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Editorial

Transfusion for trauma: civilian lessons from the battlefield?

Conflict is a potent stimulus to innovation [1]. The multiple injuries sustained in modern warfare by combatants of all sides, as in Iraq and Afghanistan, are often horrific. However, advances in combat first aid and equipment, in body armour and in rapid evacuation systems are delivering more immediate survivors to the emergency room front door and to the operating table [2]. More transfusion is now required for military trauma, creating both a wave of demand as well as a wave of interest in the civilian community. This editorial discusses the rationale for the civilian adoption of a military-style massive transfusion protocol, but suggests caution.

Blood transfusion came of age during the two World Wars [3]. During much of the intervening 70 years there has been a somewhat ad hoc, non-systematic and sometimes unscientific approach to fluid resuscitation in major trauma. It finds its roots in the understandably conservative use of blood as a scarce and potentially dangerous resource [4]. Where large amounts of blood and blood products have been used in a 'reactive' way, the outcomes are often poor and are unable to overcome the 'bloody vicious cycle of coagulopathy' [5]. Considerable efforts have been made to understand the pathophysiology of trauma and to prevent complications. This has resulted in the early and aggressive use of blood components in massive trauma, especially in blast and ballistic trauma.

Outcomes in survivable major trauma are determined very early on by physiological factors, and by the initial response of the attending trauma team [6, 7]. The contributory factors of trauma pathophysiology includes the four 'hypos': hypothermia, hypoxaemia (producing acidosis), hypovolaemia and hypocoagulability. All are intimately interrelated and interdependent, and should be corrected to stabilise the patient's circulation for definitive treatment to be effective [8]. Hypocoagulability is present in approximately one-third of severe trauma patients [9]. The coagulopathy of trauma appears to be complex. It is more than the dilution and consumption of clotting elements in a physiologically deranged milieu. One postulated mechanism for which there is some evidence is that hypovolaemic shock and the subsequent hypoperfusion induces both anticoagulation and hyperfibrinolysis, contributing further to the hypocoagulability [10]. The coagulopathy correlates with injury severity and is associated with increased mortality [11]. The mechanisms may be poorly understood but a speedy, pragmatic approach to management is required. The underlying principle of management is that 'haemostasis requires homeostasis', i.e. each of the 'hypos' should be addressed. Mild to moderate hypothermia is surprisingly common in trauma patients on admission. It should be corrected by immediate warming strategies. Hypoxia and hypoventilation should be recognised and the causes addressed; early intubation and artificial ventilation during resuscitation can be a major asset in stabilising restless and distressed casualties.

The management of hypovolaemia remains a major challenge. Rather than aggressive fluid replacement, the ability to control ongoing loss becomes the critical determinant of outcome in the seriously injured [12]. All efforts should be made to stop the bleeding rather than to replace blood loss. The control of bleeding should start in the pre-hospital environment and actively continue throughout the care pathway. Questions remain as to how volume lost should be replaced: when, what fluid, how much, and in what order? Within the British armed forces, the answer lies within the Damage Control Resuscitation doctrine, carefully balancing haemostatic and hypotensive resuscitation [13]. The target is not simply volume replacement but optimal perfusion, oxygen delivery and competent coagulation.

There is increasing opinion that massive blood loss should be managed with blood component replacement. Such haemostatic resuscitation addresses not only the question of hypovolaemia but also hypocoagulation. Where it is apparent that substantial volumes of blood are likely to be needed, as is invariably the case in patients with complex polytrauma such as that created in unprotected civilian casualties by improvised explosive devices (IEDs), a massive transfusion protocol (MTP) should be implemented immediately [14]. There are different definitions of an MTP, and the details of implementation vary between departments and institutions [15]. There is, however, an emerging opinion that red cells and clotting factors should be given in broadly similar proportions from the outset [7, 16, 17]. Many such protocols also use platelets, if these are available. The argument is that there is no purpose in holding back clotting factors [18], plasma concentrates, cryoprecipitate and platelets until coagulopathy is apparent and then using these agents sparingly. They should be used generously at the outset and their effects monitored at the bedside with point of care testing [19]. This approach is quite different to the current UK civilian Massive Transfusion Guidelines [20]. Good evidence from the US military and early evidence from the British military experience suggests that this early and aggressive use of blood components works and has saved lives (Presented at Advanced Technology Applications for Combat Casualty Care 2008). However, the strategy has been logistically challenging and has required considerable support from the National

Blood Service and the military Biomedical Staff cadre. The implications of a massive transfusion protocol have also been shown to present challenges for civilian departments, with implications for resources, training, and the dynamics of laboratory support throughout the trauma incident [21].

