

ORIGINAL PAPERS

A REALISTIC MODEL FOR CATASTROPHIC EXTERNAL HAEMORRHAGE TRAINING

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Abstract

External haemorrhage is a significant cause of combat morbidity and mortality. UK DMS have introduced topical haemostatic agents (HemCon®, QuikClot®) for use as an adjunct to control catastrophic external haemorrhage. Realistic training in new equipment is essential. A model is described that is simple, reproducible, valid, realistic and currently unique in its opportunity to train soldiers to deal with life-threatening external bleeding, without recourse to live animal training. The model has been used successfully to train UK DMS medics, nurses and doctors in Afghanistan.

Key Words: Catastrophic, haemorrhage, training, simulator, trauma

Introduction

The importance of catastrophic external haemorrhage as a cause of death in combat trauma has been identified (1,2). Recent terrorist attacks have demonstrated that military experience is relevant for modern civilian trauma practice (3). The UK military has introduced a number of innovations to arrest external haemorrhage and has pushed these far forward to the point of wounding. This is encapsulated in the haemostasis treatment ladder for UK Defence Services (Fig 1) (4), which includes appropriate use of dressings, tourniquets and the topical haemostatic agents *QuikClot*® (Z Medica Corporation) and *HemCon*® (Hemcon Inc, Portland, USA). Both of these topical haemostatic agents require contact with blood to be activated and *QuikClot*® additionally requires the presence of clotting factors. Training models for practicing the use of these new topical haemostats based on synthetic wounds are unrealistic as the haemostatic products remain inactive.

It is not UK practice to undertake medical training using live large animal models, although this is undertaken in some European countries and the USA. This paper describes a new training model that is valid for the type of wounds encountered in the military environment and realistically demonstrates the properties of *HemCon*® and *QuikClot*®.

Training context

As part of annual first aid and pre-deployment refresher training all UK soldiers are instructed to manage bleeding by wound packing and direct pressure into a wound (5). This is supplemented by use of a commercial tourniquet during Care Under Fire and re-evaluated during Tactical Field Care. Team Medics (1 in 4 combat soldiers) receive additional training on *HemCon*®, while professional healthcare personnel receive additional training on *HemCon*® and *QuikClot*®. Training currently involves the use of simulators (*SimMan*), videos of

