

## CONSENSUS STATEMENT 2018

### MANAGEMENT OF TRAUMATIC CARDIAC ARREST

#### 1. Introduction

- 1.1. Traumatic cardiac arrest (TCA) is a rare event typically associated with a poor outcome. Recent epidemiological data from the Trauma Audit and Research Network (TARN) reports an incidence of 0.6% for cardiac arrest associated with trauma, which includes patients who have sustained blunt or penetrating trauma, and those patients sustaining asphyxiation, electrocution, burns and drownings. (1) However, it is probable this figure underestimates the true incidence of cardiac arrest as the TARN database only includes patients admitted to hospital for more than three days, or require intensive or high dependency care or are transferred from other centres for further specialist care. Patients in whom resuscitation efforts for TCA were terminated in the pre-hospital setting or in the Emergency Department are not included in these figures.
- 1.2. Accurate data on outcome following TCA is hard to establish as there is significant heterogeneity in reported data, particularly with variability in the denominator due to a lack of consistency in the definition of cardiac arrest and the inclusion/exclusion criteria applied to the study populations. The majority of studies report overall survival rates between 5.1% and 7.7%. (2-5) Despite the high mortality associated with TCA, those patients who do survive appear to have a better neurological outcome than those with a non-traumatic cause of cardiac arrest. (6) Good neurological outcome is reported in 2 - 6.6% of patients who survive traumatic cardiac arrest. (5,7,8)
- 1.3. TCA is recognised as being distinct from medical cardiac arrests which frequently occur secondary to underlying cardiac pathology and there has been a move away from the provision of care based on standard Advanced Life Support (ALS).
- 1.4. The management of TCA patients remains controversial and has shifted in the last decade from withholding treatment on the basis of futility (9-11) to actively identifying and treating the cause of the arrest. The development of algorithms for the management of TCA have focussed on the provision of interventions specifically aimed at treating the

underlying pathology, reflecting the more common causes of TCA including hypovolaemia, hypoxaemia, tension pneumothorax and cardiac tamponade. (3,6,12,13)

1.5. The effectiveness of chest compressions in TCA has been debated and the most recent guidelines from the European Resuscitation Council (ERC) suggest that priority should be given to identifying and treating the cause of cardiac arrest rather than the initiation of chest compressions which may or may not be beneficial.(6)

1.6. The aim of this document is to provide guidance for the management of patients in traumatic cardiac arrest. A consensus meeting was held in September 2015, Birmingham UK. Expert opinion was assessed for the major issues associated with traumatic cardiac arrest including epidemiology, reversible pathologies, fluid administration, management of paediatric patients and the applicability of existing guidelines. There are significant barriers to the effective conduct of well-designed randomised controlled trials in pre-hospital emergency medicine and the majority of published evidence for the management of TCA is derived from observational, retrospective database studies, providing Level III evidence and as such, the majority of recommendations are Grade D recommendations. Large trauma registry studies are useful but there is a tendency to focus on interventions associated with potential benefit and how these interventions may be delivered. Significant heterogeneity between studies in terms of the patient population, inconsistency in the care provided, and varying endpoints make data interpretation difficult.(14)

## 2. Reversible Causes

2.1. The principles of management for TCA are focussed on the potentially reversible causes. Well-recognised advanced life support (ALS) resuscitation techniques including the use of chest compressions and fluid administration remain controversial in TCA management. The potentially reversible causes of traumatic cardiac arrest are considered to be hypovolaemia, hypoxia, tension pneumothorax and cardiac tamponade.(12) Depending on the mechanism of injury, these pathologies may occur in isolation or co-exist and all require rapid identification and treatment. Whilst use of chest compressions remains a standard of care for all patients, traumatic cardiac arrest may be best treated by interventions specific to the aetiology, and equal priority should be given to specific interventions. If ROSC is not obtained following these interventions chest compression should be immediately initiated.(6) If there is concern that the cause of the arrest is

medical then standard ALS protocols should be followed but if the arrest is traumatic in origin it may not be prudent to adhere fully to an ALS protocol

