H01: Principles of Major Trauma

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Reviewed:

Introduction

Trauma is one of the leading causes of death worldwide. In Canada, trauma is the leading cause of death in people under age 45 and accounts for approximately 16,000 deaths per year. Despite advances in trauma resuscitation, hemorrhage, shock and coagulopathy remain the main drivers of preventable death after trauma and are responsible for over 40% of all trauma-related deaths.

Initiation of "damage control resuscitation" in the prehospital environment has the potential to reduce complications associated to hemorrhage by intervening at the point of injury, and preventing or limiting the development of acute coagulopathy of trauma-shock (ACoTS). Adopted from damage control surgery, damage control resuscitation prioritizes rapid definitive hemorrhage control, permissive hypotension (in select patients), the minimal use of crystalloid fluid, and timely delivery of balanced blood products.

Essentials

- Rapidly obtain definitive hemorrhage control
- Maximize tissue oxygenation
- Prevent or limit the development of hypothermia
- Minimize the use of crystalloid fluid for volume replacement
- Initiate rapid transport to an appropriate lead trauma hospital

Referral Information

- Pre-hospital Triage and Transport Guidelines for Adult and Pediatric Major Trauma in BC

General Information

- Triage patients according to the Provincial Pre-hospital Triage Guideline decision tool, including Physiological Criteria, Anatomical Criteria, Mechanism of Injury Criteria, and Special Considerations.
- Assessment and stabilization should follow the CABCDE pattern: Circulation, airway, breathing, circulation, disability (neurologic status), exposure.

Interventions

First Responder

- Control external bleeding
  - → D02: Bleeding
- Consider spinal motion restriction based on clinical indications
- Provide appropriate airway management
  - → B01: Airway Management
- Prevent further heat loss
- Supplemental oxygen as required
  - → A07: Oxygen and Medication Administration

Emergency Medical Responder – All FR interventions, plus:

- Consider Auto Launch or Early Fixed Wing Activation. Transport urgently.
- Control external bleeding.

- → PR03: Tourniquets
- → PR04: Wound packing

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider IV access with minimal use of crystalloid fluid
  - → D03: Vascular Access
- Consider permissive hypotension in select patients
  - → D01: Shock
- Control suspected internal bleeding
  - → PR02: Pelvic Binders
  - Tranexamic acid in cases of shock secondary to blood loss, and occult bleeding secondary to hypovolemia
- Consider analgesia as needed
  - → E08: Pain Management

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Consider IV/IO access
  - → PR12 Intraosseous Cannulation
- Consider anesthesia planning and intubation as required
  - → PR18: Anesthesia Induction
- Consider analgesia as needed
  - → E08: Pain Management

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Consider point of care ultrasound (POCUS)
- Consider advanced anesthesia planning
- Consider balanced blood product resuscitation

Evidence Based Practice

General Major Trauma Care

H02: Crush Injuries

Tom Zajac

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Introduction

Crush injuries result from the entrapment of body parts by compressive forces, resulting in physical trauma and ischemia to tissues. These injuries are most commonly discussed in the context of collapsed structures, however crush injuries can occur even from a patient's own body weight.

If significant muscle mass is involved, crush syndrome can develop following the release of the compression; this is a potentially life-threatening, systemic condition. The major factors that lead to the development of crush syndrome include the degree of compressive force, the amount of muscle mass involved, and the duration of the compression.

The onset of crush syndrome occurs following the reperfusion of the injured muscle upon release. This may have both acute and delayed-onset clinical effects. The three main acute concerns are electrolyte imbalances, which may result in cardiac dysrhythmias (predominantly hyperkalemia), hypovolemia, and metabolic acidosis, both of which can cause shock. The delayed-onset effects include renal failure, acute respiratory distress syndrome, coagulopathies, and severe sepsis.

Delayed medical care or inappropriate rescue management, such as the uncontrolled and rapid removal of the compressive force prior to intervention, may result in rapid clinical deterioration and death of the patient.

Essentials

- Pre-treatment of crush injury prior to release of forces is essential. Failure to treat can result in death
- On advice of CliniCall, begin aggressive fluid management
- Electrolyte and dysrhythmia management should be undertaken as per license level
- Provide analgesia as appropriate

Additional Treatment Information

- Paramedics should consider the possibility of other, concurrent injuries beyond the crush, particularly hypothermia and other potential causes of shock.
- Crush injuries that occur in industrial settings, or in the context of a structural collapse or other disasters can come with significant hazards for paramedics. Scene safety is paramount – consider the risks of confined spaces, carbon monoxide, hypoxic environments, or toxic atmospheres.
- Additional pre-hospital resources should be sought early. Paramedics should also consider the need for field amputation in extreme causes – coordinate this through CliniCall.

Referral Information

All patients with crush should be transported to the closest appropriate trauma receiving hospital with dialysis capabilities per local trauma destination guidelines. Consultation with CliniCall or EPOS for destination advice is encouraged.

Interventions

First Responder

- Provide supplemental oxygen as required
  - → A07: Oxygen and Medication Administration
- Consider hypothermia. Protect patient from environment. Consider thermal protection, insulation from cold surfaces, and warming blankets as available/appropriate.

