Burn resuscitation on the African continent

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A R T I C L E  I N F O
Article history:
Accepted 8 January 2014

Keywords:
Resuscitation in burns
Africa
Developing countries
Fluid resuscitation
Parkland formula
Enteral resuscitation

A B S T R A C T
A survey of members of the International Society of Burn Injuries (ISBI) and the American Burn Association (ABA) indicated that although there was difference in burn resuscitation protocols, they all fulfilled their functions. This study presents the findings of the same survey replicated in Africa, the only continent not included in the original survey.

One hundred and eight responses were received. The mean annual number of admissions per unit was ninety-eight. Fluid resuscitation was usually initiated with total body surface area burns of either more than ten or more than fifteen percent. Twenty-six respondents made use of enteral resuscitation.

The preferred resuscitation formula was the Parkland formula, and Ringer’s Lactate was the favoured intravenous fluid. Despite satisfaction with the formula, many respondents believed that patients received volumes that differed from that predicted. Urine output was the principle guide to adequate resuscitation, with only twenty-one using the evolving clinical picture and thirty using invasive monitoring methods. Only fifty-one respondents replied to the question relating to the method of adjusting resuscitation. While colloids are not available in many parts of the African continent on account of cost, one might infer that African burn surgeons make better use of enteral resuscitation.

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1. Background

Adequate fluid resuscitation is a critical initial component in the management of burns. At least eleven formulae are currently in use and there is general consensus that they are effective [1–5]. Several reports, however, have indicated a tendency towards either under- or over resuscitation, with significant complications [6,7]. Common errors include inaccuracies in burn size estimation, fluid volume calculation, the

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http://dx.doi.org/10.1016/j.burns.2014.01.004
choice of resuscitation formula, and delay in initiating resuscitation. Most units in the United Kingdom make use of either the Parkland or the Muir and Barclay formula, while most in North America and Europe, as well as the advanced trauma life support course (ATLS), now advocate the use of the Parkland formula. Either Ringer’s lactate or Hartman’s solution are the preferred fluids [1,3–5].

The American Burn Association (ABA) has developed practice guidelines for burn fluid resuscitation [8]. These guidelines include: formal fluid resuscitation for burns both in adults and children exceeding 20% total body surface area (TBSA); a crystalloid solution at a volume of 2–4 ml of fluid per kg body mass per percentage TBSA during the first 24 h; fluid resuscitation should be titrated to maintain a urine output of approximately 0.5–1 ml/kg in adults and 1 to 1.5 ml/kg per hour in children; maintenance fluid containing glucose should be administered to children in addition to the volume of resuscitation fluid; increased volume requirements may be required for patients with full thickness burns, inhalational injury, delay in resuscitation, and concomitant trauma; fluid resuscitation should begin promptly, preferably from the time of burn injury [8].

A survey conducted in 2007 amongst members of the ISBI and the ABA at the 39th meeting of the ISBI indicated that although several different resuscitation protocols are in use, most participants felt that their individual protocols had satisfactory results. Africa, despite its tremendous burden of severe burn injury, was not represented in this survey [9].

At the conclusion of the South African Burn Society’s biennial congress in 2011, concern was expressed regarding the practice of resuscitation of burnt patients on the African continent. Informal discussions have indicated that there were significant discrepancies regarding the fluid used, the volumes administered, and means of monitoring the efficacy of the resuscitation process. To investigate some of these questions, permission was obtained to make use of the International Society for Burn Injury (ISBI) questionnaire in a survey to establish resuscitation practices in Africa [9].

2. Method

The ISBI survey (Appendix 1) was distributed at the 13th Biennial South African Burn Society Congress and at the Pan-African Burn Society Congress of 2012, both in Cape Town. The survey was also sent to burns units across the African continent, distributed by those attending the above congresses, and also by the secretaries of a number of paediatric and general surgical associations across the continent.

