6301.02: TRAUMATIC CARDIAC ARREST ADULT

INTRODUCTION

Previous EHS Clinical Practice Guidelines (EHS 6220.04 Cardiac Arrest Overview) include traumatic cardiac arrest (prior to EMS arrival) as a scenario whereby EHS crews should consider NOT initiating resuscitative efforts. This recommendation was based on the 2013 National Association of EMS Physicians (NAEMSP) and the American College of Surgeons' Committee on Trauma (ACSCOT) joint position statement for withholding or terminating resuscitation in adult cardiopulmonary arrest caused by trauma[1]. Best available evidence at that time suggested resuscitation efforts in this context are typically futile.

In the interim, additional research has suggested that a more aggressive approach towards resuscitation in this setting is warranted, and clinical care guidelines are changing for the patient in cardiac arrest secondary to trauma. EHS ground ambulance clinical practice guidelines (CPGs) are continually being revised to align with the most contemporary evidence based recommendations, in conjunction with other systems of care such as the Nova Scotia Trauma Program.

The European Resuscitation Council Guidelines[2] describe that while mortality from traumatic cardiac arrest is very high, if ROSC can be achieved these patients have a much better neurological outcome compared to survivors from other cardiac arrest etiologies[3,4]. These guidelines endorse a new treatment algorithm to prioritize life-saving measures in the setting of trauma (e.g. controlling hemorrhage and correcting hypoxia), all of which take priority over chest compressions.

While previous studies had indicated that survival rates post cardiac arrest due to blunt trauma were very low (approximately 2%), more contemporary research across a range of settings demonstrates survival rates of 5-8%.[5] It had previously been thought that patients with penetrating trauma had better survival rates than those with blunt trauma; however, registry data indicates this may not be the case.[5] Evans *et al* (2016) also reports reversible causes being the same between blunt and penetrating etiologies, suggesting that decisions regarding transport and treatment should be similar in both. It is also important to note that the greatest possibility for survival after traumatic cardiac arrest exists for patients who have vital signs present on EMS arrival; care should continue to be aggressive for these patients.

SAFETY

In situations where trauma has occurred, the clinician should ensure the scene is safe to protect the clinicians, patients and bystanders. Through the Medical Communications Centre, activate appropriate resources such as the fire department, HazMat, law enforcement and/or Nova Scotia Power if required.

Clinicians should keep themselves safe by donning personal protective equipment (PPE), including a helmet, high-visibility outerwear, eye protection and hand protection when indicated. Apply personal protective equipment to reduce exposure to bodily fluids and aerosolized particles.

Clinician safety also involves being aware of the risk of occupational stress injury when attending calls involving major trauma (or any other call). Studies have shown that paramedics and other health care workers who have experienced or witnessed trauma are more prone to Post Traumatic Stress Disorder (PTSD). Occupational stress injuries can be acute (witnessing or experiencing one traumatic event) or cumulative (response to multiple traumatic events). Much like physical injury, preventative measures prior to the precipitating event and early interventions post-event will help to reduce the risk of PTSD. Resources are available to assist clinicians who are involved with difficult calls (trauma and others). These include the Peer Support Team (which can be activated through the Medical Communications Centre), a confidential employee and family assistance program and a Health and Wellness coordinator who can provide assistance.

ASSESSMENT

Clinicians should aim to quickly determine if the cardiac arrest is likely due to major trauma or a medical etiology. If the patient is not peri-arrest or in cardiac arrest, standard EHS trauma CPGs should be followed.

In the setting of a likely medical cardiac arrest, or when unsure, clinicians should provide immediate chest compressions upon recognizing a patient who is unresponsive, has absent or agonal respirations,

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and no palpable pulse for 10 seconds. Refer to EHS CPG 6220.05: Cardiac Arrest Adult for management of cardiac arrest due to medical etiologies. Resuscitation in the setting of major trauma differs and is described below.