Emergency Medical Responder – All FR interventions, plus:

- Provide supplemental oxygen to maintain SpO2 ≥ 94%
  - → A07: Oxygen and Medication Administration
- CONSIDER APPLICATION OF A TOURNIQUET PROXIMAL TO THE INJURY SITE ON THE EXTREMITY WITH CLINICALL CONSULT (1-833-829-4099)
  - → PR03: Tourniquets
- Coordinate lift with treatments
- Consider waiting until higher licensed paramedic is on scene. Prepare for cardiac arrest on release of weight.

Primary Care Paramedic – All FR and EMR interventions, plus:

- Obtain vascular access where possible.
  - → D03: Vascular Access
- On consultation with CliniCall, normal saline IV, 2 L immediately prior to release of weight
- Consider salbutamol continuously by nebulizer
- Manage pain
  - → E08: Pain Management

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Obtain vascular access where possible:
  - → PR12: Intraosseous Cannulation
  - → PR13: External Jugular Cannulation
- Correct electrolyte disturbances:
  - Calcium chloride
  - SODIUM BICARBONATE (REQUIRES CLINICALL CONSULTATION (1-833-829-4099))
  - Caution: sodium bicarbonate and calcium chloride cannot be administered at the same time through the same IV/IO line

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Induce paralysis and facilitate ventilation if required. Use rocuronium for paralysis – succinylcholine is contraindicated in crush syndrome
- Intravenous dextrose and insulin (IFT to tertiary care on advice of EPOS)
- Mannitol 20%: May be considered once ongoing urinary production and output has been verified (IFT to tertiary care on advice of EPOS). Mannitol is contraindicated in anuric states.
- Kayexelate – sodium polystyrene sulfonate (when practical and if prolonged ITF transfer to tertiary care is expected on advice of EPOS)

Evidence Based Practice

General Major Trauma Care

Limb Amputation / Mangled / Major Hemorrhage

Extremity Trauma

References

1. International Search And Rescue Advisory Group. The Medical Management of the Entrapped Patient with Crush Syndrome. 2012. [Link]

H03: Head Trauma

Mike Sugimoto

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Introduction

In the prehospital environment, paramedics can encounter three different types of head injuries: scalp injuries, cranial fractures, and traumatic brain injuries. These can occur in isolation, but are commonly associated with each other, and are the result of blunt or penetrating trauma to the head. Head injuries are the most common cause of death and severe disability in trauma. Immediate post-injury management can have a profound effect on the patient's long-term prospects for both survival and recovery.

Essentials

- Hypoxia and hypotension, in conjunction with traumatic brain injury, are universally lethal conditions. It is imperative that paramedics work to maintain a normal blood pressure and oxygen saturation.
- Use intravenous fluids to target a mean arterial pressure of at least 80 mmHg (or a systolic blood pressure of at least 110 mmHg).
- Patients must not be hypo- or hyperventilated; paramedics must take all appropriate measures to protect the airway and ensure adequate oxygenation and ventilation at all times, up to and including supraglottic airway devices and endotracheal intubation.
- Seizures and vomiting are common complications of head injuries. Prepare to intervene as necessary.
- Except in the case of isolated penetrating trauma, head injuries are seldom isolated. Identify and manage other injuries concurrently.

Additional Treatment Information

- Select transport destinations in accordance with provincial and local trauma triage guidelines. In general, transport patients to facilities that have neurosurgical capabilities. Consider the use of Autolaunch or Early Fixed-Wing Activation where appropriate.
- Endotracheal intubation in head injuries remains fraught. The risk of hypotension and hypoxia in the peri-intubation period is significant, and adversely affects mortality. Paramedics electing to intubate patients with traumatic brain injuries must choose an induction strategy with those goals in mind.
- Moderate to severe traumatic brain injuries are often accompanied by injuries to other parts of the body. In these cases, paramedics must not neglect these injuries.
- Temperature control of patients with traumatic brain injuries can be challenging. Although the hazards of hypothermia in the context of trauma are relatively well understood, the injured brain is at equal risk from hyperthermia. Paramedics should strive to keep patients normothermic. If the patient is, or becomes hyperthermic, paramedics should promote passive heat loss. Do not begin active cooling.

General Information

- Traumatic brain injuries can be further classified based upon the degree of disability, as measured by the Glasgow Coma Scale.
  - A GCS greater than 13 is indicative of mild injury
  - A GCS that falls between 9 and 12 is suggestive of a moderate injury
  - A GCS below 9 is defined as a severe traumatic brain injury
- "Concussion" is a term that has been used synonymously with "mild traumatic brain injury" but more accurately describes the signs and symptoms experienced by an individual who has suffered a mild traumatic brain injury.
  - Signs and symptoms of a concussion include, but are not limited to: grossly observable loss of coordination, vacant stare, disorientation, delayed or difficult responses to questions, slurred speech, inappropriate emotional responses, and memory deficits. Headache, dizziness, nausea, and vomiting are common. These symptoms may immediately follow the traumatic injury, or may take hours to fully evolve.
  - Differentiating between mild traumatic brain injuries that require imaging and hospital evaluation and those

that do not is extremely difficult in the prehospital environment, and carries significant risk for paramedics. Therefore, as a general rule, patients who are "concussed" – who have experienced an alteration in mental status that may not necessarily be associated with a loss of consciousness – should be transported for further evaluation.