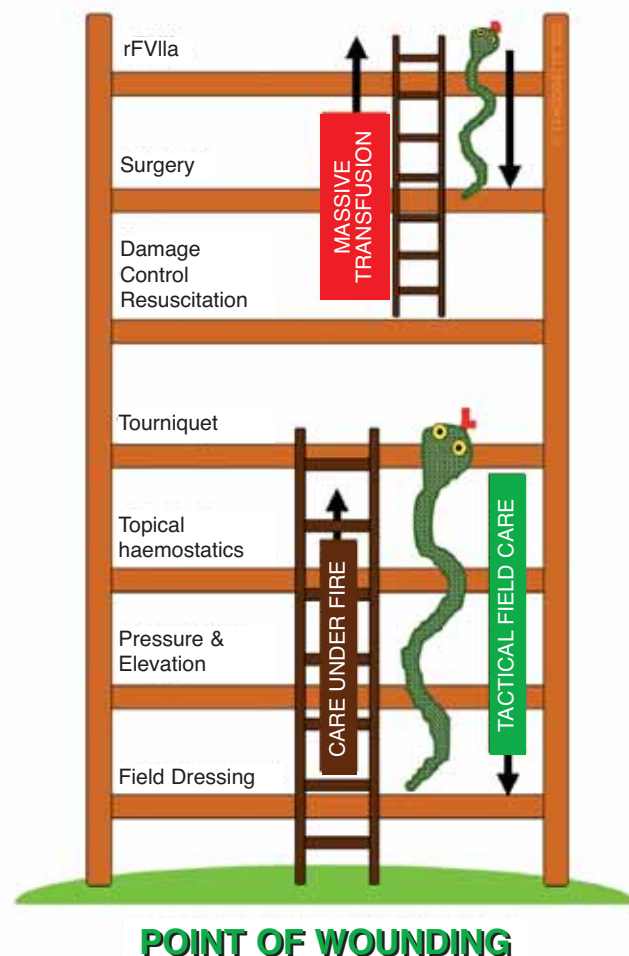


Figure 1: UK Defence Medical Services Haemostasis Ladder. Under normal circumstances there is progression from bottom to top of the large ladder considering each intervention sequentially. However, during "Care Under Fire" (effective direct/indirect enemy fire) it is appropriate for catastrophic limb bleeding to immediately apply a tourniquet BUT to reassess its requirement during "Tactical Field Care" (firefight won) the snake takes the user back to using a field dressing, pressure and elevation at this point.

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animal models from other nations, and simulated live casualties (Fig 2). None of these provide realistic hands-on experience for using novel topical haemostatic agents. Troops currently entering operational theatres in Afghanistan and Iraq undertake further contextual training - Reception Staging Onward Integration, (RSOI) - on arrival, before deploying on the ground. It is within RSOI training for medical personnel that the enhanced haemorrhage model has been used, immediately prior to likely contact with combat casualties.

The model

The model consists of a slab of meat with artificial 'vessels' (Foley catheters) running through the base of a series of wounds (Fig 3). The Foley catheters are primed with warmed, time-expired human blood and plasma. Incisions in the 'vessels' provide a bleeding model. For additional realism the bleeding model can be laid over the groin of a mannequin that is



Figure 2: A member of "Amputees in Action" acting as a simulated casualty

configured with a traumatic limb amputation. This gives the opportunity to practice all of the available aids to external haemorrhage control.

Preparation of the model

The necessary equipment to prepare this model is illustrated in Figure 4 and the numbers in this description refer to those detailed in that figure. Using a slab of belly pork **1** with skin and subcutaneous fat intact, a tunnel is created through the muscle - a chest drain trocar **7** is ideal for this purpose. Tie **4** the end of the chest drain trocar to the tip of a 16-18Fg Foley



Figure 3: Model prepared with cut down onto catheter of warm, expired human blood

catheter **8** and use the chest drain catheter to pull the Foley back through the wound. Cut off the ends of the Foley and attach a 3-way tap **6** to each cut end of the Foley. Take universal precautions for dealing with potential human blood and plasma spillage. Warm the expired human blood and prime the Foley catheter. Where *QuikClot*[®] **3** is to be demonstrated warm the expired FFP and additionally prime the Foley catheter. Use a scalpel **5** to create a large wound bowl through skin, fat and muscle. Cut through muscle until the catheter is easily palpable at the base of the wound. For a large slab of meat a series of wounds can be prepared, each with its own catheter through the base of the wound. Only one unit of blood is required as it can be connected serially to each catheter.

Suggested training drills for arresting the bleeding from this new simulation of catastrophic haemorrhage using *Hemcon* and *Quikclot* are presented in Box 1.

Discussion

Deployed UK Defence Medical Services are faced on a daily basis with the casualties of combat trauma. The requirement to be adequately prepared to deal with severe external haemorrhage is an inescapable ground truth. This model offers the only current opportunity for realistic training on available