Armed forces accept that transfusion is required for trauma and that the benefits outweigh the risks. However, the need for blood component support should be, and has been, mitigated by optimising the care pathway from point of wounding to the hospital. The Defence Medical Services have successfully re-introduced the tourniquet and introduced several external haemostatic agents into the pre-hospital environment. Within the hospital environment, the need for donor blood can be further reduced through the judicious use of patient testing and transfusion-sparing strategies. Lessons can be learnt from teams performing complex surgery without blood support and those working in resource restricted environments. Manoeuvres sparing the use of donor blood include surgical techniques, cell salvage and the use of drugs such as antifibrinolytics and haemostatics. Recombinant Factor VIIa (rFVIIa) has been used during haemostatic resuscitation in a military setting but it is acknowledged that its use in trauma remains 'off label' [22]. It has also been used safely in arresting ongoing haemorrhage in a number of major trauma cases [23]. Administration of rFVIIa may reduce blood requirement due to potentially exsanguinating haemorrhage from blunt and penetrating trauma [24]. The use of haemostatic drugs should be balanced against the risk of thrombosis and remains contentious, and the use of such drugs should therefore generally be subject to protocol and review. The use of topical haemostats is less contentious and expensive, and has successfully been used within many areas of civilian surgery. We suggest that further consideration is required for the use of internal haemostats such as fibrin sealants and surgical patches within military surgery. The use of blood sparing drugs and techniques in trauma should continue to be explored and optimised for use in the military context. However, it seems highly likely that they should be employed early in the resuscitation cascade, in order to reduce transfusion requirements, rather than as agents of last resort.

Massive transfusion policies have been used successfully in many parts of the world in both military and civilian settings. However, successful implementation requires intelligent application and sustainability. In the UK, there is great enthusiasm for such protocols, and many National Health Service (NHS) Trusts are currently considering introducing them [25]. Some Trusts have already introduced 'Shock Packs' using universal, rather than group-specific, components. As a consequence, there has been an increased demand from some Trusts for blood components in relatively short supply, such as Group O negative red cells and Group AB FFP (H. Doughty, personal communication). The UK and US Defence Medical Services are using more platelets; these have a short shelf-life and are currently not a stock item in most hospitals. If more platelets are to be used in civilian trauma practice as guided by trauma-orientated massive transfusion protocols, then consideration must be given to both the supply and stock management.

Massive trauma including ballistic trauma is a global problem. Lessons need to be learnt about its management in order to optimise survival. The relative scarcity of ballistic trauma in UK civilian practice obliges us to look widely for best practice and a good evidence base. However, caution should be applied to the civilian use of military protocols. The context is different. The military protocol is nested within a paradigm of damage control resuscitation in a violent environment with long supply lines. The civilian setting, especially within urban areas, will typically allow enough time to arrange for the use of group-specific blood components including the time to thaw frozen products. Two recent papers from civilian level 1 trauma centres in the USA have examined the outcomes of patients receiving massive transfusions [26, 27]. While both of these series report significant benefit of high ratio of FFP:RBC transfusion in terms of survival and coagulation status, they were retrospective studies and the US civilian trauma population is different to that seen in the UK just as the civilian UK and US trauma populations differ from the military trauma population. Furthermore, these two studies disagree whether the optimal FFP:RBC ratio should be 1 : 1, 1 : 2 or even 1 : 3.

More information is required to guide the best approach to haemostatic resuscitation in the civilian setting. We should quantify the problem in the UK and develop an integrated approach to the transfusion support for trauma. Rather than adopting protocols to be applied uniformly to all trauma patients receiving massive blood transfusions, a more tailored approach may be appropriate. Classical tests of clotting such as PT and APTT do not reflect the coagulation status of such patients. The use of a rapid near-patient test to direct therapy, such as thromboelastography, should be further investigated [28–30]. Such an approach, if combined with an element of transfusion triage [31] and audit, would allow proper planning for trauma, pathology and transfusion services; whilst reducing donor exposure and ensuring efficient use of blood components.

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