- Scalp lacerations are associated with extensive bleeding because the blood vessels of the scalp lack the ability to vasoconstrict as effectively as elsewhere in the body. Direct pressure is usually sufficient to control these types of wounds, but paramedics should be aware that open scalp wounds are occasionally the only indication of deeper, more serious injuries.
- Caution should be exercised in elderly patients, or individuals taking anticoagulant medications: relatively minor mechanisms of injury can cause significant (and catastrophic) hemorrhage that may be undetected during the initial assessment.
- The skull is a relatively strong body part and so cranial injuries, including basilar skull fractures, require a significant amount of force. Battle's sign (raccoon eyes) is a late finding in these patients; its absence does not exclude the possibility of a basilar fracture.
- Cerebral herniation is a complication of traumatic brain injury where the rising intracranial pressure begins to push the cerebrum caudally, obstructing the flow of cerebrospinal fluid and compressing the brainstem. Signs include a falling level of consciousness, dilation of the pupil and an outward-downward deviation of the eye on the affected side, paralysis of the arm and leg on the opposite side, and decerebrate posturing. Patients may yawn, sigh, take intermittent deep breaths, or progress to Cheyne-Stokes respirations.
- Trismus is commonly seen following severe traumatic brain injuries. In the majority of cases, these patients can be effectively ventilated using good bag-valve mask techniques, though suctioning can be difficult and adjunct placement may be impossible.
- Mean arterial pressure can be calculated by the formula ((DBP x 2) + SBP) / 3, and is in general a more meaningful measure of cerebral perfusion than systolic blood pressure alone.

Interventions

First Responder

- Protect and maintain the patient's airway. Consider potential for vomiting based on level of consciousness. Provide supplemental oxygen as required.
  - → A07: Oxygen and Medication Administration
  - → B01: Airway Management
- Control external bleeding.
  - → D02: Bleeding
- Consider spinal motion restriction based on mechanism of injury and physiological abnormalities.

Emergency Medical Responder – All FR interventions, plus:

- Provide supplemental oxygen to maintain SpO2 ≥ 94%
  - → A07: Oxygen and Medication Administration
- Where possible, elevate head to 30 degrees from horizontal
- Avoid obstructing venous return in the neck: loosen cervical collars, ties, or other mechanical obstructions around the neck
- Initiate transport. Consider ACP intercept.
- Measure capillary blood glucose sample

Primary Care Paramedic – All FR and EMR interventions, plus:

- Obtain vascular access
  - → D03: Vascular Access
- Maintain blood pressure. Target MAP of 80 mmHg (or systolic blood pressure of 110 mmHg). Do not exceed 2 L total volume.
- Correct hypoglycemia only if present:
  - → E01: Hypoglycemia and Hyperglycemia

- Dextrose intravenously. Target > 4 mmol/L. Do not exceed 12.5 g total dextrose, and do not use D10W as primary line or for medication administration.

- Consider antiemetic
  - DimenhyDRINATE
- Consider supraglottic airway device if needed to protect airway or facilitate ventilation.
  - → PR08: Supraglottic Airways

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Control seizures if actively seizing:
  - MIDAZOLam
- Consider sedation if patient is combative and unable to provide appropriate airway management:
  - KetAMINE
- Intubate if necessary
  - → PR18: Anesthesia Induction
  - Caution: do not allow peri- or post-intubation hypotension or hypoxia. If unable to maintain blood pressure or oxygen saturation, consider placement of extraglottic airway as a temporizing measure.
- Ventilate as necessary to maintain $SpO_2 \geq 94\%$. Monitor $EtCO_2$; attempt to maintain $EtCO_2$ between 30 – 35 mmHg. Do not hyperventilate.
- If signs of cerebral herniation are present, titrate ventilatory rate to $EtCO_2 < 30$ mmHg for a maximum of 15-30 minutes.
  - CliniCall consultation is mandatory. Hyperventilation requires continuous end-tidal CO_2 monitoring and **must not be attempted by paramedics who lack appropriate training and equipment**.

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Anesthesia:
  - Phase 1
    - Secure airway if required. Use an appropriate induction strategy and intubation procedure based on patient and environment specificity.
    - EPOS orders are required for paralytic use. Post-call consultation permitted for RSI in emergency situations.
  - Phase 2
    - Deep sedation is required. Target RASS -5 without complete or burst suppression.
    - Propofol is the preferred agent for phase 2 anesthesia.
    - Use narcotic analgesia as required.
    - Use EEG-guided anesthesia if appropriate.
    - Maintain neuromuscular blockade as required.
    - EPOS orders are required for paralytic use. Post-call consultation permitted for RSI in emergency situations.
- Manage hemodynamic instability:
  - Target MAP greater than 80 mmHg but less than 100 mmHg, and systolic blood pressure greater 100 mmHg.
  - Crystalloid and/or vasopressor administration may be required.
  - Consider short term phenylEPHRine administration.
  - For long term support, consider NORepinephrine.
  - Hypotension associated with traumatic brain injury should generally not be treated in the out-of-hospital setting with anti-hypertensive drugs. If severe hypertension occurs with a sustained systolic blood pressure above 160 mmHg, contact EPOS for LABETalol or hydrALAzine.
  - If hemoglobin is below 90 g/L, transfuse PRBC if available.
- Optimize cerebral venous out-flow:
  - Raise head of bed to 30°.
  - Promote venous drainage (e.g., cervical collars, ETT ties loose, trans-pulmonary PEEP of 0 cmH2O, trans-pulmonary plateau pressure less than 25 cmH2O).
  - Maintain neck neutrality.
  - If no esophageal balloon in place, set PEEP 5-12 cmH2O.