Questions related to the basic resuscitation formula used, the minimum total body surface area (TBSA) to initiate burn resuscitation, the type and volume of fluid used, methods to adjust resuscitation fluid volumes and the end-points to evaluate the efficacy of resuscitation. The position held by the respondents, the number of annual admissions, and whether the patients were managed in a formal burns unit, was also recorded. Data were collected and collated and the results were reported as values and percentages and compared to the international survey, which had included responses from the five other continents [9].

3. Results

One hundred and eight responses to the questionnaire were received. The respondents were not asked to identify their country of origin, but it was estimated that at least twenty-five were from outside South Africa, including Namibia, Egypt, Nigeria, Cameroon, Kenya, Tanzania, Malawi, Zimbabwe, Ethiopia and Ghana (Fig. 1). Thirty-three of the doctors were directors of burns units, sixty-nine were staff doctors, either general surgeons, plastic surgeons, emergency medicine staff or medical officers, and six were nurses. The mean annual number of admissions per unit was ninety-eight with a range of four to one thousand. Eighty-three facilities (76.8%) managed patients of all ages, while sixteen managed only children and nine only adults.

The minimum total body surface area (TBSA) burn to initiate fluid resuscitation was greater than 5% TBSA in six, 10% in fifty-eight, more than 15% in twenty-nine and more than 20% in ten units. Five respondents did not complete the question. Twenty-nine respondents were more specific, initiating resuscitation for 10% TBSA burns in children and 15% burns in adults. Oral resuscitation was a component of the resuscitation programme in twenty-six (24%). No specific enteral resuscitation protocols were detailed. Intravenous access was established through peripheral lines in seventy-five and thirteen via central means and a combination of peripheral and central access was used by the remainder. The preferred resuscitation formula was the Parkland in ninety-four, while fourteen respondents made use of other formulae (Table 1). Although Ringer’s lactate was the fluid selected in ninety-six (89%), a variety of other solutions were also used, either alone, or in combination (Table 2). Only seventeen respondents (17%) made use of colloid solutions during the resuscitation phase.

The vast majority (102 of 108, 94%) made use of urine output as the principle guide to adequate resuscitation; surprisingly only twenty-one respondents (21%) admitted to using the evolving clinical picture as a reference point to resuscitation. Invasive monitoring methods (e.g. central lines) were used by thirty respondents (28%), especially for the major burns. Methods used to adjust the fluid regimen during the first 24 h are tabulated in Table 3.

In response to questions addressing the adequacy of resuscitation formulae, one hundred and one (94%) felt that the formula worked well, although only seventy-two (67%) believed the volume to be accurate. Four respondents (4%) indicated that too little fluid was administered, while thirty-two (30%) felt that patients were often over-hydrated (Table 4). Only forty-nine (45%) of the respondents provided fluid volumes equal to the formula, with twenty-six (24%) regularly exceeding the formula prescribed at the beginning of resuscitation.

Oral resuscitation or early enteral feeding as part of the resuscitation programme was commented on favourably by twenty-six respondents (24%) making use of such a protocol. Thirty-eight (35%) did not utilise an enteral resuscitation protocol, but believed that it should be successful for all ages. The size of burn considered for enteral resuscitation ranged
from less than 10–30% TBSA burn, with equal numbers making use of oro- and naso-gastric tube administration. A variety of solutions were used, including milk, oral rehydration solution (ORS), 0.9% normal saline, as well as semi-elemental and polymeric feeds.

Only fifty-one (47%) of those questioned replied to question 13 (‘Describe how you adjust your intravenous solution during resuscitation’). Twenty respondents (18.5%) used clinical response and eleven urine output as guiding parameters, while fourteen (13%) routinely change the fluid from Ringers lactate to maintenance on day two. A colloid was added after twenty-four hours by six respondents (6%).

### 4. Discussion

Burn injuries are a prominent traumatic cause of mortality and morbidity in developing countries, and require significant infrastructural and multidisciplinary resources to improve outcomes. A myriad of factors negatively impacts on the provision of quality burn care on the African continent. No other continent can claim to have such variations in terms of organization, clinical management, facilities, staffing, patient-to-doctor ratio’s and outcomes [10].