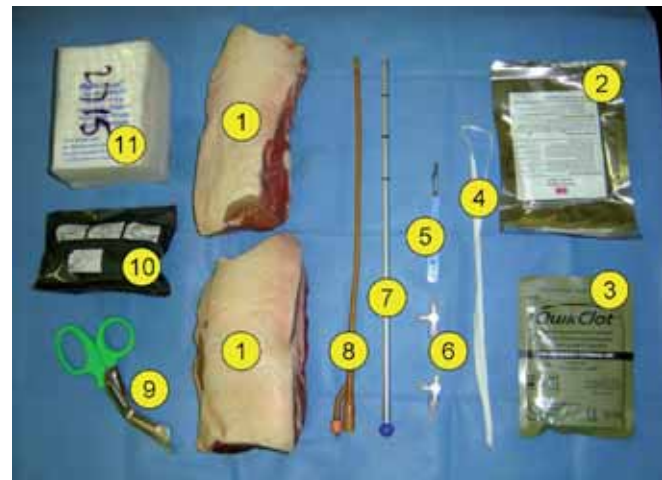


Figure 4: Equipment for preparation and use of the catastrophic haemorrhage model: (1)Pork belly; (2) HemCon[®] bandage; (3) QuikClot[®] powder sachet; (4) Cotton tie; (5) Scalpel; (6) Two 3-way taps; (7) Chest drain and trocar; (8) 16-18Fg urinary Foley catheter; (9) Tufcut scissors; (10) First Field Dressing; (11) 100 x non-sterile gauze

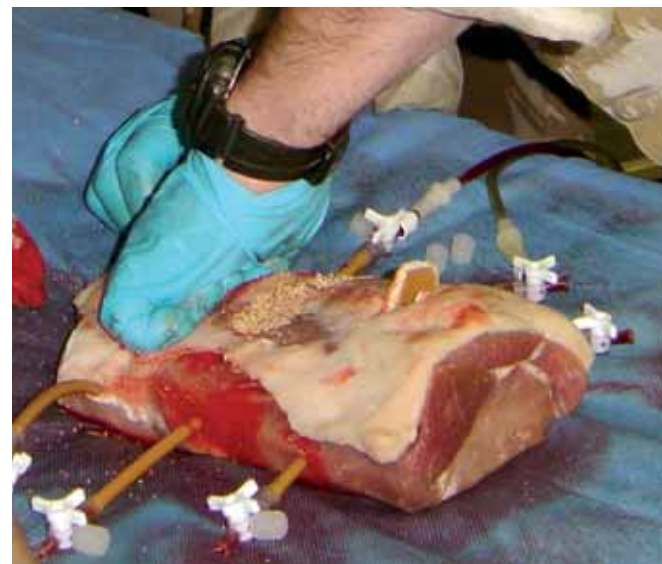


Figure 5: Model variant with multiple catheters through single slab of pork: wound pressure through gauze being applied after application of topical haemostatic

Box 1. Drills for use of HemCon and QuikClot with the catastrophic haemorrhage model

HEMCON	QUICKCLOT
Operator 1 opens HemCon® bandage and cuts in half	
Operator 1 incises the catheter at the base of the wound.	
Operator 2 applies pressure to blood bag to simulate rapid blood flow (and FFP for QuikClot®)	
Operator 1 controls haemorrhage initially with gauze (or field dressing) packed into the wound bowl	
When unsuccessful, Operator 1 places HemCon® into wound, applying even, firm pressure with fingers into wound bowl	When unsuccessful, Operator 2 opens QuikClot® sachet; Operator 1 removes gauze and Operator 2 immediately pours QuikClot® into wound bowl
Operator 1 packs wound over HemCon®/QuikClot® with gauze and then applies firm pressure (e.g. with knuckles) for 3 minutes (Figure 5)	Operator 1 checks for QuikClot® spill around lips of wound bowl and brushes away any excess.

topical haemostatic agents, given that the UK social construct prohibits training with large animal models.

Human packed red cells are provided to UK field hospitals through the National Blood Service. Any units that are unused on expiry at 35 days are usually incinerated. This model uses expired human packed cells that would otherwise be disposed of. Fresh Frozen Plasma (FFP) is supplied to UK field hospitals through both the National Blood Service and, currently in Afghanistan, through the Netherlands military deployed transfusion service. When thawed FFP exceeds its shelf life it is utilized for training models rather than being disposed of.

Summary

External haemorrhage remains a significant cause of combat morbidity and mortality. UK DMS have introduced a number of haemostatic strategies for front line use. Realistic training in new equipment is essential. This model offers a reproducible, valid, simple and currently unique opportunity to train soldiers to deal with life threatening external bleeding without requiring live animal models.

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