- Decompress stomach if required.

- Mechanical ventilation strategies:
  - BVM with PEEP valve: maintain adequate oxygenation while preserving adequate cerebral venous drainage.
  - Ensure oxygenation goals are being met. (SpO2 > 97%, PaO2 100-150 mmHg.)
  - Ensure ventilation goals are being met. (EtCO2 35-40 mmHg, PaCO2 35-40 mmHg.)
  - Minimize Pplats while maintaining ventilation goals.
- Control seizure activity:
  - Consider etiology and patient presentation when selecting appropriate agent:
    - MIDAZOLam
    - Propofol
  - Consider the side effect of hypotension: pressors may be required to maintain hemodynamic goals.
  - Consider the utility of phenyTOIN for seizing and seizure prophylaxis. Treat based on the etiology, patient presentation, and transport context. (Prophylaxis indicated for penetrating head injuries, depressed skull fractures, or a seizing patient.)
- Monitor for signs of raised ICP:
  - ONSD of < 6 mm after patient optimization.
    - If < 6 mm treat with osmotic therapy
      - If Na < 150 mEq/L: hypertonic saline or mannitol/HTS 100 mL every 5-10 minutes with continuous monitoring of ICP.
      - If Na > 150 mEq/L: Mannitol 0.5 g/kg with continuous monitoring of ICP.
      - Watch for diuretic effects. Be prepared to replace volume loss at 1:1 ratio.
      - EPOS orders are required for the use of hypertonic saline.
- Monitor for signs of cerebral herniation:
  - Neurological exam findings:
    - Unilateral pupillary dilation considered to be related to a rise in intracranial pressure.
    - Decorticate or decerebrate posturing.
    - Seizure activity.
  - With signs of herniation:
    - Osmotic therapy: hypertonic saline 3-5 mL/kg bolus, or mannitol 1 g/kg.
      - EPOS orders required for hypertonic saline.
    - Short trial of hyperventilation to PaCO2 25-30 mmHg.
    - Contact receiving hospital with updated patient status.
- Other monitoring parameters:
  - Maintain normothermia: 36-37.5°C.
    - Use fluid warmer for hypothermic patients.
    - Institute passive cooling measures and antipyretics for hyperthermic patients.
  - Maintain Na+ between 140 and 150 mEq/L.
  - Maintain capillary blood glucose between 6-10 mmol/L.
- Arterial or venous blood gas analysis:
  - Adjust mechanical ventilation to ensure adequate oxygenation, appropriate ventilation, and safe ground ventilating parameters.
- Consider anti-emetic administration:
  - DimenhyDRINATE
  - Metoclopramide
  - Ondansetron
- Other considerations:
  - Avoid steroid use.

Evidence Based Practice

Traumatic Brain Injury

Head Injury

References

1. Alberta Health Services. AHS Medical Control Protocols: Adult Head Injury. 2020. [Link]
2. Carney N, et al. Guidelines for the Management of Severe Traumatic Brain Injury, Fourth Edition. 2017. [Link]

H04: Eye Injuries

Rob Evans

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Introduction

Eye trauma can result from wide-ranging causes such as direct eye injury or chemical exposure. These can be life-altering events for patients. Any patient with an eyesight-threatening injury should be transported promptly for specialist assessment. Treatment for eye injuries is centered around recognition of the mechanism of injury, the provision of supportive care, and rapid transport.

Patients may present with minor symptoms yet still be experiencing injuries with potential long-term consequences.

Prehospital care is centered on recognizing the mechanism of injury, providing supportive care and rapidly transporting in the case of eyesight threatening trauma. Patients with minor symptoms may still be experiencing injuries with long-term consequences that may not be apparent during prehospital assessment.

Essentials

- In cases of direct eye trauma, cover both eyes and keep the patient at rest
- Remove contact lenses if present and not adhering to the cornea
- If condition permits, elevate the patient's head during transport
- Avoid placing pressure on the eye globe while packaging and transferring the patient
- In cases of chemical exposure, begin irrigation with normal saline while attempting to identify the substance. Bring relevant documentation (e.g., MSDS sheet) with the patient to hospital. Contact CliniCall for support in managing chemical exposures.
- Provide analgesia and antiemetics as required

Additional Treatment Information

- Maintain a high index of suspicion for other injuries in the case of direct trauma including head & spinal injury as well as facial fractures
- Vomiting increases intraocular pressure so early administration of anti-emetics is beneficial
- Penetrating objects should be left in place and should be stabilized as appropriate
- If condition allows, assess visual acuity in each eye
- Do not delay treatment or transport to assess visual acuity

Referral Information

All patients with ocular trauma should be transported for specialist assessment.