Decision to Not Start Resuscitation
The only predictor of increased chances of survival in the setting of traumatic cardiac arrest is the presence of vital signs at any time during the EMS course of care[5]. With this in mind, ECG rhythm, respiratory activity, and pupil reaction have all been excluded in EHS guidelines to determine if resuscitation is to be initiated. This aligns with previously published position statements from the American College of Surgeons and the National Association of EMS Physicians[6,7].

When any of the following conditions are present in the setting of major trauma, the paramedic crew should collaboratively consider not starting resuscitative efforts:

- ✓ No signs of life for 15 minutes prior to EHS arrival
- ✓ Trauma incompatible with survival, such as:
  - Decapitation
  - Transection
- ✓ Signs of prolonged death
  - Rigor mortis
  - Decomposition
  - Dependent lividity
- ✓ Valid directive indicating no resuscitation

MANAGEMENT OF CARDIAC ARREST DUE TO MAJOR TRAUMA

Management of the patient with a medical cause of cardiac arrest differs from management of the patient with cardiac arrest due to major trauma. It is possible that the patient may have had a primary cardiac event that lead to the trauma and the cause of ongoing cardiac arrest may be atraumatic. If the cause of arrest is thought to be likely medical, standard ACLS guidelines should be followed as the priority ahead of the traumatic arrest bundle of care outlined here. If the cause of the arrest is thought to be likely traumatic, the traumatic cardiac arrest bundle of care should be followed as the priority and ACLS guidelines may be initiated once resources allow.

Management of traumatic cardiac arrest prioritizes life-saving measures in the setting of trauma, such as controlling hemorrhage and correcting hypoxia, which take priority over chest compressions for the traumatic cardiac arrest algorithm. See Figure 1.

Resuscitate on Scene or On Route?
In the context of major trauma, shorter prehospital times are important for improving survival. Diagnostic tests/imaging, interventions, and definitive care are often time sensitive. Any interventions performed on scene should be considered essential and expedited to minimize delays to definitive care. That said, if the nearest facility is relatively distant (see below), additional resuscitative care on scene prior to transport is warranted. Consider both extrication and transport time when determining where the resuscitation should occur.

If vital signs are absent and there are no signs of life (i.e. no movement or respiratory effort) on EHS arrival, and the decision is made to start resuscitation, the patient is placed in one of the following 2 categories:

- If the patient can be transported to a level I, II or III facility within 20 minutes from the time the decision is made to initiate resuscitation, **transport immediately** to the highest level I, II or III facility and provide resuscitative efforts while en route.
- If the patient is farther than 20 minutes from a level I, II or III facility from the time the decision is made to initiate resuscitation, resuscitative care should be initiated on scene and **transport only if ROSC is obtained** or signs of life return.

Traumatic Cardiac Arrest Trip Destination When ROSC is Obtained on Scene
All traumatic cardiac arrest patients are considered major trauma patients. When ROSC is obtained, trip destination will follow the major trauma trip destination principles with regards to bypassing smaller facilities.

Other Considerations
A Trauma Team Activation must be requested for all transported patients within the trauma team catchment area.

Requesting LifeFlight be put on stand-by early is crucial as resuscitated patients might require critical care transport from a level II or III facility to a level I facility for multi-disciplinary trauma care. If ROSC is achieved, clinicians should launch LifeFlight if transporting to a facility other than a level 1 facility. In most cases LifeFlight will prepare for a possible interfacility transport as opposed to a scene mission.

If multiple patients are present, prioritize patients based on MCI START Triage guidelines.

In most cases transport to hospital will continue if a trauma patient loses vital signs enroute. Crews may consider MCCP consult if they feel ongoing transport is futile due to extended transport times.

Hemorrhage Control

As uncontrolled hemorrhage is one of the leading causes of traumatic cardiac arrest[8], temporary hemorrhage control is critical for increased possibility of survival[8] (**PEP 2 supportive**). For all cardiac arrests due to major trauma:

- Hemorrhage control is the top priority over fluid resuscitation.
- Treat compressible external hemorrhage with direct pressure and/or tourniquets as required.
- Apply a pelvic binder (to treat non-compressible hemorrhage) (**PEP 2 neutral**)
- Administer a 20 mL/kg fluid bolus
- Minimize delays to blood product administration.

