Treatment at Point of Injury – A Proposal for an Enhanced Combat First Aider and Health Technician Skillset

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Abstract

Management of trauma in the future operating environment might be significantly different from the recent experience in the Middle East Region if it were to occur in the context of hostilities between coalition, including Australian forces and a near-peer or peer-level threat. Specifically, reliance on rotary-wing aeromedical evacuation may be compromised if air superiority is degraded or denied.

Two alternative approaches may be considered in the context of constrained evacuation capability. First, enhanced treatment of the injured soldier on the ground at or near the point of injury by first responders may broaden the window during which a patient may survive on the battlefield awaiting evacuation. Alternatively, moving the surgical resources to the casualty may also improve the chances of survival for an injured soldier. However, this comes at the cost of risking higher-level assets. The first of these approaches is considered here with an exploration of what life-saving interventions (LSI) can be delivered by first responder soldiers.

Numerically dropping as a result of tactical combat casualty care principles but persisting as causes of preventable battlefield death, exsanguinating extremity haemorrhage, tension pneumothorax and airway obstruction are areas where future gains may be possible with an expanded skillset deliverable by combat first aiders and health technicians.

Earlier administration of blood products by health technicians to casualties with exsanguinating haemorrhage would align military trauma management principles with the civilian world, where blood products can now be administered en route by trained paramedics. Similarly, there is a shift towards managing tension pneumothorax with finger thoracostomy in preference to needle decompression in the hospital and pre-hospital environment in the civilian sector.

Of much greater complexity, management of non-compressible truncal haemorrhage remains problematic on the battlefield. A highly specialised intervention with significant haemodynamic consequences that nevertheless has been shown to be achievable in both military and civilian contexts is REBOA (resuscitative endovascular balloon occlusion of the aorta). This technique is encumbered with a significant training burden but warrants discussion and is most relevant when evacuation times are expected to fall between 1 and 6 hours.

Expanding the skillset deliverable by combat first aiders and health technicians may offset delays in evacuation and maintain battlefield casualty survival in the future operating environment and may be obtained leveraging existing Defence training programs.

Background

Contemporary treatment of traumatic military injuries in the Middle East Region (MER) has been facilitated by rapid evacuation and transfer of injured soldiers to higher-level care, primarily utilising rotary-wing aeromedical evacuation (RWAME) with relative impunity against an air-inferior enemy. Air transport is a highly efficient way of transporting casualties to medical care. The adoption of expedited helicopter casualty transfers to mobile army surgical hospitals during the Korean War reduced the time from injury to surgical care to 1–2 hours from 10 hours compared to World War II.[1]

Future health planning needs to consider an environment whereby RWAME may be restricted in movement capability. To that end, exploring alternative approaches to the surgical management of injured soldiers is pertinent.

In short, two alternative approaches may be considered. First, enhanced treatment of the injured soldier on the ground at or near the point of injury with the associated resource, training and logistic implications that carries may broaden the window during which a patient can survive on the battlefield. Alternatively, positioning the surgical resources closer to the patient may also improve the chances of survival for an injured soldier. However, this comes at the cost of risking higher-level assets and considerable force protection and load capacity are required. The first of these approaches is considered here.

Persisting causes of death on the battlefield

Since the introduction of tactical combat casualty care (TCCC), initially developed for the US Special Forces in the mid-1990s,[2] the numbers of fatalities from the three leading causes of battlefield death have decreased significantly in comparison to deaths from these causes in the Vietnam War, Korean War and World War II. Overall, however, exsanguinating extremity (compressible) haemorrhage, tension pneumothorax and airway obstruction remain in the order of 9%, 5% and 1% of preventable deaths on the battlefield.[3]

Even if these three pathologies are eliminated as causes of death in a perfect model of point of care treatment, non-compressible haemorrhage will, by definition, remain a significant cause of potentially preventable death in the absence of surgical intervention. New techniques to address this issue in a minimally-invasive (and non-surgeon dependent) manner exist and have been demonstrated successfully in both the civilian[4] and military trauma settings.[5]

The skill set of a military trauma surgeon

An ADF general surgical clinical skillset for operational readiness has been developed for general surgeons once a casualty arrives at a medical treatment facility (MTF).[6] However, treatment at the point of injury will dictate outcome more so than upskilling deployed surgeons and a consideration of what can be done, by whom, and in the field follows.