General Information

- If available, an injured eye should be covered with a rigid shield.
- Patients with eye injuries associated with other facial fractures may have specific considerations for air transport if they are being transferred. Associated sinus fractures may result in complications such as pneumocephalus and may present complications when changes in atmospheric pressure occur. Contact Clinicall for guidance if the patient is undergoing air transport as part of care.

Interventions

First Responder

- Keep patient at rest

- Identify source of ocular injury (and chemical substance if appropriate)
- Initiate irrigation with normal saline for chemical injury or other injuries associated with contamination of the eye
  - → PR05: Patient Decontamination

Emergency Medical Responder – All FR interventions, plus:

- Cover both eyes with a rigid shield if available and clinically indicated
- Transport patient with head elevated if condition allows
- Administer analgesia:
  - → E08: Pain Management
  - Nitrous oxide

Primary Care Paramedic – All FR and EMR interventions, plus:

- Treat or prevent nausea and vomiting:
  - DimenhyDRINATE
- Provide analgesia:
  - Ibuprofen
  - Acetaminophen
  - KetAMINE

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Provide analgesia:
  - FentaNYL
  - KetAMINE
- Treat or prevent nausea and vomiting:

Evidence Based Practice

Ocular Trauma

References

1. Alberta Health Services. AHS Medical Control Protocols: Adult Eye Injury Management. 2020. [Link]
2. Ambulance Victoria. Clinical Practice Guidelines: Ambulance and MICA Paramedics. 2018. [Link]

H05: Spinal Cord and Neck Trauma

Ryan Ackerman

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Introduction

Spinal cord injuries (SCI), while relatively rare, contribute significantly to morbidity and disability among those affected. Spinal motion restriction (SMR) must be undertaken on any patient who is at risk for SCI. Traditional SMR devices, such as cervical collars and rigid immobilization boards, carry risks of their own and should not be applied without a clinical indication to do so.

Contemporary care for potential SCI patients does not need to be an "all or nothing" approach, but instead should be patient centric. At all times the risks of applying SMR should be weighed against its benefits for each individual patient.

Cervical spine injuries are often the sole source of focus; attention must be paid to thoracic and lumbar injuries as well.

Essentials

- The mechanism of injury alone is not an accurate predictor of spinal column/cord injury.
- The NEXUS c-spine clearance tool may be used for adult patients.
- NEXUS only applies to cervical spine injuries. Thoraco-lumbar injuries must be assessed separately.
- Factors such as intoxication, altered levels of consciousness, language barriers, and major distracting injuries can all confound the assessment of spinal injuries.
- Only multi-trauma patients or those with new onset neurological impairment require transport on a clamshell stretcher.

Additional Treatment Information

- Known risks associated with SMR include: airway compromise, respiratory restriction, pressure ulcers, decreased cardiac output, vomiting/aspiration, increased intracranial pressure, pain, increased scene time and more complicated ER management.
- Elderly patients (age > 65) are at greater risk for spinal fractures from lower force injuries. Careful attention must be paid to thorough assessment with any trauma above the clavicles.
- Penetrating trauma requires rapid transport. SMR has been shown to increase mortality in these patients.
- Early and frequent focused neurological assessments (motor, sensation) may help monitor an evolving injury.
- Spinal cord injuries often require higher perfusion pressures to overcome swelling. Target a systolic BP of 120 mm/hg or greater in patients with clear signs of neurological deficit.

General Information

- NEXUS Criteria:
  1. Does the patient have midline tenderness of the cervical spine?
  2. Is the patient's level of consciousness altered? (Must be alert and oriented to time, person, place, and events.)
  3. Are there new focal neurological deficits?
  4. Is the patient intoxicated? (Judgement and pain sensation must be intact.)
  5. Is there a major distracting injury significant enough to interfere with their ability to assess pain response when palpating spine?
- If the answer to all five NEXUS questions is "no," SMR is not warranted.
- Thoracolumbar injuries: If the patient does not require SMR based on the NEXUS criteria but has any of the following findings do not sit the patient up or raise the head of the stretcher on the assumption that thoracic or lumbar injuries may be present:

- Fall from height > 3m
- Axial loading to head or base of spine
- High speed MVI >100 kph
- Rollover MVI
- New back deformity, bruising or bony midline tenderness

Interventions

First Responder

- Apply spinal motion restriction as clinically indicated
- Supplemental oxygen as required
  - → A07: Oxygen and Medication Administration

Primary Care Paramedic – All FR and EMR interventions, plus:

- Treat nausea/vomiting:
  - DimenhyDRINATE
- Correct hypo-perfusion/hypotension:
  - → D03: Vascular Access and Fluid Administration
  - For suspected or confirmed spinal cord injury target systolic BP of 120 mmhg or greater

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Secure airway if required.
  - → PR18: Anesthesia Induction

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Manage hemodynamic instability:
  - MAP > 80-85 mmHg for isolated spinal cord injury.
  - In cases of distributive shock, early vasopressors may be required to maintain a higher than normal MAP to ensure spinal cord perfusion.
  - Crystalloid and/or vasopressor administration may be required.
    - PhenyLEPHRine.
    - DOPamine.
    - NORepinephrine.
- If mechanical ventilation is required, refer to mechanical ventilation procedure guideline.
- Maintain appropriate blood glucose levels.
- Arterial or venous blood gas analysis:
  - Adjust mechanical ventilation to ensure adequate oxygenation, appropriate ventilation, and safe ground ventilating parameters.