Spinal Precautions

While traumatic cardiac arrest patients are at significant risk for cervical spine trauma, the priority is to address life threatening injuries with the bundle of care outlined here. Cervical spine immobilization (either manual or C-spine collar application) should not take place until the traumatic arrest bundle of care is completed and/or resources allow for this to be addressed. That said, while managing higher priority life threats clinicians should make efforts to minimize movement of the cervical spine at all times. It is impossible to "clear the C-spine" in this setting so care is taken both before and after the C-spine collar is applied. C-spine immobilization is not required in the setting of penetrating trauma unless there is suspicion for spinal injury.

Hypoxia and Chest Trauma Management

Traumatic cardiac arrest may be caused by asphyxia and/or hypoxia due to airway obstruction[9,10] therefore establishment of an airway and initiation of ventilation may reverse the cardiac arrest state. Decisions regarding airway management need to consider that tracheal intubation can be time-consuming, resource intensive, and more likely to cause episodes of hypotension and further hypoxia.

Traumatic cardiac arrest may also be caused by chest trauma leading to blunt or penetrating lung injury causing life-threatening hypoxia, or circulatory obstruction due to tension pneumothorax. Impaired circulation may also be secondary to cardiac trauma resulting in dysrhythmia, myocardial injury, or tamponade.

For all cardiac arrests due to major trauma:

- Insert a supraglottic airway (**PEP 2 neutral**). If the insertion of an i-gel is not possible due to the nature of the traumatic injuries or other circumstances, use bag mask ventilation (**PEP 2 supportive**) or endotracheal intubation.
- Provide positive pressure ventilations at a rate of 10 breaths/min and with low tidal volume in order to avoid hyperinflation and impeding venous return, thus avoiding further hypotension.
- $EtCO_2$ must be used and monitored, targeting a value of 35-45 mmHg.
- If pneumothoraces are considered possible, bilateral needle decompression should be performed (**PEP 2 supportive**) using a 14 gauge catheter in the mid-clavicular in the 2nd intercostal space or the 4th/5th intercostal space.
- Defibrillate any ventricular dysrhythmias as soon as identified. If the cause of the arrest is commotio/contusio cordis, or a primary cardiac event that led to the trauma, other management as described above may not be required.

Standard BLS or ACLS Care

The priority in traumatic cardiac arrests is to manage the reversible traumatic cause(s). Standard BLS care such as chest compressions do play a role once the above trauma bundle of care has been initiated[11]:

- Defibrillate any shockable rhythms as soon as identified (see Hypoxia and Chest Trauma Management section above)
- Initiate chest compressions (if resources are available)

The provision of any defibrillation or chest compressions should be done in accordance with standards outlined in the EHS Cardiac Arrest Adult CPG (e.g., quality metrics, energy level, etc.)

If a LUCAS device is available, it may be utilized. Even with the availability of a LUCAS device, chest compressions remain the last priority of care for the traumatic arrest patient. Applying a LUCAS device early may interfere with higher priority management. Once higher priorities are managed, the LUCAS device may be helpful during transport and improve provider safety.

PREHOSPITAL POST ARREST CARE (TRAUMA)

Primary and Secondary Survey

If resources allow, a full primary and secondary using the ABCDE approach survey should occur once a ROSC is obtained.

Titrated Oxygen

After a return of spontaneous circulation (ROSC), it is still important to avoid hyperventilating the patient. 10 ventilations per minute is most often adequate. Oxygen should also be titrated in order to achieve an SpO_2 between 94 and 99% while maintaining an $EtCO_2$ between 35-40 mmHg.

Further Hemorrhage Control

Tranexamic acid (TXA) may be administered after achieving ROSC. TXA is an antifibrinolytic medication that works by inhibiting the degradation of fibrin, the protein that forms the framework of blood clots. If given within 3 hours from the time of injury, tranexamic acid has been shown to decrease mortality in trauma patients with significant hemorrhage. It may actually increase the risk of death if administration is delayed beyond 3 hours. Refer to the Tranexamic Acid medication profile for specific indications and contraindications.