Existing trauma management skillset outside a medical treatment facility

All Australian Regular Army (ARA) personnel undergo a four-day Army first aid training course and TCCC training. TCCC training is reiterated as part of force preparation and on deployment during reception, staging and onward movement (RSO) at an intermediary staging base upon deployment. Specific trauma-related procedural skills taught under the auspices of TCCC comprise tourniquet application for uncontrolled extremity haemorrhage, packing of junctional wounds and applying a three-sided occlusive chest seal with a one-way valve (SAM seal/Ferno) for open chest wounds.

Further training provided as a twelve-day course equips non-medical corps ARA members to function as Combat First Aider (CFA) in addition to their primary employment category. Personnel trained to this level are integral roughly within every section and are capable of an expanded skillset of initial diagnosis and treatment. CFA training goes above and beyond standard Army first aid to include advanced intervention and treatment as outlined in the TCCC handbook, including needle thoracocentesis/needle decompression for tension pneumothorax and intravenous cannulation. Given that these personnel function primarily within their own employment category, CFA's (and other non-medical soldiers) will almost always be the first responder on scene at the point of injury, prior to the arrival of an ADF medic (medical/health technician).

In the Army Reserve, employment as Combat Medical Attendant (CMA) exists with the training continuum commencing with Advanced Combat First Aider (ref Health Manual, Volume 8, Chapter 4, annex 4F). The intent is that a CMA is capable of providing basic pre-hospital care as a first responder; however, CMA's are only to deploy on low-level non-warlike operations, and this employment category is not considered further here for that reason. Additionally, these members have no medical background in their civilian roles. On the other hand, combat paramedics are Army Reserve members with a civilian paramedic background and will be integrated into the new employment category ECN368 (see below).

Health technician

The medical technician ECN category within the ADF is in the process of being updated. These personnel will, in the future, be known as health technicians (HLTH TECH, ECN 368). Training of these practitioners takes 14–18 months. At the end of the training continuum, HLTH TECH will possess a TAFE qualification in Nursing and be capable of addressing several life-saving traumatic injuries affecting airway, breathing and circulation. Training for the specific skillset expected of a HLTH TECH will be provided at the Army Logistics and Training

Centre (ALTC) located at Latchford Barracks. The source documents specifically related to trauma management include the Primary Clinical Care Manual (PCCM) 10th edition (2019), produced by the Rural and Remote Clinical Support Unit, Torres and Cape Hospital and Health Service, Cairns and the TCCC handbook.

'Assessment and management' of trauma is specified as a requisite skill in the job task profile document for all employment categories as HLTH TECH (ECN368), from first employment via either Paramedic or Nursing stream. These generic statements are in accordance with the HLTH TECH Scope of Clinical Practice (SoCP) outlined variously in the PCCM, TCCC matrix and the Defence Health Manual. A draft combined document outlining these respective SoCP is presently under consideration at the Directorate of Army Health as a central source document. It is recognised that trauma management is categorised as 'very difficult'; however, it is also considered to be 'critical' to training.

Advanced Medic HLTH TECH (ECN368-34) are expected to lead the resuscitation of a casualty and be capable of providing prolonged field care. Training in higher level of TCCC, in addition to assisting in minor surgical operations, applying and caring for casting/splinting and wound care with skin closure is provided after Initial Employment Training (IET) for this group. Beyond that, sergeant and warrant officer HLTH TECH have extended administrative (but not clinical) skill training requirements.

A small and highly selected group of HLTH TECH equivalents throughout the ADF, such as HLTH TECH Underwater Clinician (HT-UC), are currently trained and expected to perform advanced emergency care clinical procedures, including insertion of an endotracheal airway, surgical cricothyroidotomy, thoracostomy tube insertion, finger thoracostomy, familiarisation of ventilation of patient using closed circuit ventilator and administration of blood and blood products.