Evidence Based Practice

Spinal Injuries

References

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H06: Chest Trauma

Rob Evans

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Introduction

Management of chest injuries represents a challenge in prehospital care. Common chest trauma injuries seen by paramedics include rib fractures, flail chest, simple pneumothorax, hemothorax, open pneumothorax and tension pneumothorax. Paramedics must maintain a high index of suspicion for underlying life-threatening injuries is critical necessary, as many patients may present with initially stable vital signs.

Essentials

- Closely monitor all patients with chest trauma for signs of deterioration, with particular attention to respiratory status. Be prepared to support oxygenation and ventilation as necessary.
- Be suspicious of the potential for underlying torso injuries in cases of high mechanisms. Injuries to the great vessels, diaphragm, abdominal organs, and the myocardium can occur.
- Differentiate between blunt and penetrating mechanisms of injury.
- Place a commercial vented chest seal (preferred) or occlusive dressing taping on 3 sides to seal open chest wounds.

Additional Treatment Information

- Sealing of open chest wounds may place patients at risk for tension pneumothorax.
- Monitor these patients closely and relieve pressure by lifting the chest seal or occlusive dressing if a tension pneumothorax is potentially developing.
- Entonox is contraindicated in patients with suspected pneumothorax or inhalation injury.
- Decompression of a suspected tension pneumothorax should be rapidly performed in patients with deteriorating respiratory and hemodynamic status (ACP/CCP).
- Positive pressure ventilation may worsen clinical status in patients with untreated tension pneumothorax.

Referral Information

Follow the appropriate BCEHS Provincial Major Trauma Triage Guideline as appropriate to the local response area. Use Auto Launch or Early Fixed Wing Activation processes as indicated.

General Information

- Palpation of the chest wall, axilla and neck can be helpful in feeling the presence of subcutaneous air
- CPAP is contraindicated in the patient with suspected pneumothorax

Interventions

First Responder

- Position patient sitting if other injuries permit
- Perform basic airway interventions and be prepared to provide ventilatory support as needed
  - → B01: Airway Management
- Administer high flow oxygen
  - → A07: Oxygen and Medication Administration
- Rapidly apply a chest seal to an open pneumothorax if present

Primary Care Paramedic – All FR and EMR interventions, plus:

- Insert supraglottic airway as indicated to support oxygenation and ventilation
  - → PR08: Supraglottic Airways
- Consider vascular access
  - → D03: Vascular Access
- Tranexamic acid if indicated

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Perform needle decompression in a patient with signs of decompensating obstructive shock secondary to a suspected tension pneumothorax
  - → PR21: Needle Thoracentesis
- Consider advanced airway management as necessary to support oxygenation and ventilation in deteriorating patients
  - → PR18: Anesthesia Induction
- Manage cardiac dysrhythmias associated with myocardial injury as indicated
  - → C02: Bradycardia
  - → C03: Narrow Complex Tachycardia
  - → C04: Wide Complex Tachycardia
- Administer analgesia as necessary
  - → E08: Pain Management

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Perform ultrasound assessment for pneumothorax
- Consider rapid sequence intubation for patients requiring oxygenation and ventilator support
- Secure and manage chest drainage system in the interfacility transfer environment as necessary

Evidence Based Practice

Chest Trauma

References

1. Ambulance Victoria. Clinical Practice Guidelines: Ambulance and MICA Paramedics. 2018. [Link]
2. Alberta Health Services. AHS Medical Control Protocols. 2020. [Link]
3. Campbell JE, et al. International trauma life support for emergency care providers. 8th edition. 2016.
4. Greaves I, et al. The trauma care pre-hospital manual. 2018.

H07: Abdominal Trauma

Ryan Ackerman

Updated: December 14, 2020
Reviewed:

Introduction

Abdominal trauma is one of the major causes of preventable death. Whether blunt or penetrating, the possibility of intra-abdominal injury must be recognized and treated in a timely fashion.

All types of abdominal trauma carry the risk of significant hemorrhage and infection. Blunt abdominal trauma carries a mortality rate of up to 30% and can prove challenging to assess in the pre-hospital environment. Penetrating trauma is easier to identify, is more often a true surgical emergency, and has a lower mortality rate than blunt trauma.

For both blunt and penetrating abdominal injury, the mainstays of treatment are virtually the same: rapid recognition and rapid transport, gentle patient handling, minimal crystalloid fluids to maintain vital organ perfusion, and early administration of tranexamic acid.

Essentials

- Abdominal distension is often a late sign and is indicative of severe intra-abdominal bleeding
- Penetrating trauma from the nipple line to the umbilicus may result in both chest and abdominal injuries
- Early TXA administration for suspected intra-abdominal bleeding is associated with decreased mortality rates
- Aggressive fluid resuscitation in abdominal trauma is associated with higher mortality rates. Titrate fluid administration to achieve normal mentation, peripheral pulses or a systolic blood pressure of 80-90 mmHg.