Treat hypotension

Clinicians should aim to keep the systolic blood pressure above 90 mmHg. Intravenous fluid can be used to maintain a patient's blood pressure at an acceptable level.

In the polytraumatized head injured patient, care must be taken to avoid hypotension, and the target blood pressure for fluid resuscitation is therefore a SBP of 110 mmHg. For trauma patients with hemorrhagic hypovolemic shock without a head injury, the target blood pressure for fluid resuscitation is a SBP of 90 mmHg. The role of vasopressors in hypovolemic shock secondary to trauma is unclear.

Management of Specific Body Systems

Any injuries noted can be managed using the pertinent EHS CPG. These may include Airway Management, Facial and Neck Trauma, Neurological Trauma, Torso and Pelvic Trauma, Extremity Trauma, Burns, or Shock.

Temperature Management

Both hypothermia and hyperthermia are harmful to traumatic arrest patients. Maintaining normothermia 36-38°C is recommended. Using passive warming or cooling may help maintain normothermia.

TRANSFER OF CARE

For patients **with ROSC** it is important to provide all relevant details to the receiving facility in terms of the resuscitation up to that time. It is expected that the emergency department will continue the post-arrest care of the patient including: temperature management, neurological, cardiovascular, and metabolic support, as well as potential transfer to the PCI lab. The clinician should state what measures have been (or have not been) taken in the pre-hospital setting. For example, stating 'no cooling has been started' may cue the staff to begin this process as soon as possible.

For patients **without ROSC** despite ongoing resuscitation, it is critical to ensure quality chest compressions during the transfer of care and to provide support as needed to the hospital team.

Early notification to the receiving facility is essential, so they can be prepared with appropriate resources and clinicians. It is acceptable to give an early radio patch with limited information and follow up with another radio patch when en route with further findings.

The verbal report to in-hospital staff should include details on scene findings, mechanism of injury, time of injury, initial assessment of the patient, changes in assessment and treatments provided.

If TXA was initiated in the prehospital setting, the clinician should ensure the receiving facility staff is aware of the time the initial bolus was administered and that there is a requirement for subsequent infusion.

ON-SCENE TERMINATION OF RESUSCITATION

Guidelines for Termination of Resuscitation (**PEP 2 neutral**)

Studies have demonstrated a large variance in mortality reported depending on factors such as age[3,10] and presenting rhythm[4,10,12,13,14], though neurologically intact survivors have been reported even in the setting of trauma patients presenting with apnea and pulselessness with no organized ECG activity[4].

If resuscitation has been provided on scene and no ROSC is obtained, contact MCCP to discuss further treatment/transport options or termination of resuscitation (TOR). MCCP consult is required prior to TOR on scene. The MCCP should be contacted after the trauma bundle of care and standard ACLS care have been provided.

TISSUE DONATION

If resuscitative efforts are not initiated or are terminated on scene, the clinician should tell the Medical Examiner if there are, or are no, contraindications to tissue donation (or if this is unknown).

CHARTING

When documenting a cardiac arrest in ePCR, there are a number of important details to include, such as:

- ✓ Patient identifiers, including age and gender, where possible
- ✓ Scene findings
- ✓ Estimated time of arrest (known or estimated)
- ✓ If the arrest was witnessed and by whom
- ✓ If resuscitation was attempted prior to EMS arrival and by whom
- ✓ Suspected etiology of the arrest (including mechanism of injury)
- ✓ Time of first shock given
- ✓ The rhythm on arrival at destination (if the patient is transported)
- ✓ If there was a ROSC and if it was sustained
- ✓ What interventions were done (including accurate times)
- ✓ Reversible causes that may have been considered
- ✓ A complete set of vitals if ROSC was achieved and sustained long enough to acquire them
- ✓ Any communication with MCC clinical team
- ✓ Reason(s) why resuscitation was terminated or not initiated
- ✓ Presence of a DNR/AND and/or identification of the Substitute Decision Maker and the patient's goals of care
- ✓ Pronouncement of death time

All data must be uploaded from the ZOLL X Series to the online server.

