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CATASTROPHIC HAEMORRHAGE CONTROL A BRIEF REPORT

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ABSTRACT

In the civilian setting, haemorrhage contributes to death during the prehospital period in 33-56% of cases, and accounts for almost 50% of deaths in the first 24 hours of trauma care. Outlined in this brief report are key steps to reducing the burden of mortality due to haemorrhage in the United Arab Emirates. The authors will review the current practices in haemorrhage control, from basic first aid treatments through to advanced invasive procedures, as well as taking a look to future developments.

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INTRODUCTION

In the civilian setting, haemorrhage contributes to death during the prehospital period in 33-56% of cases, and accounts for almost 50% of deaths in the first 24 hours of trauma care. Haemorrhage accounts for the largest proportion of mortality occurring within the first hour of trauma centre care [1].

In the military setting, Eastridge et al. [2] investigated 4596 deaths in war theatres over a 10-year period. They found that nearly 25% were "potentially survivable", and that 91% of these potentially survivable deaths were due to uncontrolled blood loss. They estimate that adequate haemorrhage control could have saved over 1000 of these fatalities.

Current opinion is that uncontrolled coagulopathic haemorrhage is now the major cause of potentially preventable death following trauma [3]. Stopping haemorrhage early will result in better outcomes for patients. But how can we achieve this?

Whilst lessons can be learned from military studies and the results applied to civilian systems, we must not forget that the populations studied and interventions available vary dramatically between these two settings [4]. Military populations generally comprise of physically fit, young and healthy subjects (mainly male), whilst civilian populations are a mix of male and female, young and old, trauma and medical presentations, with many patents have underlying co-morbidities such as diabetes, heart disease, hypertension etc. These differences in populations studied mean the results from military studies may not be reflected when the interventions are applied to civilian populations.

The American College of Surgeons Committee on Trauma released a document entitled "An evidence-based prehospital guideline for external haemorrhage control" in 2014 [4]. In this document, they review the evidence base for current haemorrhage control interventions. This article will review the components of