General HLTH TECH are familiar with thoracostomy and chest tube insertion with underwater seal drain for pneumothorax and can assist medical staff in completing this procedure (although they are currently not trained to perform it directly). Application of a pelvic binder is also taught as well as general resuscitative measures such as supplemental oxygen delivery, spinal immobilisation and intravenous/intraosseous access.

It is recognised that on warlike operational deployment, conditions of employment may be of long duration in austere conditions in a potentially hazardous threat environment. It is anticipated that there may be limited logistic and technical support such that the HLTH TECH may be required to work as a sole practitioner, far removed from technical support.

Recommended areas of upskilling

Although not medically trained, the CFA is currently able to deliver a targeted set of life-saving interventions (LSI) (in addition to their core employment duties). As the first responder, the CFA has the potential to save a life within minutes of injury in even the highest-risk environment. Of the immediate traumatic threat to life, the use of the combat application tourniquet (CAT) to control exsanguinating extremity haemorrhage has saved countless lives in the MER over the past two decades.[7] This skill is appropriately disseminated widely to all deployed ADF members and is to be commended.

Tension pneumothorax and finger thoracostomy

Tension pneumothorax and airway obstruction are the next two most common causes of preventable death. Appropriately, management of both of these life-threatening conditions is currently likely first attended to by the CFA. It is not anticipated to be practical, feasible or appropriate to consider teaching further surgical or endotracheal approaches to the compromised airway to non-medical staff, and no further upskilling in this area is foreseen.

However, management of tension pneumothorax may be suboptimal due to using only needle thoracocentesis, which may result in technical and clinical failure due to variable thickness of the chest wall, kinking of the catheter or anatomic complications such as puncture of intercostal vessels or other structures. Additionally, the optimal position of a needle to attempt decompression is now recognised as the 5th intercostal space in the mid-axillary line (rather than the 2nd intercostal space in the mid-clavicular line).[8]

The ATLS course (10th edition) recognises these issues and advises that finger thoracostomy is an appropriate alternative to needle decompression. Indeed, the Victorian State Trauma System guidelines for traumatic cardiac arrest in hospital place finger thoracostomy ahead of needle decompression in the management algorithm of suspected tension pneumothorax[9] referenced from the Australian and New Zealand Committee on Resuscitation.[10] Finger thoracostomy must be followed by intercostal catheter insertion; however, the life-saving intervention is decompression of the pleural space by thoracostomy and chest tube insertion may be delayed if necessary in a tactical military environment. Of note, chest tube insertion was administered by a US resuscitation team in nearly 10% of interventions of 173 casualties reported from the MER published 2017[11] and is therefore not infrequently indicated.

Equally, Ambulance Victoria also recognises the urgent need for finger thoracostomy (and do not mention needle decompression at all) in their clinical practice guideline for managing traumatic chest injury by highly trained air ambulance paramedics.[12] If there is an anticipated delay of pleural decompression, then needle decompression may be considered as a bridging procedure; however, for the aforementioned reasons, this is not ideal.

Finger thoracostomy is currently within the skillset of the HLTH TECH 'Underwater Clinician' category, so the training required is already embedded within Defence training capability. It is recommended that to prepare for treatment at the point of injury in a future contested operating environment (with denied access to early evacuation), consideration must be given to upskilling all HLTH TECH ECN's to deliver this life-saving intervention in preference to needle decompression further forward to minimise preventable loss of life secondary to tension pneumothorax.

Haemorrhage control and blood product transfusion

Junctional haemorrhage continues to represent a significant cause of potentially preventable battlefield death.[3] Haemorrhage in this anatomical region is not amenable to CAT application; however, haemostatic compounds have a role and are applicable on deployment. On the other hand, recommendations for fluid resuscitation have undergone a significant change in civilian practice, with the earlier institution of blood product transfusion now widely established in civilian protocols.

