Resuscitation in major burns: The problem of fluid creep

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To the Editor: We have noticed an alarming tendency for burn patients to be over-resuscitated, and we believe that protocols should be reviewed in light of our own and international experience.

We recently managed an 8-year-old boy with 52% full-thickness burns, who developed abdominal and limb compartment syndromes during the period of resuscitation. The fluid volumes infused above those calculated were 1.6 and 4.7 litres on days 1 and 2 respectively to maintain haemodynamic stability and urine output above 2 ml/kg/h. Within 48 hours of the injury, he developed poor peripheral perfusion and a distended abdomen; the intravesical pressure was 32 mmHg and the abdominal perfusion pressure 23 mmHg. Abdominal decompression and three limb fasciotomies were performed, but small-bowel and lower limb muscle necrosis had developed. The patient deteriorated rapidly despite inotropic support and died.

Fluid calculations were based on the Parkland formula at 4 ml/kg/% burn, and a major goal of resuscitation was to maintain urine output above 2 ml/kg/h.[1] The Advanced Paediatric Life Support (APLS) course manual[2] states that the Parkland formula is 'only a guide; subsequent therapy will be guided by urine output, which should be kept at 2 ml/kg/hour or more'.

Such formulae and guidelines do not negate the value of regular re-assessment of the patient's clinical condition. Over-reliance on the Parkland formula, and attempts at maintaining fluid output above 2 ml/kg/h as prescribed by APLS,[2] may lead to over-hydration; if severe, this may manifest as compartment syndromes in unburnt limbs and in the abdomen, with potentially lethal consequences.[3-5]

The pendulum appears to have swung from under-resuscitation before use of the Parkland formula towards over-hydration, the sequelae encapsulated as 'fluid creep', a term coined by Pruitt.[3] Over-resuscitation can result in pulmonary oedema, acute respiratory distress syndrome, pneumonia, multiple organ dysfunction, compartment syndromes, and cerebral oedema.[4,5]

The British Burn Association has suggested that formulae be adjusted to 3 ml/kg/% burn, with a target urine output of 0.5 ml/kg/h for children and adults, and also recommended that colloids be introduced early (within 12 hours of the burn) to decrease fluid requirements.

We suggest the following to optimise fluid resuscitation and prevent adverse complications:

1. The first 8 hours are critical; intravenous resuscitation should start immediately for all burns with body surface area involvement of more than 15%.
2. The fluid volume formula should be reduced to 3 ml/kg/% burn during the initial 24 hours.
3. Urine output goals for both adults and children should be reduced to 0.5 - 1 ml/kg/h.
4. Colloids should be introduced early (after 8 hours) and inotropes initiated judiciously to maintain haemodynamic stability.
5. Biochemical markers, lactate, mixed venous saturation and base excess should be aggressively normalised and used as endpoints in conjunction with urine output.[6,7]
6. Feeding (preferably transpyloric) should be initiated early.
7. Intravesical and abdominal perfusion pressures should be measured routinely and regularly.[8,9]
8. The concept of an escharotomy for a burn eschar may fall short of adequate decompression of burnt tissues, necessitating frequent re-assessment and possible conversion of an eschar release to a fascial release.[10]
9. Guidelines and protocols should be used, such as those recently published in the *SAMJ*.[11]
10. Patients with major burns should be referred to the local burns unit during the initial assessment and resuscitation phase.
11. If the response to resuscitation is inadequate despite adequate fluid replacement, one should consider a covert source of fluid loss (internal haemorrhage, undetected trauma, etc.) or the early onset of a toxic shock syndrome-like state (usually caused by Gram-positive organisms).

Fluid creep is a recognised entity with significant detrimental effects on cardio-respiratory function, and it may also result in limb and abdominal compartment syndromes. Strategies to prevent and manage its development should be incorporated into 'care bundles' designed for the management of severely

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burnt patients. A modified Parkland formula (3 ml/kg/% burn) is a useful guide to fluid resuscitation calculations, but the patient's general condition should be repeatedly reviewed and alterations made according to clinical examination findings, biochemical markers and endpoints of resuscitation, in addition to urine output.

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Accepted 23 October 2008.