

## Damage control resuscitation for severe trauma: less is more?

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Trauma and serious injury is on the rise all over the world.<sup>1,2</sup> Damage control resuscitation has been popularized in the battlefield recently and is being evaluated for its applicability in the civilian setting.<sup>3,4</sup> It differs from current resuscitation models by attempting "earlier and more aggressive correction of trauma-induced coagulopathy in conjunction with interventions designed to achieve early surgical haemostasis and control of contamination".<sup>5</sup> The end goal of all resuscitation strategies should aim for survival from life threatening haemorrhage. The anaesthesiologist is vital in overseeing the process of resuscitation and to optimize haemostasis as well as to prevent a 'second hit' of coagulopathy and further shock.

Firstly it is important to determine if the patient is sick or not. We need to assess by means of reliable criteria for initial assessment which can predict outcomes and direct therapy. This new diagnostic criteria avoids the "but he looked good" phenomenon. Within the first five minutes in the ED it is essential to identify patients in trouble, with increased mortality and with increased probability of massive transfusion. 'The Lethal Triad' as popularized by Brohi, K et al<sup>6,7</sup> in 2003, includes: acidosis, coagulopathy and hypothermia and can sensitively prognosticate death. If during triage any of the following is present there is a higher mortality: acidosis with a base deficit  $>-6$ , coagulopathy with INR  $>1.5$ , hypotension with a systolic blood pressure of  $< 90$ , a haemoglobin of  $< 11$  and a temperature  $< 36$ . Pattern recognition is important. A weak or absent radial pulse and abnormal mental status are also signs of danger. In severe traumatic injury, a base deficit (BD) of  $\geq 6$  identifies patients that require early transfusion, increased ICU days and a higher risk for ARDS (adult respiratory distress syndrome) and MOF (multi organ failure).<sup>8,9</sup>

Patients will have an elevated base deficit before their blood pressure drops to classic "hypotension" levels. Acidosis contributes to coagulopathy. Activity of the tissue factor/factor VIIa complex decreases 55% and prothrombinase complex declines by 70% as pH declines

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from 7.4 to 7.030.<sup>10</sup> Plasma clotting times prolong as pH is reduced as well. An initial INR  $\geq 1.5$  reliably predicts those casualties who will require massive transfusion. Patients who have a significant injury generally present with a coagulopathy. This is worsened by hypothermia which is often also present. The severity of injury and mortality is linearly associated with the degree of the initial coagulopathy. Derangements in coagulation occur rapidly after trauma. In a recent study by the time of arrival at the emergency department, 28% (2,994 of 10,790) of trauma patients had a detectable coagulopathy that was associated with poor outcome.<sup>11</sup>

A systolic blood pressure of 90 mm Hg or less is indicative of over 40% of the blood volume loss. There is impending cardiovascular collapse and again a significantly increased mortality. Otherwise young healthy patients with haemoglobin of  $< 11$  have only one reason for their anaemia, namely acute blood loss. Significant haemorrhage can be present in overtly or covertly and should be investigated.<sup>12,13</sup> Common sites include abdomen, thorax, brain, thighs or the field! A temperature of  $< 96^{\circ}\text{F}$  or  $35^{\circ}\text{C}$  is associated with an increase in mortality. Trauma patients that are hypothermic are not perfusing their tissues. The coagulation cascade is an enzymatic pathway that degrades with temperature and ceases at  $92^{\circ}\text{F}$ .

Hypotensive resuscitation is not new. It was a technique developed by military physicians during World War-I and World War-II. The principle is maximizing the resuscitation benefit to the mitochondria while minimizing rebleeding by avoiding "popping the clot".<sup>14,15</sup> This is supported by a significant body of scientific data. This approach preserves the resuscitation fluid within the vascular system and prevents needless waste of blood and fluids.

Damage control philosophy can be extended to haemostatic resuscitation which dictates restoring a normal coagulation and minimizing crystalloid. Traditional resuscitation strategies dilute the already deficient coagulation factors and increase multiple organ failure. The aggressive haemostatic resuscitation should be combined with equally aggressive control of bleeding.<sup>16,17</sup> The pillars of damage control resuscitation (or DCR) is early diagnosis in ED a 1:1 ratio for transfusion

of PRBC to FFP, considering use of rFVIIa early and most importantly damage control surgery or angioembolisation for stopping haemorrhage as early and quickly as possible. It is important to call for preferably fresh whole blood if available from the ED. Frequently FFP (fresh frozen plasma), cryoprecipitate and platelets are also needed. Minimal crystalloid should be used. Increased FFP transfusions within first 24 hours of admission were independently associated with increased survival. The median ratio of FFP: RBC was 1:1.7 in survivors compared to 1:3 in non-survivors ( $p < 0.001$ ). As for Factor VII, the results of the CONTROL trial showed efficacy and safety of recombinant activated Recombinant Factor VII in the management of refractory traumatic haemorrhage, however, even though it reduced blood product use but it did not affect mortality compared with placebo.<sup>18</sup> Also it is extremely expensive and most societies do not recommend its routine use.

Modern evidence-based trauma management along DCR principles lower mortality, paradoxically making outcomes studies increasingly difficult. Our goals should be a stable airway and oxygenation, haemostasis by controlling of life-threatening haemorrhage, a quick and focused exploratory laparotomy or thoracotomy as needed. The goals of damage control surgery should be a rapid, wide exposure and excision rather than repair of "expendable" organs.<sup>19</sup> The focus should be on haemostatic procedures only such as vessel ligation or repair (avoid grafting if possible). Packing for diffuse bleeding is advisable such as liver lacerations. Temporary closure can be done. These days angiographic embolization in selected cases saves time and reduces mortality and morbidity. ICU care of such patients is essential.

In Summary, keeping a low index of suspicion for and to recognize shock, using critical criteria to identify the critical 10%, to resuscitate immediately to devote attention to haemostatic resuscitation, to provide volume that also restores the haemostatic cascade, to minimize crystalloid and stop the bleeding should be the cornerstones of damage control resuscitation. If available, the use of the thromboelastograph may be highly useful.<sup>20</sup> Most importantly, vigilance and timely team work is of extreme importance in saving trauma patients.

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