# Recent advances in Military Medicine

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## In 2010, I was privileged to command the British Military Hospital in Camp Bastion, Afghanistan, the best Trauma Hospital in the World, ever.

War is an accelerator of many things, not least in medicine, from the Thomas splint developed in the First World War, to penicillin in the Second. Each conflict brings its own influence on medical practice, be it climate (the Russian winter, Burmese jungle or North African desert), terrain (the trenches of Flanders, the Normandy bocage) or weaponry (the bayonet versus the Improvised Explosive Device - IED), but there are many generic factors: efficacy of treatment and evacuation.

This article draws upon experience in recent conflict in Iraq and Afghanistan, but seeks universal conclusions, and demonstrates their application to NHS practice.

From the Point Of Wounding (POW) on any battlefield back to definitive hospital care, there is a "chain of survival", and as with any chain, the casualty's chances of survival are dependent on the weakest link.

The excellence in clinical care now provided by our Defence Medical Services results from critical analysis of every link in that chain, and the resulting success depends on many factors.

The Advanced Trauma Life Support (ATLS) algorithms have saved many lives. The military has adapted them as BATLS (Battlefield), and it was realised that the greatest threat to a wounded soldier was not airway obstruction, but exsanguination from catastrophic haemorrhage.

**Advance 1**: A new algorithm for resuscitation

The ABC algorithm was changed to CABC, with treatment of ***Catastrophic Haemorrhage*** taking clinical precedence.

It is a statement of the obvious that the sooner a casualty receives treatment, the more likely he is to survive, yet as recently as the Falklands War, this was not given significant priority.

**Advance 2**: Training

Every soldier must pass an annual First Aid test, and carry an Aide Memoir that uses the CABC algorithm to "talk" him through how to administer that First Aid. Every tenth soldier receives enhanced "Team Medic" training, and all formations are accompanied by Combat Medical Technicians ("Medics") who can initiate resuscitation.

**Advance 3**: Control the bleeding on the battlefield

.**Advance 3a**: the Combat Application Tourniquet (CAT).

In order to treat Catastrophic haemorrhage, every soldier carries two CATs. These are designed to be applied with one hand, so that the soldier who has lost an arm can apply the tourniquet to the injured limb using his remaining hand. Worries about ischaemic limb damage due to prolonged application of tourniquets have not been borne out in practice.

**Advance 3b**: For open wounds, coagulating agents such as Hemcon, Quickclot and Celox, either as powders to pour into wounds, or as impregnated bandages to pack into cavities, have transformed haemorrhage control. Finally, the improvement of the old First Field Dressing (an elastic bandage and pad used as a pressure dressing) means that compressible haemorrhage is now readily manageable.

The Improvised Explosive Device (IED) predominantly causes injury to the lower limbs and it was soon noted that a blast capable of causing lower limb amputations carried a risk of also causing pelvic fractures in 14% of single amputations and 31% of double amputations.

**Advance 3c**: A pelvic binding sling is now routinely applied to all cases of lower limb amputations in order to control pelvic haemorrhage.

Treatment of trauma must address the Lethal Triad: "the mutually perpetuating combinations of acute coagulopathy, hypothermia and acidosis seen in exsanguinating trauma patients". Hypo perfusion leads to reduced delivery of oxygen, a switch to anaerobic metabolism, lactate production and a metabolic acidosis. Anaerobic metabolism limits endogenous heat production, exacerbating hypothermia caused by exposure of injured areas and injudicious administration of cold resuscitation fluids and blood. Evacuation at high speed in a helicopter, with an icy gale blowing through the open gun doors compounds the problems and this risk of hypothermia directly predisposes to coagulopathy. Between 37-33 degrees, platelet adhesion and aggregation is reduced, and below 33 degrees core temperature, coagulation cascade enzymes are strongly inhibited.

**Advance 4**: Control the temperature

During evacuation, the casualty is wrapped in a thermal blanket, and all IV fluids are passed through a warming device (Enflow) in order to enter the body at 37 degrees.

The prime cause of death in otherwise survivable trauma is exsanguination. It would seem obvious that the treatment of blood loss is blood transfusion, but as late as 2011, only the British Forces routinely did this.

**Advance 5**: Use blood to treat blood loss

This is done with "Shock Packs" of four Packed Red Blood Cells (PRBCs) and four thawed Fresh Frozen Plasma (FFP) units in a ratio of 1:1 on the basis of "permissive hypotension". This means transfusing the casualty only up to a level that maintains a palpable radial pulse (equivalent to a systolic pressure of 80mmHg). This minimises hypoxaemia without risking re-bleeding or "blowing off" a healing clot.

Intravenous access to a shocked patient in a helicopter flying fast and "tactically" is difficult, therefore extensive use was made of intra-osseous access, principally to the sternum, though humeral, tibial and iliac sites were also used. In experienced hands, sternal IO siting was almost as quick as IV access. This procedure was particularly valuable where the casualty was a child.

