THE BURNS FLUID GRID. A PRE-HOSPITAL GUIDE TO FLUID RESUSCITATION IN BURNS

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Introduction

The BATLS (2005) policy for burns fluid resuscitation is based on the Parkland Formula [1,2]. The calculations required can be performed manually or by using the "Burns Calculator" [3,4]. Experience from the BATLS course has shown that the Combat Medical Technicians (CMTs) struggle with these calculations. We wished to identify a simpler alternative.

Background

Burn injuries in the military are likely to increase in modern warfare [5]. Burns cause tissue oedema [1,6-8] which is maximal between 4 and 12 hours for superficial burns. However for deep burns the peak is at 18 hours because of the damaged dermal vasculature and lymphatic drainage [8,9]. In major burns, defined as >20% Total Body Surface Area (TBSA), the fluid loss will lead to shock requiring large volume fluid resuscitation to minimise morbidity and mortality [7,8]. All fluid resuscitation regimens in burns are estimates [9]. The response to fluid resuscitation is usually assessed by the hourly urine output [1-4,6,7,9] but other methods have been used [10]. The aim is to avoid shock due to under-resuscitation, or 'fluid creep' due to over-resuscitation. Excessive fluid resuscitation may result in peripheral or pulmonary oedema and/or abdominal compartment syndrome [11]. Delay in initial fluid resuscitation is known to increase overall fluid needs which may further aggravate fluid creep [7,9] and lead to increased mortality [5]. In designing a simplified fluid regime for the pre-hospital phase of burn wound management we made a series of reasonable assumptions regarding burn victims in the military context (Table 1).

Assumptions about the patient	**Assumptions about the burn**
• Aged 18-50 years • ASA 1 or 2 • Weighs 50 - 100kg • May have other injuries • Will have a variable degree of dehydration • The oral route may be available	• TBSA 20 - 80% (or less if involving face/head, hands, perineum) • TBSA will be overestimated [4] • Inhalational and co-existing injuries will increase fluid requirements [2,7,11]
Assumptions about the provider	**Assumptions about current practice**
• A CMT using BATLS dependent on the tactical situation • Urinary catheterisation not possible • Assessment of circulatory volume will be by the history, capillary refill time (CRT) and radial pulse • Will secure intravenous (i.v.) or intraosseous (i.o.) access • Resuscitation with warmed Hartmann's solution. • Will be seen by a Medical Officer (MO) within 4 hours of burn	• 1000ml of IV crystalloid for adults if transfer to hospital >1 hr [12,13] • 500ml/hr pre-hospital (American Burns Association Regimen) [14] & US Special Forces (personal communication, 2007)

Table 1. Assumptions made when designing the burns fluid grid

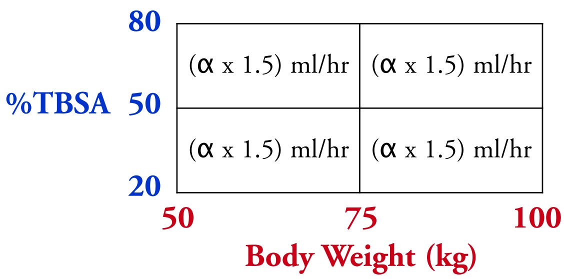

Figure 1. Prototype Burns Fluid Grid

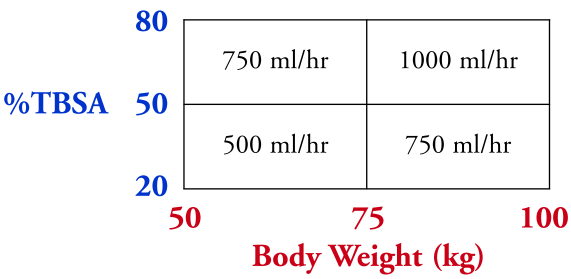

Figure 2. Burns Fluid Grid

The concept of "Burns Fluid Grid"

Using these factors we wished to develop a simple fluid regime to be used in the pre-hospital phase for major burns. Given the availability of 500ml and 1000ml bags of Hartmann's intravenous fluid we wanted to use multiples of these volumes as the hourly rate. Taking into account body weight and TBSA we came up with a prototype "Burns Fluid Grid" (Figure 1). This requires an estimate of the patient's body weight (kg) and %TBSA which will place the patient in one of the four boxes of the grid and offer the CMT a fluid regimen for the first four hours after burn.

Comparison against the Parkland Formula

We investigated three different values for the infusion rate "α" (250ml, 500ml and 1000ml) in the bottom left square of the grid and compared the total volumes infused after 4 hours with those derived from the Parkland Formula for a range of infusion rates (2

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	Parkland Formula 2ml/kg/TBSA	Parkland Formula 4ml/kg/TBSA	Burns Fluid Grid a=250	Burns Fluid Grid a=500	Burns Fluid Grid a=1000
50kg man 20% burn	500	1000	1000	2000	4000
75kg man 50% burn	1875	3750	1500	3000	6000
100kg man 80% burn	4000	8000	2000	4000	8000

Table 2. Volumes of fluid infused after 4 hours comparing Parkland Formula versus prototype Burns Fluid Grids

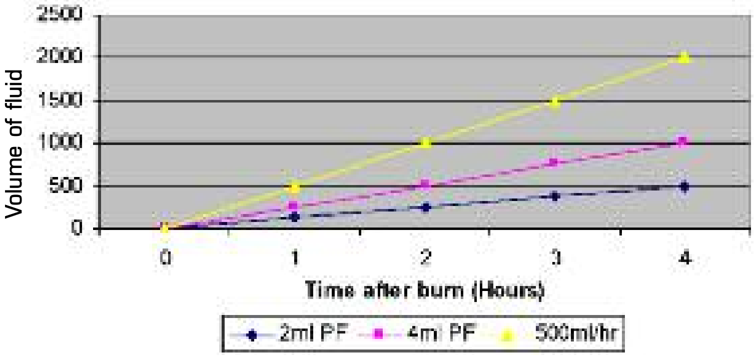

Figure 3. Comparison of Burns Fluid Grid vs Parkland Formula for 50kg man with 20% TBSA burn.

