculated estimate (range 1.01–2.27). Figure 5 shows volumes received per time period, demonstrating that again, in the first 8 hours, actual volume given was

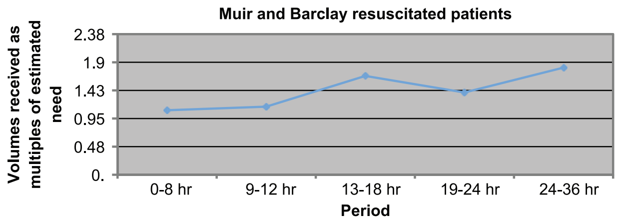

Figure 5. Volume of fluid received per time period expressed as a multiple of that estimated to be required by the Parkland followed by the Muir and Barclay formula.

very close to that estimated, but peaked in the 13-18 hour period to 1.6 times that calculated.

Comparison between Parkland only group and those switched to Muir & Barclay

As documented above, those in the Parkland group received a mean of 1.62 times more fluid than calculated requirement while those switched to Muir and Barclay received 1.36 times more fluid than their calculated requirement. This difference was statistically significant ($P = 0.0363$).

Comparison with urine output

The main parameter used to quantify adequacy of fluid resuscitation was hourly urine output, aiming at 0.5 mL/kg/h. The studied patients achieved supramaximal urine outputs during their resuscitation phase; Parkland only patients averaged 1.18 mL/kg/h and Muir and Barclay patients averaged 1.11 mL/kg/h. There was no statistically significant difference between these groups ($P = 0.7710$).

Discussion

Fluid creep

This study demonstrates that fluid creep does exist in our burns centre, with a peak incidence in the 13–18-h time period. The extent of fluid creep, however, is less than that published elsewhere, and is significantly less in our albumin resuscitated patients. In our study, Parkland resuscitated patients received on average 6.5 mL/kg/TBSA (1.62 times more than that estimated from formula) while those that were switched to the albumin Muir and Barclay regime received on average significantly less fluid (1.36 times estimate). This is despite the fact that these patients had significantly larger burns injuries. Friedrich et al.[6] found that a group of burns patients in the year 2000 received over double the fluid received by a matched group in the 1970s. Interestingly, quantities of fluid given in our Parkland resuscitated patients mirror quite closely those of a Canadian group who found that the 24-h resuscitation volume was on average 6.7 mL/kg/TBSA and was most pronounced after the first 8-h period.[7] Recent alternative approaches to prevent fluid creep include use of ‘colloid rescue’ during resuscitation with the Parkland formula, whereby those patients who are exceeding Parkland estimates to maintain their urine output are given combinations of albumin and lactated lactate until their fluid requirements are normalised.[8] This, in similarity to our study, has equated to decreased fluid requirements, ‘ameliorating’ fluid creep.

Strengths and limitations

Completeness of dataset. Although data were entered prospectively into the research database, retrieval of detailed fluid data was performed retrospectively, and this accounts for less than 50% of the patients identified on the database having intensive care charts available for analysis.

Deviation from protocol. Although our protocol stated that patients be switched from Parkland formula to Muir and Barclay after 8 h post burn it is interesting to note that in 41% of patients this did not occur and the crystalloid based regime was continued throughout the resuscitation phase. These patients, however, had significantly smaller burns and were younger patients. These decisions appear to have been made under the care of the non-specialist burns teams out of hours, according to *Emergency Management of Severe Burns* protocols.

Future directions. Our study suggests that albumin resuscitation of burns patients may reduce the incidence of fluid creep. Further prospective randomised controlled studies need to be performed to confirm these findings. Already, however, there is recognition in the burns community that overzealous fluid resuscitation has negative consequences for our patients, and that steps are taken to reduce this occurrence. Some units are adapting the Parkland formula to 2 mL/kg/TBSA, a strategy that has shown decreased volume requirements without increase in morbidity or mortality among military burns patients[9] while others are introducing tighter feedback loops of input to output, and there is a renewed interest in albumin use.[10,11]

Conclusion

Our study suggests that resuscitation with albumin may reduce the likelihood of fluid overload and its negative outcomes. We hope that further studies will be forthcoming to elucidate further the role of albumin and hybrid regimes in burn resuscitation.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Ethical approval

The authors confirm that the necessary written, informed consent was obtained from patients for this article.

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