Resuscitation tables: a useful tool in calculating pre-burns unit fluid requirements

A J Lindford, P Lim, B Klass, S Mackey, B S Dheansa, P M Gilbert

Abstract

Background: There is considerable variation in the standard of initial burn management, particularly by burn surface area assessment and application of resuscitation formulae. Early aggressive management of major burns improves survival. Internationally, the Parkland formula employing lactated Ringer’s solution is used for fluid resuscitation. This study aimed to assess whether Parkland fluid resuscitation tables could improve the accuracy of initial fluid requirement calculations.

Methods: The burn size had first to be determined for an adult and a child using a preshaded Lund and Browder chart. Fluid requirements then had to be calculated using the conventional Parkland formula. The burn size had to be similarly calculated for two further cases and fluid requirements calculated using resuscitation tables. The study had a sample size of 50, consisting of plastic surgery trainees, anaesthetists and burn nurse specialists.

Results: All the participants found the resuscitation tables to be quicker and easier to use. The burn size was correctly calculated in 72% of cases. Fluid resuscitation requirements were correct in only 55% when using the Parkland formula. The use of resuscitation tables improved the accuracy in calculating fluid requirements to 75%.

Conclusions: The use of Parkland fluid resuscitation tables can improve accuracy and ease of calculation of fluid resuscitation requirements.

There is considerable variation in the standard of initial burn management, particularly assessment of burn surface area and application of resuscitation formulae. It is well known that the early aggressive management of major burns improves survival. Internationally, the standard for fluid resuscitation in major burns is now accepted to be the use of the Parkland formula using lactated Ringer’s solution (Hartman’s solution). This has been our standard practice since 1997. Although our Burns Centre treats an average of 30 resuscitation burns per annum, most emergency departments may only see an average of 1.5 resuscitation-sized burns per year. Consequently, emergency department junior medical staff and nurses are unlikely to be experienced in the assessment and initial management of a major burn. They are expected to estimate the patient’s weight (accurate weight determination is often difficult in emergency departments), assess the burn surface area (using a Lund and Browder chart) and then, using the Parkland formula, calculate the amount of fluid required to resuscitate the patient. This study aimed to assess whether Parkland fluid resuscitation tables with pre-calculated values could improve the accuracy and ease of calculation of the initial fluid requirements.

Methods

In our Burns Centre we use the Parkland formula to calculate the total fluid requirement in the first 24 h. For adults this is equal to:

\[4 \text{ ml} \times \left[\text{total burn surface area (\%) \times \text{body weight (kg)}}\right]\]

Half of the calculated amount is given in the first 8 h and the rest is given over the next 16 h.

For children, a modified Parkland formula is used in which the total fluid requirement in 24 h is equal to:

\[3 \text{ ml} \times \left[\text{total burn surface area (\%)} \times \text{body weight (kg)}}\right]\]

Half of this is given in the first 8 h and the rest over the next 16 h.

Children also receive maintenance fluid (dextrose saline) at an hourly rate of 4 ml/kg for the first 10 kg body weight plus 2 ml/kg for the second 10 kg body weight plus 1 ml/kg for >20 kg of body weight. We designed a resuscitation table based on the Parkland formula, with body weight in kilograms along one axis and percentage burn surface area along the other axis (fig 1). By simply checking these two variables on the table, two pre-calculated values are supplied: a flow rate (ml/h) for the first 8 h and a flow rate for the following 16 h. Insensible losses in adults were not taken into account as this can vary according to the circumstances. A modified table for children weighing <36 kg was also devised (fig 2). This table included normal paediatric maintenance fluid requirements in the pre-calculated flow rate values.

In order to compare the use of the conventional Parkland formula with the use of the resuscitation tables in calculating fluid requirements, we designed a calculation test (fig 3). First, questions were asked about burn sizes in adults and children requiring fluid resuscitation, choice of fluid and correct formula. Then followed four cases in which the burn size had to be determined for an adult and a child using a preshaded Lund and Browder chart. Fluid requirements then had to be calculated using the Parkland formula. The burn size had to be similarly calculated for two further cases, but this time the fluid requirements had to be calculated with the aid of resuscitation tables.

Plastic surgery trainees, anaesthetists and burns specialist nursing staff were selected to complete the test. They were asked to take the test under examination conditions with a maximum time of 20 min allowed for completion. They had access only to a calculator and also had no prior knowledge of the test.
The study had a sample size of 50, consisting of 25 plastic surgery trainees, 15 anaesthetists and 10 burns nurses. Sixteen (32%) did not know the correct burn size percentages for adults and children that require fluid resuscitation and 11 (22%) did not know that Hartman’s solution is the preferred crystalloid for resuscitation. Only three (6%) did not know that the Parkland formula was the correct formula for calculating fluid requirements.

All 50 participants found the tables quicker and easier to use than the conventional use of the Parkland formula. The burn size was correctly calculated in 144 of the 200 cases (72%) in both groups. When assessing the accuracy of the calculations, any initially incorrectly assessed burn size was ignored to enable comparison of the two calculation methods. A correct answer was awarded if the calculated value fell within 10 ml/h (arbitrary) of the correct value.

### RESULTS

The study had a sample size of 50, consisting of 25 plastic surgery trainees, 15 anaesthetists and 10 burns nurses. Sixteen (32%) did not know the correct burn size percentages for adults and children that require fluid resuscitation and 11 (22%) did not know that Hartman’s solution is the preferred crystalloid for resuscitation. Only three (6%) did not know that the Parkland formula was the correct formula for calculating fluid requirements.