The Ambulance Victoria Clinical Practice Guideline recommends early administration of packed red cell concentrate (PRCC) during resuscitation for hypovolaemic shock, or a priori if hypovolaemic shock is associated with measured anaemia (Haematocrit<30) or in patients with severe anaemia (Hct<21). The usual dose is between 1 and 5 units, preferably delivered via a fluid warming device.[12]

CFA personnel capable of obtaining IV access should be supported by HLTH TECH capable of proceeding to PRCC transfusion in a patient suffering hypovolaemic shock from trauma. The additional load burden of carrying 1–5 units PRCC (plus a lightweight, compact, easy-to-use warming device) should not be arduous or inappropriate for a HLTH TECH and would align with current civilian trauma management practices.

Spinal immobilisation

One area of significant divergence from civilian trauma management guidelines is in regards to spinal immobilisation. This initially arose from a finding that only 1.4% of casualties suffering military traumatic (primarily penetrating) injuries to the neck may have benefited from spinal immobilisation during the Vietnam War.[13] This finding is replicated in UK casualties from Afghanistan where although the mechanism of injury was primarily explosive force in more than ¾ of casualties (anticipated to be associated with a higher probability of cervical spine injury), ultimately only 1 of 56 survivors (1.8%) sustained an unstable cervical spine injury requiring surgical stabilisation (this patient later died due to head injury).[14]

Severe trauma to the neck is invariably associated with severe head injury and high mortality, such that mandatory spinal immobilisation in a high-threat environment is likely to incur more risk to the casualty and responders than any benefit it may provide. As such, spinal immobilisation does not require further undue attention and is rarely indicated in military trauma.

Areas for familiarisation

Rare and extreme LSI in which HTLH TECH should have exposure and familiarisation include resuscitative thoracotomy (RT) for thoracoabdominal trauma and lateral canthotomy for ocular trauma. Familiarisation regarding indication, contraindication and outcome is justified to fully equip the HLTH TECH to function as part of the advanced resuscitation team at higher-level care.

RT should only be performed by adequately trained trauma surgeons or retrievalists in appropriately equipped locations. The pericardial window at RT is associated with a survival opportunity. HTLH TECH should be aware of what is involved in preparing to assist (if required) a trauma surgeon upon delivery of a patient with cardiac tamponade, as this may be performed in a resuscitation bay of an MTF.

Similarly, a lateral canthotomy for ocular trauma and globe at risk may preserve eyesight but should only be performed by an appropriately trained clinician. Assistance at this procedure is reasonably within the expected skillset of a HLTH TECH and may be performed in a resuscitation bay.

Tailored Trauma Upskill (TTU) training

Rather than recommending training all HLTH TECH to the level of HT-UC, an abbreviated course to specifically target the skills of finger thoracostomy and blood product administration could therefore be designed for advanced HLTH TECH and would expect to be deliverable in as little as a one-week package. All Defence doctors are expected to complete the three-day ATLS/EMST course, which delivers much more than finger thoracostomy training indicating the academic and practical content required can be taught in this time frame to suitably selected candidates with existing trauma management training.

Linking a TTU course with subsequent clinical placement at a civilian trauma hospital would equip HLTH TECH with the skills, knowledge and experience to deliver these LSI on the battlefield. Clinical Placement Deeds between the Department of Defence and the relevant hospital networks are extant at various trauma centres around Australia to facilitate such clinical placements. A minimum two-week block would be expected to provide an opportunity to observe and perform a sufficient number of finger thoracostomies so as to render the candidate proficient in that specific skill.

Considerations for Special Forces

When extraction times and access to Role 2E MTF are anticipated to be between 1 and 6 hours, special consideration should be given to an expanded skillset of more invasive advanced procedures, only applicable or relevant to the special forces, and therefore not encumbering a high-volume training load. Anticipated extraction times beyond 6 hours contraindicate these measures secondary to futility.

REBOA

Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) is a haemorrhage-control adjunct that has been used by several Defence Forces (including the US Defence Forces) over the past decade.[15]

Non-compressible haemorrhage remains the leading cause of preventable death in combat.[7,16,17] Non-compressible trauma is categorised into intrathoracic (involves injury to heart, lungs, major vascular structures within the thorax and rib cage) or abdominopelvic (involves injury to solid organs and/or major vascular structures within the abdomen and pelvis).[18,19] REBOA is only appropriate for patients with major abdominopelvic and junctional trauma.