A number of considerations make evaluating epidemiology and outcomes on the African continent challenging. These include disparity in terms of patient profiles, high proportions of burnt women and children, domestic violence as a cause, self immolation, electrical burns in copper thieves, debilitating co-morbidities (most notably malnutrition and infectious diseases, e.g. HIV/AIDS, tuberculosis, malaria, gastroenteritis), time delays from sustaining the injury to first aid, logistical and transport problems, and indigent domestic circumstances leading to a high demand for admission. By necessity, emergency care has therefore been prioritised, often at the expense of comprehensive service delivery.

#### Table 1 – Preferred resuscitation formulae.

<table>
<thead>
<tr>
<th>Formula</th>
<th>African survey 2013 (108)</th>
<th>ISBI/ABA survey 2010 (101)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parkland</td>
<td>94 (87%)</td>
<td>70 (69%)</td>
</tr>
<tr>
<td>Modified Parkland</td>
<td>7 (6.5%)</td>
<td>7 (6.9%)</td>
</tr>
<tr>
<td>Brooke</td>
<td>5 (4.6%)</td>
<td>7 (6.9%)</td>
</tr>
<tr>
<td>Galveston</td>
<td>2 (1.8%)</td>
<td>9 (8.9%)</td>
</tr>
<tr>
<td>Warden</td>
<td>–</td>
<td>6 (5.9%)</td>
</tr>
<tr>
<td>Slater</td>
<td>–</td>
<td>2 (2%)</td>
</tr>
<tr>
<td>Hypertonic</td>
<td>–</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Colloid</td>
<td>–</td>
<td>12 (11.9%)</td>
</tr>
<tr>
<td>Consensus</td>
<td>–</td>
<td>5 (5%)</td>
</tr>
<tr>
<td>Oral resuscitation as a component</td>
<td>26 (24%)</td>
<td>14 (14%)</td>
</tr>
</tbody>
</table>

Fig. 1 – Map of the African continent showing the countries represented in the survey.
Access to quality health care is grossly limited, and those systems that do exist, struggle constantly with crippling fiscal constraints. Although scanty, published data on burns in Africa paint a sombre picture in terms of incidence, morbidity and mortality rates [10–14]. It is estimated that up to two-thirds of burnt patients present to health facilities for delayed treatment of large, deep and infected burns, while smaller burns are often managed using ‘traditional’ methods, often unique to the cultural setting [10,12]. Fortunately, many of these burns are small and superficial, with a minority requiring resuscitation with more than additional oral fluid intake [14,15]. Late presentations, often without fluid resuscitation in major burns, invariably impacts on outcomes [16]. It is therefore of critical importance to strive towards a more uniform, acceptable standard of care using international guidelines. Many of these are founded on inexpensive and easily applicable principles.

Resuscitation of the thermally injured remains controversial, however, and there is considerable variability in the practical application of burn resuscitation formulae. [1-4,17-19]. Uncertainty relates to issues regarding, for instance, the percentage TBSA requiring intravenous resuscitation in children and adults, the formula to use to estimate resuscitation volume, and the type and route (intravenous, enteral, or both) of fluid to use. In addition, many have debated the role for colloids, particularly albumin, and when or if compositions of fluid should be altered during the resuscitation process. Furthermore, questions remain regarding the efficacy of clinical means and conventional monitoring techniques to ensure adequate tissue oxygenation and hemodynamic stability. This pan-African survey, the first of its kind, was undertaken to reflect current attitudes towards burn resuscitation. One hundred and eight respondents from across the continent of Africa participated. Despite varied practical challenges in difficult conditions, the survey illustrates that the resuscitation practises on the continent compare favourably with published international surveys.