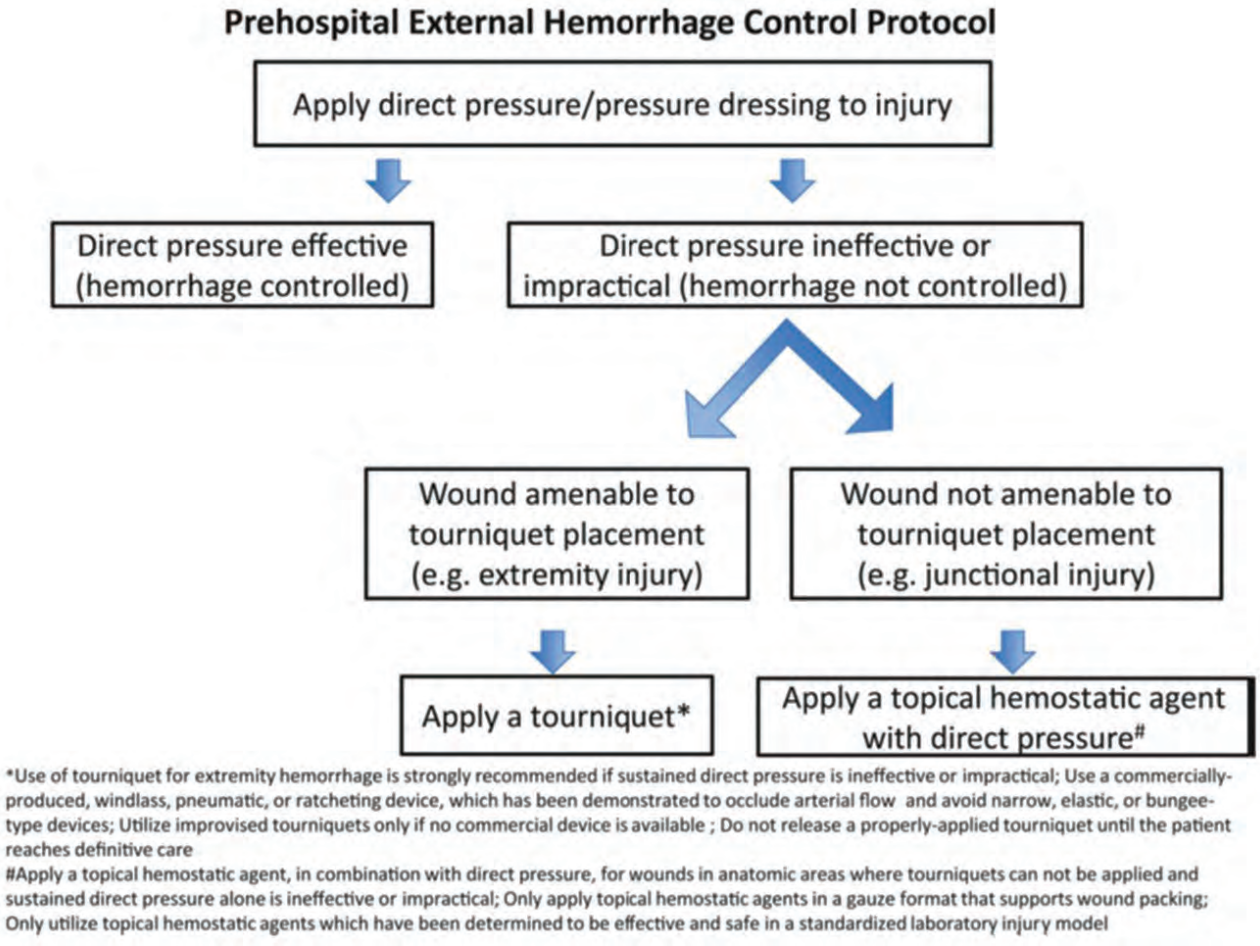

Figure 1 : Prehospital external haemorrhage control protocol by the american college of surgeons [4]

this protocol, and some additional haemorrhage control devices and strategies.

Measures to control catastrophic haemorrhage include provision of basic first aid training to all, specifically haemorrhage control training to police and other first responders, early use of tourniquets and haemostatic agents, application of splinting and the early administration of tranexamic acid and blood products.

BASIC FIRST AID

General advice that can be followed by anyone, from civilian to physician includes the principles of first aid. First apply direct pressure to the wound that is bleeding, ideally using a gloved hand. Application of a gauze dressing and applying direct pressure to the wound to aid in clotting are the next recommended steps to be undertaken. If rescuers are trained to do so, such as military medics or those with advanced level first aid training, then they should pack the wound if possible. Several studies have shown that continuous application of direct pressure and wound packing are the key steps in controlling haemorrhage [5-7].

In the military setting, especially in a care under fire scenario, it may be prudent to skip the steps of basic first aid, and apply pressure whilst simultaneously applying a tourniquet. Once the tactical situation has resolved, the tourniquet can be loosened and first aid measures can be attempted. If these are unsuccessful then the tourniquet should be re-tightened. This care-under-fire process is followed by military medics in several armed forces around the world.

TOURNIQUETS

The current range of tourniquets is designed for significant extremity trauma, and they control bleeding by providing circumferential pressure, compressing the arteries and reducing blood loss. The Combat Application Tourniquet (CAT) is by far and wide the most popular version in both civilian and military settings. Application of a tourniquet may cause significant pain to the patient, and therefore adequate analgesia should be supplied to any patient who requires tourniquet application. Narcotic analgesia should ideally be avoided, and an agent such as ketamine is preferred.

Studies have shown that prehospital care providers have irrational fear of complications surrounding the application of tourniquets, and despite proper training, approximately 80% are not tightened adequately [8]. There is a moderate level of evidence that tourniquets should be used to control significant extremity haemorrhage if direct pressure is ineffective or impractical [4].

HAEMOSTATIC AGENTS

A study by Littlejohn et al. [5] compared four haemostatic agents to standard gauze. These dressings were applied to simulated wounds in a porcine model, and thus the applicability of the results to a human population with varying wound presentations is questionable. However, they found that standard gauze and adequate wound packing were found to perform equally as well as advanced haemostatic agent products, and they conclude that continuous application of pressure and wound packing is the key factor in stopping bleeding.

A case series of 30 actively haemorrhaging patients treated with QuikClot Combat Gauze (QCG) in a prehospital setting in Paris, France resulted in 22 out of 30 successful treatments (definitive cessation of bleeding) [9]. However, the authors acknowledge that for these dressings to be effective they must be introduced close to the vascular breach (wound packing) and associated with manual compression for at least 3-5 minutes.