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### Adults

#### Case 1

Burn as percentage of total body surface area = 25%.

Using the Parkland formula:

First 8 h: correct rate = 500 ml/h

There were 31 correct and 19 wrong answers; the lowest calculated rate was 300 ml/h and the highest was 700 ml/h; 10 cases were over the correct rate, 5 cases were under and in 4 cases no answer was given.
Parkland resuscitation formula for children (<36 kg)

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Figure 2  Parkland resuscitation table for children (<36 kg).

NB: The above fluid volumes include maintenance volumes per hour.
Case 3
Burn as percentage of total body surface area = 20%.
Using resuscitation table:
First 8 h: correct rate = 350 ml/h
There were 41 correct and 9 wrong answers; the lowest calculated rate was 175 ml/h and the highest was 788 ml/h; 6 cases over, 2 cases under and in one case no answer was given.

Children
Case 2
Burn as percentage total body surface area = 16%.
Using Parkland formula:
First 8 h: correct rate = 120 ml/h
There were 19 correct and 31 wrong answers; the lowest calculated rate was 40 ml/h and the highest was 240 ml/h; 17 cases over, 12 cases under and in 2 cases no answer was given.

Case 4
Burn as percentage total body surface area = 23%.
Using resuscitation table:
First 8 h: correct rate = 135 ml/h
There were 35 correct and 15 wrong answers; the lowest calculated rate was 48 ml/h and the highest was 166 ml/h; 5 cases over and 10 under.

Calculation of fluid resuscitation requirements when using the Parkland formula was correct in only 50 of the 100 (50%) adult and child cases. This total included only 19 (38%) correct answers for the 50 child cases and 31 (62%) correct answers for the 50 adult cases. The use of resuscitation tables, however, improved the accuracy in calculating fluid requirements in 76 of the 100 adult and child cases (76%). This included 35 (70%) correct answers for the 50 child cases and 41 (82%) correct answers for the 50 adult cases.

We compared these two calculation methods using the \( \chi^2 \) test. This revealed that the results for both adults and children were significantly (p<0.05) better when using the resuscitation tables.

When using the Parkland formula to determine fluid requirements in children, difficulty arose when calculating the maintenance fluid requirements.

Many participants noted that a common problem encountered when using the resuscitation tables was if a burn size or weight value fell between two adjacent values on an axis. A way of avoiding this problem would be to have ranges of values along both axes.

**DISCUSSION**
The study has shown that the use of our resuscitation tables appears to make calculating fluid requirements quicker and easier resulting in improved accuracy, particularly in children.

Our study has also revealed that, rather surprisingly, even among more specialist personnel, certain fundamental facts...
about fluid resuscitation do not seem to be clear. One-third of participants did not know what burn sizes warrant formal fluid resuscitation and one-fifth did not know which fluid is most appropriate for resuscitation.

Immediate burn care involves airway management and fluid resuscitation, the most important period being the first few hours after the burn injury. On admission to the emergency department the total body surface area percentage burn should be assessed and the time of injury must be obtained. If the burn is assessed as <15% (10% in children), oral fluids alone will suffice, presuming no other concomitant injury requiring fluid resuscitation has been sustained. With burns greater than these values, intravenous replacement is needed. All these patients should have a urinary catheter for monitoring of adequate replacement. The aim of resuscitation is to maintain a urine output of 0.5–1.0 ml/kg/h in adults and 1.0–1.5 ml/kg/h in children.

The starting point for resuscitation is the time of injury, not the time of admission. There is no ideal fluid resuscitation regimen and all formulae are only guidelines. Their success relies on adjusting the amount of fluid administered against monitored physiological (urine output, pulse, blood pressure and respiratory rate) and non-physiological (humidity and environmental temperature) parameters.

The main aim of resuscitation is to maintain tissue perfusion to the zone of stasis and so prevent the burn deepening. Too little fluid will cause hypoperfusion, whereas too much will lead to oedema resulting in tissue hypoxia. In children, in particular, there is a non-linear relation between body surface area and weight. This has led to the under resuscitation of small burns and the overhydration of those with larger burns.

Major burns are uncommon in the UK and, as most patients with burns will initially be managed in an emergency department, staff may lack experience in their management.

Other methods have previously been designed to help in calculating fluid requirements such as the Burns calculator and the Burn wheel. We would like to propose the use of our even simpler Parkland fluid resuscitation tables to improve accuracy and ease of calculation of fluid resuscitation requirements. Medical and nursing staff without burns experience should find these tables very helpful in determining quickly and easily the correct amount of fluid needed to resuscitate a patient with burns.

We acknowledge that there are limitations to the use of these tables in a patient with burns requiring fluid resuscitation who presents late. In this case the burns resuscitation tables will not be appropriate for the calculation of the fluid resuscitation regimen.

We would also like to encourage attendance by specialists and non-specialists at courses such as the Emergency Management of Severe Burns Course to improve their general understanding of the acute management of burn injuries.

All major burns need to be discussed at the earliest possible stage with the regional burns centre to facilitate further management of the patient. The burns resuscitation tables, however, will allow more accurate and appropriate fluid resuscitation in the emergency department before referral and transfer of the patient.

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**Competing interests:** None.

**REFERENCES**

Resuscitation tables: a useful tool in calculating pre-burns unit fluid requirements
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