Most units resuscitate burns greater than 10% TBSA in children and 15% in adults. Five percent started resuscitation at 5% TBSA, and two indicated that all patients are routinely resuscitated, as a result of the late presentation of so many patients, especially children. There was reasonable consensus

<p>| Table 2 – Fluids used for burn resuscitation. Some burns units use more than one fluid. |
|------------------------------------------|----------------|----------------|</p>
<table>
<thead>
<tr>
<th>Resuscitation Fluid</th>
<th>African survey 2013 (108)</th>
<th>ISBI/ABA survey 2010 (101)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactated ringers</td>
<td>96 (88.9%)</td>
<td>92 (91.1%)</td>
</tr>
<tr>
<td>Normal Saline</td>
<td>10 (9.2%)</td>
<td>5 (5%)</td>
</tr>
<tr>
<td>HES</td>
<td>1 (0.9%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Hypertonic saline</td>
<td>2 (1.9%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>FFP</td>
<td>5 (4.6%)</td>
<td>3 (3%)</td>
</tr>
<tr>
<td>Albumin solution</td>
<td>12 (11%)</td>
<td>21 (20.8%)</td>
</tr>
<tr>
<td>Hartman’s solution</td>
<td>2 (1.9%)</td>
<td>5 (5%)</td>
</tr>
<tr>
<td>LR/NaHCO3</td>
<td>1 (1%)</td>
<td>13 (12.9%)</td>
</tr>
<tr>
<td>Hespan</td>
<td>1 (1%)</td>
<td>4 (4%)</td>
</tr>
</tbody>
</table>

<p>| Table 3 – Indicators used to adjust fluid administration during burn resuscitation. |
|------------------------------------------|----------------|----------------|</p>
<table>
<thead>
<tr>
<th>Indicator</th>
<th>African survey 2013 (108)</th>
<th>ISBI/ABA survey 2010 (101)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine output</td>
<td>102 (94.5%)</td>
<td>94 (94.9%)</td>
</tr>
<tr>
<td>Invasive Monitoring</td>
<td>27 (25%)</td>
<td>17 (16.8%)</td>
</tr>
<tr>
<td>Clinical picture</td>
<td>21 (19.4%)</td>
<td>3 (3%)</td>
</tr>
<tr>
<td>Formula based</td>
<td>20 (18.5%)</td>
<td>1 (1%)</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>14 (13%)</td>
<td>21 (20.8%)</td>
</tr>
</tbody>
</table>

| Table 4 – Responses to questions addressing the adequacy of resuscitation formulae. |
|------------------------------------------|----------------|----------------|
| Question                                | African survey (108) | ISBI/ABA survey (101) |
| Feels formula works well                | 101 (93.5%)    | 87 (87%)       |
| Amount of fluid provided during resuscitation |           |                |
| Just right                             | 72 (66.7%)    | 70 (70%)       |
| Too much fluid                         | 32 (29.6%)    | 24 (24%)       |
| Too little fluid                       | 4 (3.7%)      | 7 (7%)         |
| Fluid provided compared to formula     |                |                |
| Above formula                          | 26 (24%)      | 55 (55%)       |
| Below formula                          | 33 (30.5%)    | 12 (12%)       |
| At formula                             | 49 (45.4%)    | 33 (33%)       |
as to the formula used. The Parkland formula was favoured, probably because it is easy to calculate, logical and uses fluid that is inexpensive and almost universally available. It is also in line with more recent international interventions, and the implementation of national burns and ATLS guidelines. This should be considered in comparison to the ISBI survey, which found that 30% use other formulae [9].

Fluid choice is often determined by availability, and most respondents favoured Ringer’s lactate, which correlates with the ISBI results. The addition of a colloid preparation remains controversial; many units in the ISBI survey (35%) make use of a colloid solution during the first 24 h resuscitation period [2,17,20]. In this survey only seventeen percent included colloids in their regime, probably on account of expense and lack of availability.