Bulger et al. [10] also advise clinicians to only use haemostatic agents in a gauze format that supports wound packing. The prehospital use of topical haemostatic agents is recommended in conjunction with direct pressure for controlling haemorrhage in injuries where direct pressure alone is ineffective or not practical and in cases where tourniquet application is not possible due to anatomic limitations.

Singletary et al. [11] in the 2015 American Heart Association and American Red Cross Guidelines Update for First Aid advise that haemostatic dressings may be considered by first aid providers when standard bleeding control (direct pressure with or without gauze or cloth dressing) is not effective for severe or life-threatening bleeding.

PELVIC BINDERS

Pelvic binders or circumferential tightening devices have been widely distributed across prehospital and retrieval services for decades. Reduction and stabilization of pelvic ring injuries reduces blood loss. The binder splints the fracture, realigning bone ends, and reduces venous and low-pressure bleeding from bone ends and disrupted veins. Because of the reduction of blood loss with this treatment, application should occur as soon as possible after injury to prevent unnecessary blood loss.

Examination of the pelvic ring is unreliable (especially if the patient has a reduced Glasgow Coma Scale, or if there are any distracting injuries) and current recommendations are that the pelvis should not be palpated if the patient has significant mechanism or pain in the pelvic region [12]. Application of a pelvic binder is recommended in all trauma care courses at present (International Trauma Life Support, Prehospital Trauma Life Support, Advanced Trauma Life Support, Tactical Combat Casualty Care, etc.), and it is important that the pelvic splint should remain in situ throughout resuscitation. It should not be removed prematurely.

Several manufacturers have devices on the market, with varying mechanisms of application. The Royal College of Surgeons in Edinburgh in their consensus statement on pelvic binder application do not recommend any one device over another, rather they highly recommend the application of any device [13].

TRACTION SPLINTS

Renowned for their ability to reduce pain in femoral fractures, there is limited data available on the benefit of traction splint application for haemorrhage control in femur fractures in the prehospital environment [14]. Application of a traction splint may reduce haemorrhage in femoral fractures, and requires further investigation. Some of the most compelling evidence surrounding the application of traction splints comes from World War I, where physicians at the special femur fracture hospital in Bastogne noted a drop in mortality from 13% in 1916 to 7% in 1918 through application of traction splints [15]. This is hypothesised to be as a result of haemorrhage control and a subsequent drop in mortality as a result.

TRANEXAMIC ACID

The latest widely-available prehospital intervention for haemorrhage control is an intravenous medication called tranexamic acid, often abbreviated as TXA. TXA is an anti-fibrinolytic that competitively inhibits the activation of plasminogen to plasmin, thus preventing clot lysis. It is included on the World Health Organisations' list of essential medications, and importantly for developing countries and systems, it is relatively inexpensive.

The CRASH-2 trial studied over 20,000 patients admitted to 274 hospitals across 40 countries. The findings of this study showed that TXA resulted in decreased mortality if given less than three hours from injury, and resulted in an overall 32% reduction in mortality [16]. There were no apparent increases in fatal or nonfatal vascular occlusive events (such as pulmonary embolism, deep vein thrombosis, etc.). The conclusion from this trial was that early administration of tranexamic acid to trauma patients with, or at risk of, significant bleeding reduces the risk of death from haemorrhage [17].

BLOOD PRODUCTS

Regarding replacement of lost volume, it is oft debated whether colloids or crystalloids are better for hypovolaemic patients. Crystalloid delivery should be minimized, as it is associated with coagulopathy and acidosis, two components of the infamous "trauma triad of death" depicted in **figure 2**. The best resuscitation appears to be with whole blood rather than component therapy, but this is a logistical and often insurmountable issue in many countries where the use of whole blood is banned.