Key Points – Traumatic Arrest Resuscitation

Determine early transport or resuscitate on scene

Manage hemorrhage

Manage hypoxia and chest trauma

Defibrillate and initiate chest compressions as resources allow

KNOWLEDGE GAPS

Published evidence on the universal approach to cardiac arrests does not necessarily reflect the management of traumatic cardiac arrest. There are fewer studies on traumatic arrest care than medical etiologies, most of which may not necessarily reflect the same system of care as found in Nova Scotia.

It is not always possible to update all local resuscitation documents at the same rate at which international guidelines are changed. Please refer to current AHA guidelines for the most up-to-date information on resuscitation practices.

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Future research could be targeted towards the efficacy of chest compressions in traumatic cardiac arrest care vs. no compressions.

EDUCATION

Formal certification in PHTLS or ITLS will enable improved assessment and care for patients with major trauma, including those in cardiac arrest due to trauma. Practitioners are encouraged to maintain certification in these courses. Ongoing practice in scenario management can improve the care provided in a traumatic arrest situation.

QUALITY IMPROVEMENT

Reviewing resuscitation data and providing feedback to clinicians can help improve subsequent resuscitation efforts. The availability of cardiac monitor data through case push to the server is essential for quality improvement and is a key component of the Patient Care Record.

Complete and concise clinical documentation is important for communicating the care that was or was not delivered. All cardiac arrests where resuscitation was provided by EHS clinicians are reviewed for clinical performance. Performance measures are used to inform areas for system improvement and to identify where there may be gaps in education.

It is encouraged that clinicians report technological issues and patient safety concerns through occurrence reporting.

CONTRIBUTORS

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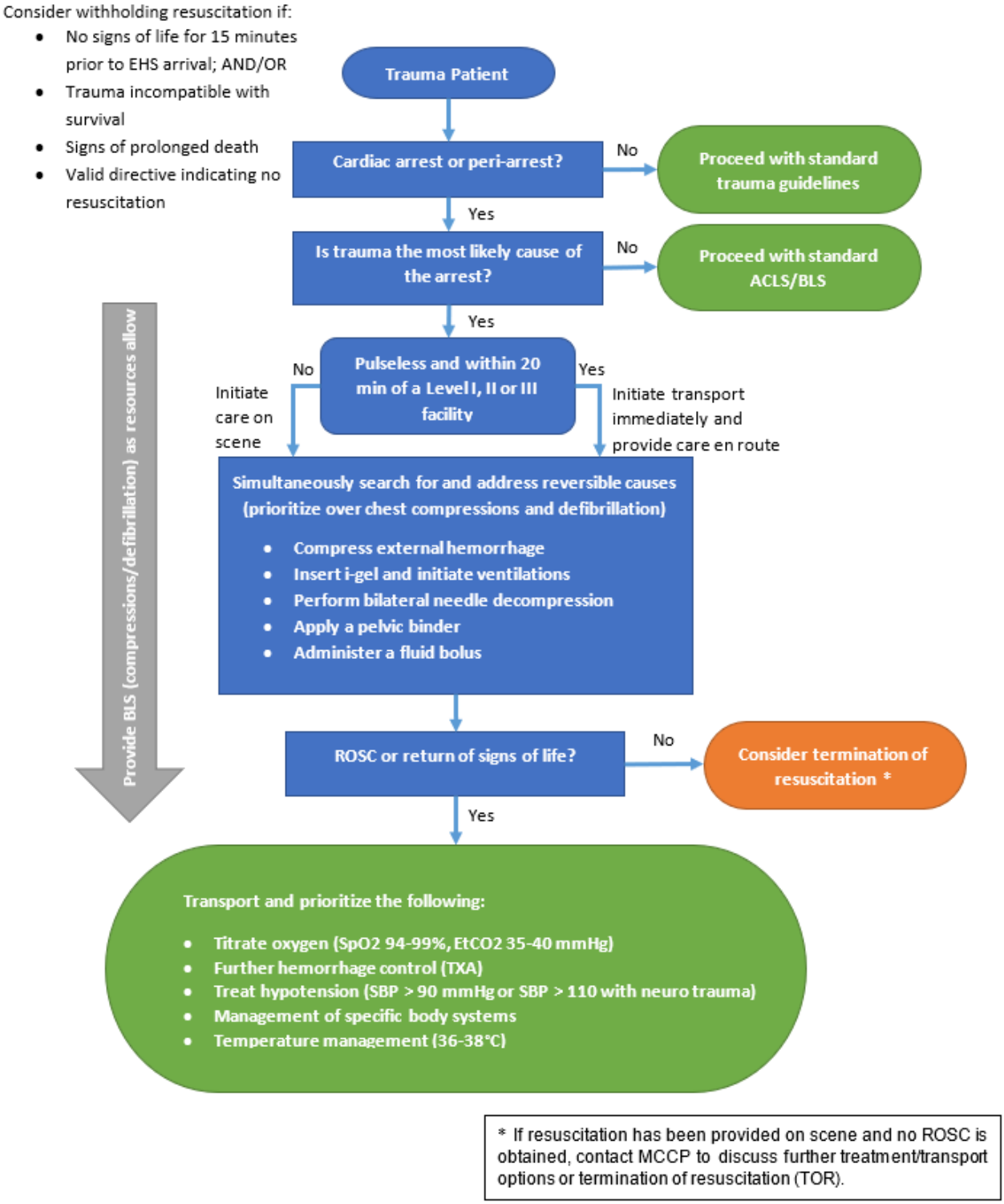
FIGURE 1: Out of Hospital Traumatic Cardiac Arrest Algorithm (Adult)