In response to the question of ‘the adequacy of resuscitation formula’, 94% felt that the formula was effective, which was very similar to the ISBI review [9]. However, only 67% felt that the correct volume of fluid was provided during the process, with 30% stating that too much fluid was administered. This may reflect increasing recent awareness of ‘fluid creep’ as a significant cause of morbidity in major burns requiring resuscitation [6]. In addition, 46% stated that the amount of fluid provided was accurate according to the formula, while 31% said it was below that predicted. This is in keeping with international literature, and in fact also with Baxter and Shires’ review of their own formula, which stated that it was accurate for only two-thirds of patients [6,7]. Resuscitation should be adjusted according to the patient’s physiological response and urine output, as well as additional endpoints where available, rather than blind adherence to a formula.

Monitoring in infants is particularly difficult and most physicians have adopted the Sheridan endpoint criteria: sensorium (child lightly asleep yet arouses to tactile stimuli), physical examination (clear breath sounds and warm distal extremities), pulse rate (120–180 beats per minute depending on the age), systolic blood pressure (60–80 mm Hg), and urine output (0.5–1 ml kg⁻¹ h⁻¹) [21].

In Africa, the vast majority of burn injuries are seen first in rural areas at under-resourced primary health care clinics, without the means to apply modern burn care principles. A method pioneered by paediatricians for children with diarrhoea has become a widely accepted and effective method of fluid resuscitation [22–24]. This method can be used if standard intravenous resuscitation fluid is not available or may be delayed, making use of more readily available, inexpensive fluids [22–24]. Enteral resuscitation can be combined with intravenous resuscitation for minor to moderate burns (10–40% TBSA) [24]. There are many benefits and only a few contraindications to such an approach, including hypovolemic status and pre-existing gastro-intestinal disease, both suggesting deficient absorption. Enteral resuscitation and enteral feeding should start as soon as possible, administered via oro- or naso-, gastric or -jejunal routes. This concept is not universally accepted and many may be unaware of it as an option. Only 22% of respondents use the method. Remarkably, 34 of the remaining 76 doctors reported favourably on potential benefits, although they were not implementing the method. There is debate about the most beneficial enteral fluid to use; in this survey choices ranged from crystalloid solutions to polymeric feeds [23–25]. Enteral resuscitation is rarely used in developed countries, despite its physiological benefits.

This survey identified that enteral resuscitation is perhaps an under-appreciated adjunct in the developed world despite its physiological justification. On the other hand, there is increasing support for the use of colloids and albumin in the early phase of burn resuscitation, and the lack of availability of colloids in the developing world may be a significant impediment to resuscitative efforts in the major burn victim.

A major proportion of the world’s burden of burn injury occurs in Africa, and every effort should be channelled to introducing inexpensive, effective and standardised means of improving outcomes. While prevention and education are paramount to reducing burn injury, access to basic first aid measures, wound care and fluid resuscitation at the primary level should be improved simultaneously to efforts to centralise expertise and resources for continued comprehensive care.

There is a tremendous need for audits of burn practice in most African countries, and presentation at national and continental meetings like the South African Burn Society and the Pan African Burn Society is important, and should be encouraged and supported by healthcare authorities and policy makers. Individuals with an interest in the care of burns patients, with backgrounds in any of the disciplines involved in this work (nursing, medical, therapists, etc.), should be supported to visit units in other African countries or regions where burns services are better developed. Supernumerary registrar training has been effectively implemented in many units in South Africa, for example, and this should be further enhanced by the creation of burns fellowship training positions.

A concerted effort was made to obtain information from relevant sources throughout the African continent. Unfortunately only twenty-five responded from outside South Africa. Nevertheless the units who did respond manage large numbers of patients, and it is believed that this represents practice in their countries. Less developed nations, frequently the nations with the highest burden of disease, are less likely to have representation in these meetings, and despite efforts to contact units across the continent, a minority were actually represented. Approximately 20% of all surveys were returned. This study provides further impetus towards support for truly pan-African representation at continental burns meetings.