Additional Treatment Information

- Retro-peritoneal hemorrhage, often from damage to the kidneys or their supplying vasculature, may be difficult to detect and can produce life-threatening blood loss
- Eviscerated contents should be covered with moist, sterile dressings with an occlusive layer above
- Blunt trauma to the abdomen is frequently associated with concurrent pelvic injury

General Information

- The most common causes of intra-abdominal injuries are motor vehicle collisions followed by stabbing and gunshot wounds.
- Paramedics should pay particular attention to visual clues on inspection prior to palpating. The "seat-belt sign" is a large bruise or abrasion across the lower abdomen, and is associated with significant hemorrhage in 25% of patients. Peri-umbilical bruising, or Cullen's sign, is a late sign indicative of a retroperitoneal hemorrhage. A "scaphoid" or sunken appearance to the abdomen may indicate diaphragmatic rupture.
- On physical exam, tenderness or rigidity is often a sign of blood or digestive contents in the abdomen, resulting in irritation to the peritoneum. Fractures to the lower ribs may suggest splenic or hepatic injuries. Splenic injury often presents with referred pain to the left posterior shoulder while hepatic injuries refer pain to the right posterior shoulder.
- Auscultation of the abdomen in the pre-hospital trauma setting rarely yields pertinent information.
- Administration of excessive crystalloid fluids has been shown to increase mortality due to hemorrhage and to increase the risk of secondary abdominal compartment syndrome. When intra-abdominal hemorrhage is suspected or likely based on mechanism of injury or physical exam, crystalloid fluids should only be given when absolutely necessary to restore perfusion to vital organs.
- The application of abdominal junctional tourniquets has been shown to reduce mortality in patients with large vessel hemorrhage of the abdomen and pelvis. In some studies, the benefits of junctional tourniquet application were similar to those achieved through resuscitative endovascular balloon occlusion of the aorta.
- Pre-hospital use of focused assessment with sonography in trauma (FAST) has demonstrated benefit in the early

detection of abdominal trauma in both blunt and penetrating injuries. However, while a positive FAST is highly specific for intra-abdominal bleeding, a negative FAST by itself should not be used to rule out injury or haemorrhage.

Interventions

First Responder

- Control external hemorrhage
- Limit patient movement to reduce clot disruption
- Protect against heat loss: foil blanket against the skin, cover with blankets for insulation, consider chemical heating blanket
- Cover extruded bowel or eviscerated abdominal contents with moist, sterile dressings followed by an occlusive layer
- Correct hypoxemia from diaphragmatic or concurrent thoracic injury:
  - → A07: Oxygen and Medication Administration
  - → B01: Airway Management

Emergency Medical Responder – All FR interventions, plus:

- Consider application of T-POD pelvic binder if evidence suggests concurrent pelvic injury
  - → PR02: Pelvic Binders

Primary Care Paramedic – All FR and EMR interventions, plus:

- Obtain vascular access and correct hypoperfusion
  - → D03: Vascular Access
- Consider tranexamic acid

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Correct hypoxemia from diaphragmatic or concurrent thoracic injury
- Needle thoracentesis as needed for suspected tension pneumothorax
  - → PR21: Needle Thoracentesis

Evidence Based Practice

Abdominal Trauma

Pelvic Trauma (Corsette-Style Compression Device)

References

1. Balogh Z et al. Secondary abdominal compartment syndrome is an elusive early complication of traumatic shock resuscitation. 2002. [Link]
2. Cole E et al. Tranexamic acid use in severely injured civilian patients and the effects on outcomes: A prospective cohort study. 2015. [Link]
3. Do WS et al. Minimally invasive preperitoneal balloon tamponade and abdominal aortic junctional tourniquet versus open packing for pelvic fracture-associated hemorrhage: Not all extrinsic compression is equal. 2019. [Link]
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5. Hussmann B et al. Does increased prehospital replacement volume lead to a poor clinical course and an

increased mortality? A matched-pair analysis of 1896 patients of the Trauma Registry of the German Society for Trauma Surgery who were managed by an emergency doctor at the accident site. 2013. [Link]

6. Kheirabadi BS et al. Physiological consequences of abdominal aortic and junctional tourniquet (AAJT) application to control hemorrhage in a swine model. 2016. [Link]
7. Kirkpatrick AW et al. Acute resuscitation of the unstable adult trauma patient: bedside diagnosis and therapy. 2008. [Link]
8. Madigan MC et al. Secondary abdominal compartment syndrome after severe extremity injury: Are early, aggressive fluid resuscitation strategies to blame? 2008. [Link]
9. Maegele M et al. Early coagulopathy in multiple injury: An analysis from the German Trauma Registry on 8724 patients. 2007. [Link]
10. Quinn AC et al. What is the utility of the Focused Assessment with Sonography in Trauma (FAST) exam in penetrating torso trauma? 2011. [Link]
11. Schechtman DW et al. Abdominal aortic and junctional tourniquet versus zone III resuscitative endovascular balloon occlusion of the aorta in a swine junctional hemorrhage model: 2020. [Link]
12. Smith S et al. The effectiveness of junctional tourniquets: A systematic review and meta-analysis. 2019. [Link]
13. Spahn DR et al. The European guideline on management of major bleeding and coagulopathy following trauma: Fifth edition. 2019. [Link]
14. Wherrett LJ et al. Hypotension after blunt abdominal trauma: The role of emergent abdominal sonography in surgical triage. 1996. [Link]
15. Williams-Johnson JA et al. Effects of tranexamic acid on death, vascular occlusive events, and blood transfusion in trauma patients with significant haemorrhage (CRASH-2) A randomised, placebo-controlled trial. 2010. [Link]