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PEP 3x3 TABLES for Adult OOHCA due to Major Trauma

Throughout the EHS Guidelines, you will see notations after clinical interventions (e.g.: **PEP 2 neutral**). PEP stands for: the Canadian **P**rehospital **E**vidence-based **P**ractice Program.

The number indicates the Strength of cumulative evidence for the intervention:
1 = strong evidence exists, usually from randomized controlled trials;
2 = fair evidence exists, usually from non-randomized studies with a comparison group; and
3 = weak evidence exists, usually from studies without a comparison group, or from simulation or animal studies.

The coloured word indicates the direction of the evidence for the intervention:
Green = the evidence is supportive for the use of the intervention; **Yellow = the evidence is neutral**; **Red = the evidence opposes** use of the intervention;
White = there is no evidence available for the intervention, or located evidence is currently under review.

PEP Recommendations for Traumatic Arrest Interventions, as of 2023/03/01. PEP is continuously updated. See: https://emspep.cdha.nshealth.ca/ for latest recommendations, and for individual appraised articles.

Traumatic Arrest

Recommendation		RECOMMENDATION FOR INTERVENTION			
		SUPPORTIVE (Green)	NEUTRAL (Yellow)	AGAINST (Red)	NOT YET GRADED (White)
STRENGTH OF EVIDENCE FOR INTERVENTION	1 (strong evidence exists)				
	2 (fair evidence exists)	• Blood transfusion • BVM • Hemorrhage control • HEMS • Optimal Trip Destination • POCUS • Thoracostomy	• Advanced airway • Needle Decompression • Pelvic Binding • Termination of Resuscitation (Blunt) • Termination of Resuscitation (Penetrating) • Thoracotomy	• Epinephrine • Spinal immobilization	
	3 (weak evidence exists)				

*PEP is the **Canadian Prehospital Evidence-based Practice** Program. Every clinical intervention is given a recommendation based on the strength of available research evidence (1 = randomized controlled trials and systematic reviews of RCTs; 2 = studies with a comparison group; 3 studies without a comparison group or simulation) and direction of the compiled evidence: **supportive** of intervention; **neutral** evidence for intervention; or **opposing** evidence for intervention). See: **https://emspep.cdha.nshealth.ca/***

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