The direction for the administration of blood products to bleeding patients has been largely influenced by the major conflicts in the world over the past century. The initial use of preserved blood can be traced back as far as 1917 where it was used in the First World War with great success [18]. In current practice,

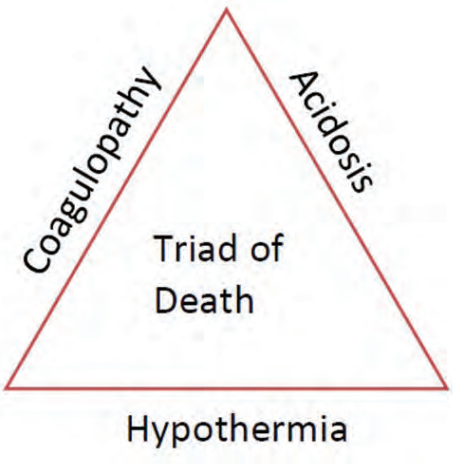

Figure 2 : Trauma triad of death

the recognition of trauma induced coagulopathy (TIC) and treatment with damage control resuscitation (DCR) such as permissive hypotension, haemostatic resuscitation and damage control surgery is fundamental to improve outcomes in patients who are severely injured [19]. DCR with the early administration of blood products such as packed red blood cells (PRBC's), fresh frozen plasma (FFP), platelets and other coagulation factors is commonplace in today's trauma resuscitation strategies however the efficacy of these products to correct TIC in the bleeding patient is unknown [20].

Currently most trauma centres institute a massive transfusion protocol where blood components are readily available for the most severely injured patients where blood components (RBC's, FFP, platelets) have been shown to improve outcome when administered on a ratio of 1:1:1, although there is some evidence emerging of 1:1:2 being an acceptable ratio [21].

Supplementary to this other coagulation factors may be given to increase fibrinogen levels such as FFP, cryoprecipitate and fibrinogen concentrate as fibrinogen levels are depleted earlier than other coagulation factors and low values are associated with increased mortality.

PREVENTION OF HYPOTHERMIA

As can be seen from the trauma triad above, hypothermia plays a significant role in mortality from haemorrhage. Hypothermia's role in trauma morbidity and mortality is complex, but it is known that a decrease in core body temperature following injury correlates with poor prognosis. The importance of preventing heat loss in trauma patients cannot be stressed enough. Spontaneous hypothermia after major trauma is associated with greater transfusion and fluid requirements and worse outcomes [22-24]. Simple measures such as controlling environmental temperature, selective exposure of skin, and providing warmed fluids can assist in the prevention of hypothermia.

FUTURE DEVELOPMENTS

Trauma clamps

Filips et al. [25] studied the iTClamp, a novel clamp-like system for sealing wounds and encouraging clotting in a porcine model. Twenty subjects had femoral artery injuries created, and were randomised to clamp application or non-application. A total of 100% of subjects treated with clamp survived, compared to 60% of the standard treatment (gauze and direct pressure) group. In total, none of the group who received no treatment survived, as would be expected. These trauma clamps have potential to reduce mortality and overall volume of blood loss, but require further independent and clinical research. It should be noted this study was performed by the manufacturers of the iTClamp device.

Resuscitative Endovascular Balloon Occlusion of the Aorta

Resuscitative endovascular balloon occlusion of the aorta (REBOA) is insertion of an inflatable balloon-tipped catheter through the femoral artery, which is then inflated thus occluding the aorta in the appropriate zone (as decided by the physician performing the procedure), reducing blood flow below the point of occlusion. Whilst seen as a relatively new and innovative procedure, the technique was first described during the Korean War in the 1950's. The world's first documented prehospital REBOA was performed in May 2014 in London by staff from London Air Ambulance. It is a feasible prehospital intervention, and with appropriate training, can be inserted successfully in under three minutes [26].

CONCLUSION

Bleeding is a significant problem in trauma. It accounts for a substantial percentage of mortality from trauma. Many of these deaths occur early during treatment and transport, when prehospital providers are with the patient, and these deaths are largely preventable.Simple first aid treatment, such as application of direct pressure and trauma dressings, saves lives. These steps and more advanced fluid replacement can be administered by paramedics on scene and en route to the trauma centre.

Paramedics and other prehospital care providers should be provided with education on packing wounds, and ideally will have access to alternative haemorrhage control equipment such as haemostatic agents and tourniquets. Different strategies can be applied to control bleeding depending on clinician judgement and wound location, and ultimately controlling bleeding and providing appropriate resuscitation strategies will result in improved patient outcomes. This is fundamental to help reduce mortality from trauma in the United Arab Emirates where trauma continues to be a significant burden on the healthcare and social system.

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