### 3. Hypovolemia

- 3.1. Traumatic cardiac arrest occurring secondary to major haemorrhage has a very poor prognosis.(3) The management of the hypovolaemic patient in cardiac arrest should focus on prevention of ongoing haemorrhage and achieving definitive surgical control.
- 3.2. Ongoing bleeding is managed with techniques such as direct compression, splinting of long bone and pelvic fractures, application of tourniquets and packing of wounds with haemostatic agents. The benefit of chest compressions in hypovolaemic traumatic cardiac arrest has been challenged. Studies in dogs have demonstrated that chest compressions do not improve survival in hypovolaemic cardiac arrest.(15) Spinal shock may precipitate cardiorespiratory arrest secondary to ventilatory failure and often presents with low blood pressure that could be confused with hypovolaemia. The pulse rate and mechanism of injury may guide diagnosis but chest compressions should be continued in the face of ambiguity.
- 3.3. Resuscitative emergency thoracotomy should be considered in the management of non-compressible haemorrhage. Whilst there is some evidence for use of this technique in penetrating trauma (16), its role in blunt trauma remains unproven with very poor outcome reported.(17) Other complex techniques such as Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) are being trialled for the early aggressive management of non-compressible haemorrhage but whilst the feasibility of this procedure as an immediate resuscitation technique has been demonstrated and initial studies suggest improvements in the haemodynamic status of the patient and central perfusion, it is associated with complications such as ischaemic injury and procedural error.(18-20)
- 3.4. The choice of resuscitation fluid has been the subject of debate and to date, the consensus has been to use isotonic saline as the first line fluid in cautious boluses of 250ml in hypovolaemic trauma patients until a radial pulse can be palpated.(21) (22) The use of blood and blood products has become more common in the pre-hospital setting and their inclusion in a 'care bundle' to control haemorrhage on scene has been suggested.(23) However whilst the use of pre-hospital red blood cells have been associated with an improvement in the rate of return of spontaneous circulation following

traumatic cardiac arrest, a survival benefit has not been demonstrated (24,25) and further studies are warranted.

***Recommendation 1. Hypovolaemic cardiac arrest should be managed with aggressive haemorrhage control and early surgical intervention.***

***Recommendation 2. Chest compressions may be interrupted in order to provide definitive treatment of hypovolaemia.***

#### 4. Hypoxia

4.1. Hypoxia precipitating a cardiac arrest or peri-arrest state can occur following major trauma and is usually the result of significant neurological, chest or abdominal trauma resulting in airway obstruction, ventilatory failure, reduced level of consciousness or traumatic asphyxia. Adequate oxygenation and ventilation must be immediately provided using basic or advanced airway interventions, depending on the skillset of the provider. Where advanced airway techniques are not available, meticulous attention must be paid to the provision of basic interventions.

4.2. The withdrawal of the skill of tracheal intubation from the majority of UK paramedics by the Joint Royal Colleges Ambulance Liaison Committee (JRCALC) Airway Working Group (26) has resulted in increased use of supraglottic airway devices and the efficacy of these compared with tracheal intubation is currently being assessed in the AIRWAYS-2 study.(27)

4.3. The effect of positive pressure ventilation on venous return in patients with potential compromise such as those with hypovolaemia, tension pneumothorax or cardiac tamponade should be considered prior to tracheal intubation and appropriately managed with bilateral thoracostomies at the earliest opportunity.

***Recommendation 3. Definitive airway management with a tracheal tube should be achieved at the earliest opportunity if the healthcare provider is adequately trained in this intervention. If advanced airway support cannot be provided then basic airway support using airway adjuncts and bag valve mask ventilation should be performed.***

#### 5. Tension Pneumothorax

5.1. Tension pneumothorax has been reported in 13% of patients who are in traumatic cardiac arrest and 37% have been shown to have inadequate or no chest decompression.(28) A tension pneumothorax is relatively straightforward to treat and definitive treatment can be immediately effective. Tension pneumothoraces must always be rapidly excluded in

any traumatic cardiac arrest. Simple thoracostomy with or without the initial placement of a tube is a more effective treatment than needle decompression. Decompression using a cannula is often unsuccessful; a 14G cannula (45mm in length) may not penetrate the chest wall in more than one third of trauma patients.(29) The technique of needle thoracostomy is also prone to complications including displacement, obstruction and kinking;(30) conversion to definitive thoracostomy is often required.

***Recommendation 4. Bilateral thoracostomies should be performed in traumatic cardiac arrest to rule out tension pneumothoraces. These should be made using a surgical technique and a thoracostomy tube sited once the patient is stabilised.***

## 6. Cardiac Tamponade

6.1. Traumatic cardiac tamponade describes the acute accumulation of blood within the pericardial cavity. Whilst the majority of cases of cardiac tamponade are secondary to penetrating trauma, cardiac injury has been described into up to 20% of patients involved in road traffic collisions (RTCs) (31) and this pathology should be considered in patients with significant blunt chest trauma.