**Advance 6**: Recognise and treat coagulopathy.

In the hospital at Camp Bastion, we trialled the ROTEM machine: Rotational thromboelastometry. This gives the anaesthetist a real-time assessment of the patient's state of coagulation. To treat or prevent coagulopathy, platelets are added in a ratio of 1 unit to every 5 PRBCs, to maintain a platelet count of over $100{,}000 * 10^9$

Blood is used on the basis of "last in (fridge) first out" because use of PRBCs with increased storage age is associated with increased risk of infection and multiple organ failure.

An effective treatment for severely coagulopathic patients: one unit was given to the patient "on the hoof" from a passing nurse. Our Live Donor Panel consisted of pre-screened personnel working in the Hospital, and within fifteen minutes, blood would be out of the donor and into the patient.

Citrate in PRBCs chelates calcium. Hypocalcaemia is common in critically ill patients and is associated with increased mortality. Calcium levels of 0.6-7 mmol/l are thought to contribute to coagulation defects, so calcium supplements were given to maintain a level of at least 0.9mmol/l.

**Advance 7**: Apheresis

Platelets have a shelf life of four days. In case of re-supply problems from the UK, Bastion had an apheresis machine, and could harvest platelets from the Live Donor Panel on demand.

Recombinant Factor VIIa was available but rarely used. Having to use it was regarded as a marker of failure to adequately manage coagulopathy.

**Advance 8**: Rapid Sequence Intubation (RSI)

Management of the airway in an unconscious patient is of critical importance, particularly in those with head injuries. All doctors in the Medical Emergency Response Team, (MERT) were capable of carrying out RSI in the back of the helicopter. This enabled them to give high flow rate oxygen, and minimise cerebral hypoxaemia.

**Advance 9**: Damage Control Surgery (DCS)

The first eight Advances comprise Damage Control Resuscitation, which aims to present the patient to the surgeon in the best possible condition to undergo DCS.

DCS limits intervention to life-saving procedures including securing haemostasis, thorough debridement of wounds to prevent sepsis, and open reduction and external fixation of fractures.

**Advance 10**: "Right turn resus"

The Theatre in Bastion was next door to the Emergency Department (ED). Patients in extremis were brought in through the ED and immediately took a "right turn" into Theatre, but the ED staff would accompany the patient into the Theatre and continue resuscitation whilst the surgeons started DCS.

**Advance 11**: Communicate, Command, Control

The best clinical care is useless if it is in the wrong place at the wrong time. A vital link in the Chain of Survival was the ability of the troops on the ground to relay rapid and accurate clinical information back to HQ through a standard signal format: the "9 Liner", so called because it consists of nine lines of information. This enables the Patient Evacuation Control Cell (PECC) to despatch the appropriate clinical response speedily and efficiently.

On return to the hospital, the MERT doctor briefs the trauma team in approximately 30 seconds using another standard format: MIST A-T. This tells them the Mechanism of injury (e.g.: gunshot wound), the Injury sustained (gunshot wound left thigh, no exit wound), the Signs and Symptoms (using the CABC format) plus D for Disability of the CNS (unconscious) and E for other signs. The Age (child or adult) and Time of wounding complete the brief. Furthermore, if the casualty had needed blood in flight, the aircrew would signal ahead: "Op Vampire", a code word to alert the hospital to standby with further Shock Packs.

The MIST AT brief is given to the whole team, but then the Trauma team leader, always a senior clinician, takes over and directs the therapeutic interventions.

All clinicians worked to Clinical Guidelines on Operations (CGOs): a solid evidence base. In theory this might be thought to restrict clinical freedom; in practice it was a rapid and effective induction aid for ensuring that clinicians from many parts of the UK health service, and also from other nations (USA, Denmark) all used the same regimes and protocols.

At the start of this article, I made the bold statement that the British Military Hospital in Camp Bastion was (and remained so until its closure) the best Trauma Hospital in the world, ever. There are more than fifty scoring systems for the classification of trauma patients. Using the NISS (New Injury Severity Score) and TRISS (Trauma and Injury Severity Score) it is possible to predict the likelihood of survival. Beyond a certain score, patients are not expected to survive. Bastion had an "unexpected survivor" rate of 14%, in other words 14 out of every hundred patients who were expected to die did not. That those soldiers lived rather than died reflects the standard of care they received at every link in the Chain of Survival. In comparison, the US unexpected survivor rates were only half of the Bastion ones (due to doctrinal constraints imposed at a high level, and not due to failings of individual clinicians).

So, military medicine has shown what can be done; what are the implications for the NHS?

Some of the advances have indeed been adopted, for instance, all hospitals must now have a Massive Transfusion policy, and the experience gained in treating poly trauma is now concentrated in Regional Trauma Centres. Air ambulances are experimenting with carrying blood for in-flight resus. What the NHS has singularly failed to do is adopt the military ethos of command, control and leadership, or perhaps more accurately, and sadly, it has abandoned what ethos it had when I started my NHS career thirty seven years ago.

**This article reflects my personal views, as a non-specialist, of the advances in Damage Control Resuscitation and Surgery which provided the clinical outcomes that support my claim of excellence. My views are my own and not necessarily those of the Ministry of Defence.**