Non-compressible abdominopelvic and junctional trauma in combat casualties are particularly challenging in austere environments because of the inability to control haemorrhage by direct pressure. This progressively leads to hypotension, systemic shock and, ultimately, death. Demise is accelerated by attempts to volume resuscitate or cardiopulmonary resuscitation. Traditionally, the only way to resuscitate these patients would be the surgical application of vascular clamps across the aorta (resuscitative aortic occlusion) by an anterolateral or clam-shell thoracotomy or a laparotomy with supracoeliac control.[20] This allows direct control of the haemorrhage distal to the clamp site, increases cardiac afterload and improves perfusion to the heart and brain. However, these procedures have generally been conducted in an operating theatre by Specialist Medical Officers. There are usually significant delays in transfer time from the point of contact to the point of treatment. The procedures are maximally invasive and have a significant amount of associated morbidity and mortality.

REBOA is a minimally-invasive alternative to Resuscitative Aortic Occlusion in patients with major abdominopelvic injuries.[15] REBOA is a principle rather than a product. The technique involves accessing the common femoral artery by applying a modified-Seldinger technique using an ultrasound. An open cutdown exposing the common femoral artery is also appropriate, and access to the artery can be determined by the clinical state of the patient. A specialised endovascular REBOA balloon is then inserted into the common femoral artery and advanced into the descending thoracic aorta or infrarenal aorta (Figure 1). The final location for the site of inflation depends on the location of the injury, mechanism of injury and pattern of injury. To minimise the potential for incorrect placement, standardisation of field location can be taught by utilising consistent anatomic landmarks such as distance to the umbilicus. Once positioned, the balloon is inflated, thereby applying 'an internal tourniquet' within the aorta to reduce the extent of internal haemorrhage. REBOA allows temporary stabilisation of the haemodynamic state of the casualty using a minimally-invasive intervention, thereby creating a bridge to definitive surgical control of haemorrhage in an operating theatre or hybrid suite.

REBOA had initially been described in the mid-1950s during the Korean War by LTCOL Carl Hughes (US Army),[21] but was not adopted in trauma management until 2011 by COL Todd Rasmussen (US Air Force).[22] Animal models have demonstrated the effectiveness of REBOA for survival, with balloon (partial) occlusion times of up to 90 minutes.[23,24] REBOA was successfully used with London Helicopter Emergency Medical Service (HEMS) in a pre-hospital setting in 2014,[4] and has been successfully utilised in military austere situations.[5] REBOA has been utilised by the UK and US military but is not being implemented in the ADF yet.

The use of REBOA has traditionally been within the scope of trauma surgeons with considerable vascular surgical experience. However, aeromedical evacuation of combat casualties may not be as easy in future conflicts, and more responsibility for patient stabilisation may be necessary for HLTH TECH. This would warrant consideration of further upskilling for this group of first-line point-of-injury Medics.

Summary

By targeting just the highest value interventions at the immediate point of injury as areas to improve outcomes, upskilling CFA and HLTH TECH may be afforded with minimal training load but maximal impact regarding reducing preventable battlefield death.

Finger thoracostomy in preference to needle decompression of tension pneumothorax to be administered by CFA and HLTH TECH, and earlier administration of blood products by HLTH TECH represent the two highest value targets in this regard.

The training burden required can be minimised by leveraging and modifying existing training courses and supplementing these didactic and theoretical practice sessions with clinical rotations embedded in civilian trauma hospitals utilising existing Defence Deeds and Memoranda of Understanding.

REBOA as a specialty intervention to the highly trained HLTH TECH also represents an opportunity to save a life in the special operations domain when extraction times are anticipated to be between 1 and 6 hours. The introduction of new techniques to address non-compressible truncal haemorrhage such as this are, however, encumbered with a significant training burden but must be considered. Injudicious use may be counterproductive and worsen outcomes if inappropriately deployed. Earlier evacuation may render REBOA redundant if the casualty is moved within an hour and certainly renders this intervention futile if evacuation is not likely until beyond 6 hours.

Disclaimer: The views presented here are those of the authors and do not represent the views of the Directorate of Army Health or the Australian Army.

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