6.2. The definitive treatment for traumatic cardiac tamponade causing a cardiac arrest is a resuscitative emergency thoracotomy. This procedure is most effectively performed using a clamshell technique and should be carried out by adequately trained personnel within 10 minutes of loss of cardiac output.(32) Resuscitative emergency thoracotomy is a time-critical event and survival is improved the earlier the intervention is performed for patients in traumatic cardiac arrest.(33) Estimated survival rates for emergency thoracotomy are 8.3% for patients who present to the Emergency Department without signs of life (defined as absent pupillary reflexes, spontaneous ventilation, presence of carotid pulse, measureable or palpable blood pressure, extremity movement, or cardiac electrical activity) following penetrating thoracic trauma, and 4.6% following blunt trauma. Good neurological outcome was reported in 3.9% of patients who sustained penetrating trauma and 0.1% of blunt trauma patients. The likelihood of survival depends, in part, on the injury sustained, patients with gunshot wounds have a worse outcome than those with stab wounds.(6) In one series reporting the use of pre-hospital resuscitative emergency thoracotomy for penetrating cardiac trauma the overall survival rate was 18%, with 11 of the 13 survivors were neurologically intact. The majority of patients who survived had single stab wounds to the right ventricle.(34)

***Recommendation 5. Resuscitative emergency thoracotomy should be performed for patients with penetrating trauma to the chest or epigastrium within 10 minutes of loss of cardiac output.***

7. Paediatric Traumatic Cardiac Arrest

7.1. Traumatic cardiac arrest in children is rare and the reported survival rates vary with some studies reporting similar results to those found in adult studies, 5-8.8% (35,36) and other studies reporting more favourable survival rates of 25%.(37) It is likely this discrepancy reflects differences in defining 'cardiac arrest' and the inclusion or exclusion of patients in whom resuscitation efforts were terminated in the pre-hospital setting, as with adult studies. A recent systematic review on traumatic cardiac arrest reported a survival rate of 13.6% in paediatric patients compared with 7.2% in adult patients.(5) There is also a statistically significant difference in survival for blunt trauma patients compared with penetrating trauma patients of 26.2% and 2.2% respectively. The majority of survivors of paediatric traumatic cardiac arrest are found in the group of patients who experience profound hypoxaemia precipitating a respiratory arrest and subsequent cardiac arrest.(35,38)

8. Withdrawal or termination

8.1. Despite survival from traumatic cardiac arrest being universally reported as poor, the rate is comparable to survival from non-traumatic out-of-hospital cardiac arrest. (39) There has been much debate over when to withdraw or terminate resuscitation efforts. The publication of some studies reporting improvements in survival rates and improved resuscitation techniques have weakened the argument to withhold treatment based on futility. In 2003 the National Association of EMS Physicians and the American College of Surgeons Committee on Trauma published guidelines for withholding or terminating resuscitation in prehospital TCA (9) However, these guidelines have been questioned as survivors have been identified amongst patients who the guidelines suggest should not be resuscitated, particularly penetrating trauma patients who undergo on scene thoracotomy.(3,40) Several studies have examined data for prognostic factors associated with survival, which include a shockable rhythm as the arresting rhythm,(10,41) and blunt rather than penetrating trauma,(41,42) In contrast to other studies, one study reported survivors in the group of patients who sustained penetrating trauma and underwent pre-hospital emergency thoracotomy.(3) The location of the cardiac arrest may also influence

outcome and those patients who do not have a cardiac arrest until after arrival at hospital have an improved survival rate of up to 25.6%.<sup>(43)</sup> Whilst prognostic information is useful it is unlikely to influence time-critical decision-making in the immediate resuscitation phase. The ERC guidelines suggest resuscitation efforts should be withheld if there are no signs of life in the preceding 15 minutes or there is evidence of massive trauma incompatible with survival – decapitation, penetrating heart injury loss of brain tissue. Termination resuscitation efforts should be considered if there is no ROSC after reversible causes have been addressed, or no detectable cardiac activity on ultrasonography.<sup>(6)</sup>

## 9. Summary

9.1. Traumatic cardiac arrest is associated with a poor outcome but improvements in the delivery of care both in the pre-hospital setting and in-hospital are reflected in small improvements in survival rates. There are certain pathologies, which may precipitate traumatic cardiac arrest and require rapid and effective treatment, which varies from conventional treatments for other causes of cardiac arrest. Algorithms have been developed to focus on the provision of simultaneous interventions, which specifically target reversible causes. Termination of resuscitation efforts should be carefully considered as survivors have been identified in groups of patients in whom termination of resuscitation efforts were previously considered appropriate.

## **Summary of recommendations**

**Recommendation 1** - Hypovolaemic cardiac arrest should be managed with aggressive haemorrhage control and early surgical intervention.