5. Conclusion

This comparative survey indicates that resuscitation practices in Africa are not dissimilar to international standards, with a few exceptions. The Parkland formula and Ringer’s Lactate are the cornerstones of fluid resuscitation for burn injuries. Colloids are seldom used, and an appreciable number of respondents’ rely on enteral resuscitation for minor to moderate burns. The patient’s clinical response, limited biochemical markers and urine output are used to monitor the patient’s progress and to adjust the resuscitation fluid administered.

Conflict of interest

There are no conflicts of interest to declare.
Appendix 1. The questionnaire used in the survey, replicating the same used in the ISBI/ABA survey.

BURN RESUSCITATION IN AFRICA SURVEY

Thank you for completing this survey evaluating the practice of burn resuscitation in Africa. We aim to compare results with those of the same survey completed by members of the American Burn Association and the International Society of Burn Injuries, collated by Dr Greenhalgh, and published in Burns in March 2010 (Greenhalgh DG. Burn Resuscitation: the results of the ISBI/ABA survey. 2010 Mar; 36(2): 176-82. Doi: 10. 1016/j.burns. 2009.09.04. Epub 2009 Dec 16). Permission was obtained from the author. Any caregiver involved in burn care is invited to complete this survey. Please fax, email or post the completed survey to Professor Rode.

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Cape Town
South Africa
7700

Telephone: 0027216589111

Email: heinz.rode@uct.ac.za

1. Do you have a formal burn unit?

2. If you do not have a formal burn unit, in what capacity do you treat burns?

3. What is your position in the unit?
   a. Director
   b. Staff doctor
   c. Nurse
   d. Other caregiver

4. How many acute burns do you admit per year?

5. What age group do you treat?
   a. All ages
   b. Adults only
   c. Children only

6. At what size burn do you perform IV resuscitation?
7. For the majority of patients, how do you obtain IV access?
   a. Peripheral line
   b. Central line
   c. Cutdown
   d. I do not obtain IV access
   e. Other

8. What is the basic resuscitation formula do you use for acute burns?
   a. Parkland
   b. Brooke
   c. Galveston
   d. Warden
   e. Modified
   f. Oral
   g. Other

9. Do you use the formula for initiation of resuscitation only?
   a. Yes
   b. No

10. Do you follow the formula exactly?
    a. Yes
    b. No

11. What initial IV solution do you use? (please describe any additives)
    a. Ringer’s Lactate
    b. Normal Saline
    c. Ringers Lactate plus Na HCO3
    d. Ringers Lactate with additives
    e. Normal Saline with additives
    f. Hypertonic saline
    g. Hypertonic saline with Dextran
    h. Other hypertonic solution
    i. Albumin solution
    j. Fresh Frozen plasma
    k. Other (please describe)

12. Do you change the IV solution during resuscitation?
    a. Yes
    b. No

13. Describe how you change the IV solution during resuscitation:

14. How do you modify resuscitation volume per hour?
    a. Based on urine output
    b. Based on formula
    c. Using invasive monitoring (describe technique)
    d. Other (describe)

15. How do you determine the endpoint of resuscitation?
16. Do you calculate a maintenance fluid rate after completion of resuscitation?
   a. Yes
   b. No

17. Do you feel that your resuscitation protocol works well?
   a. Yes
   b. No
   c. Why?

18. Does your resuscitation protocol provide:
   a. Too much fluid
   b. Too little fluid
   c. Right amount of fluid

19. Do you typically resuscitate:
   a. Above the formula
   b. Below the formula
   c. Right on the formula

20. Do you have an oral/enteral resuscitation formulae?
   a. Yes
   b. No

21. Describe your oral/enteral resuscitation formula:

22. What patient population receives oral/enteral resuscitation?

23. What fluid do you use for oral/enteral formula?

24. Do you give oral/enteral fluids by:
   a. Oral only
   b. NG tube
   c. Nasoduodenal/Nasojejunal tube
   d. Varies

25. How do you titrate oral resuscitation?

26. Do you feel that oral/enteral resuscitation works?
   a. Yes
   b. No

27. Any other comments?
REFERENCES