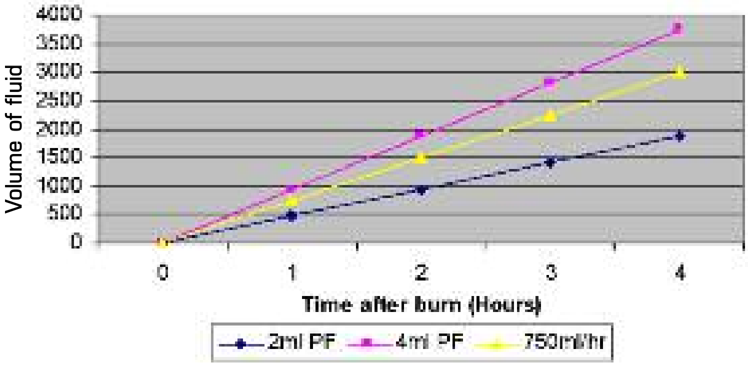

Figure 4. Comparison of Burns Fluid Grid vs Parkland Formula for 75kg man with 50% TBSA burn.

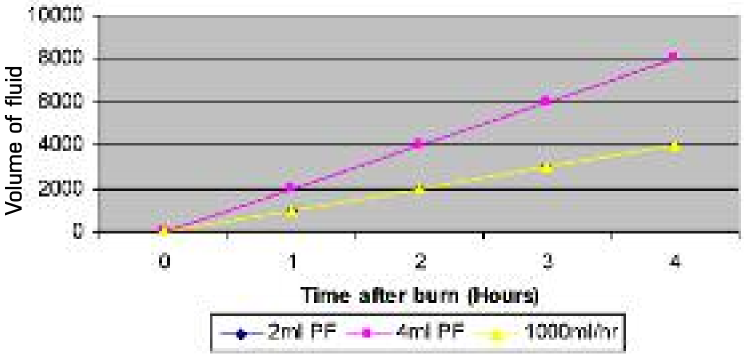

Figure 5. Comparison of Burns Fluid Grid vs Parkland Formula for 100kg man with 80% TBSA burn.

or 4 ml/kg/%TBSA), patient weights (50, 75 and 100kg) and TBSA (20, 50 and 80%) (Table 2). A value of α=500ml gave the best fit in terms of approximating to the volumes predicted by the Parkland Formula (Figure 2). For a lighter patient it overestimates the fluid volume needed but underestimates it for the heavier patient (Figures 3-5). Using 500ml as the basic unit has the advantage that a lighter patient with a smaller burn will require 500ml/hr whereas a heavier patient with a larger burn will require 1000ml/hr giving rise to a simple aphorism:

"small man, small burn, small bag; big man, big burn, big bag"

The Burns Fluid Grid is for burn fluid resuscitation and does not take into account the extra fluid requirements for inhalational burns, other injuries and maintenance. Therefore if the patient is thirsty and is able to drink then they should be allowed a free oral fluid intake. If their CRT or radial pulse suggests an ongoing hypovolaemia they should receive 250ml intravenous boluses of Hartmann's solution to correct the deficit. When the patient reaches the care of a medical officer the Parkland Formula should be applied (Figure 6).

<C>

A

B

C → **Patient thirsty and able to drink?**
Rx: Allow free oral fluid intake

↓

Intravenous or intraosseous access?
Rx: Apply Burn Fluid Grid

↓

Palpable radial pulse?
Rx: If not give 250 ml boluses & assess response

↓

Reassess using Parkland Formula when possible

Figure 6. Pre-hospital burn fluid resuscitation regime.

Discussion

The need for a simple fluid resuscitation protocol was identified during the BATLS (2005) courses. CMTs struggled with the Parkland Formula calculated manually or with the Burns Calculator; the Burns Fluid Grid offers a potential solution. How does this compare to the civilian experience? In a retrospective analysis of six patients admitted with severe burns to the ICU at Wythenshawe hospital during a six-month period in 2007 no patients received intravenous fluids pre-hospital. The average time from burn to applying the Parkland Formula was 1.5 hours. Although the volume of fluid using the Burns Fluid Grid does not equate to the Parkland formula; its simplicity should allow easier fluid resuscitation in the pre-hospital phase. It should be remembered that both the Parkland Formula and the Burn Fluid Grid are merely estimates and the care provider should frequently reassess the patient's vital signs (CRT and radial pulse) and response to interventions. The proposed use of the Burns Fluid Grid in the military pre-hospital setting is a simple alternative to the use of the Parkland formula. The only practical assessment of the efficacy of the Burns Fluid Grid regime will be a prospective audit of its use.

We have primarily considered the intravenous or intraosseous routes but in mass casualty situations the oral route may be the only feasible logistical possibility [15,16] and the concept of liberal oral fluids for all burns should be considered.

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