**Recommendation 2** - Chest compressions may be interrupted in order to provide definitive treatment of hypovolaemia

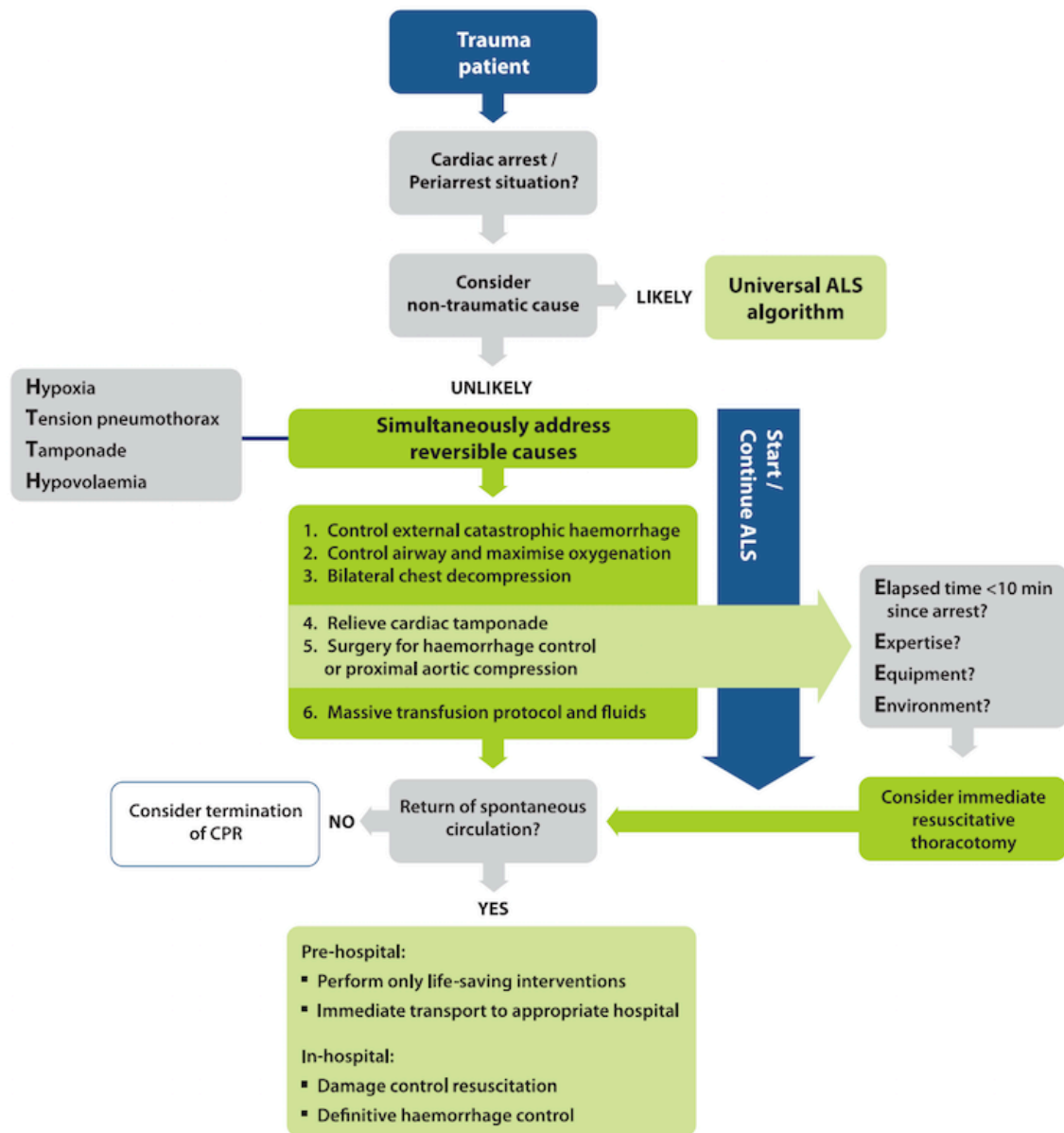
**Recommendation 3** - Definitive airway management with a tracheal tube should be achieved at the earliest opportunity if the healthcare provider is adequately trained in this intervention. If advanced airway support cannot be provided then basic airway support using airway adjuncts and bag valve mask ventilation should be performed.

**Recommendation 4** - Bilateral thoracostomies should be performed in traumatic cardiac arrest to rule out tension pneumothoraces. These should be made using a surgical technique and a thoracostomy tube sited once the patient is stabilised.

**Recommendation 5** - Resuscitative emergency thoracotomy should be performed for patients with penetrating trauma to the chest or epigastrium within 10 minutes of loss of cardiac output.



Figure 1: European Resuscitation Council algorithm for the management of traumatic cardiac arrest 2015 (6)



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