H08: Pelvic Trauma

Rob Evans

Updated: December 07, 2020
Reviewed:

Introduction

Pelvic trauma represents a serious injury and can be associated with high mortality, and is the third most common cause of death in blunt trauma after head and chest injuries. The pelvis is formed by the articulation of the illium, ischium, pubic bones and sacrum, and can be fractured by several different mechanisms. Pelvic fractures are often associated with other major traumatic injuries; careful examination and urgent transport are key principles of management in these patients.

Paramedic management of pelvic trauma includes: early recognition, early application of pelvic binding, rapid transport and treatment of other associated traumatic injuries.

Essentials

- Pelvic binding is not indicated for an isolated femoral neck fracture (hip fracture)
- Paramedics should be highly suspicious of pelvic fractures in all patients who have sustained trauma from a high-energy mechanism
- Apply a pelvic binder early – pelvic splinting should be considered a hemorrhage control intervention
- Handle the patient gently. Avoid log rolling if possible and transport using a clamshell stretcher.
- Examine the abdomen and pelvis gently. Do not rock pelvis to check stability.

Additional Treatment Information

- Pelvic binders are most beneficial in anterior-posterior pelvis fractures (i.e., open book pelvic fractures)
- Tranexamic acid should be considered in all patients with suspected pelvis fractures

General Information

- The pelvis is typically fractured through one of three primary mechanisms:
  - Anterior-posterior fractures, or open book pelvis fractures, occur when force is applied anteriorly to the iliac crests, as might happen in a motorcycle accident where the patient strikes the handlebars.
  - Lateral compression fractures occur when force is applied to the sides of the pelvis. Side-impact motor vehicle incidents, or pedestrians struck by vehicles can cause these kinds of forces.
  - Vertical shear fractures occur when a patient falls from a height and force is transmitted to the pelvis from the lower extremities
- All mechanisms of pelvic fractures can be associated with injury to major blood vessels, viscera and nerves.

Interventions

First Responder

- Keep the patient warm and prevent further heat loss
- Supplemental oxygen as required
  - → A07: Oxygen and Medication Administration
- Maintain a high index of suspicion for pelvic trauma in patients who have sustained a high mechanism of injury
  - → H01: Principles of Major Trauma

Emergency Medical Responder – All FR interventions, plus:

- Bind pelvis if indicated using a commercial or improvised pelvic binder
  - → PR02: Pelvic Binders

- Transport urgently in accordance with provincial triage and destination guidelines
- Consider higher level of care intercept

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider vascular access
  - → D03: Vascular Access
- Consider antifibrinolysis:
  - Tranexamic acid

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Consider administration of blood products if available

Evidence Based Practice

Pelvic Trauma

References

1. Ambulance Victoria. Clinical Practice Guidelines: Ambulance and MICA Paramedics. 2018. [Link]
2. Alberta Health Services. AHS Medical Control Protocols. 2020. [Link]
3. Campbell JE et al. International trauma life support for emergency care providers. 8th ed. 2016.

H09: Extremity Trauma

Neal Carman

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Reviewed:

Introduction

Extremity trauma is a common, potentially life-threatening phenomenon. Injuries to the limbs include fractures and bleeding, which should be immobilized and controlled, respectively. Paramedics should endeavour to resolve neurological or vascular compromise wherever possible.

Essentials

- Bleeding from limbs can be life threatening. Control using direct pressure. Apply tourniquets as necessary.
- If a limb is pulseless and severely angulated, it should be repositioned to allow for the restoration of pulses.
- Fractures require stabilization with good splinting practices.

Additional Treatment Information

- Altered sensation, a loss of a pulse, or cold and dusky skin in a limb distal to a fracture or dislocation is an indicator of neurological or vascular compromise. This is a limb threatening injury, and is time critical.
- The general principles of reducing a fracture are:
  - Provide procedural analgesia (→ CPG E08)
  - Irrigate open wounds with 500 mL to 1 L of saline
  - Apply traction and gentle counter-traction in the line of the limb
  - If required, further manipulation should be done while the limb is still under traction
  - Splint the limb following reduction
- Amputated limb portions should be rinsed with cool sterile saline prior to being wrapped in loose, saline-moistened sterile gauze. The limb can then be placed inside a plastic bag and kept in a cool, protected place while being transported with the patient. Do not immerse the amputated limb in water, do not allow the limb to warm, and do not place directly on ice, or use dry ice to cool.
- The use of traction splints should be reserved for isolated, closed, mid-third femur fractures. In major trauma cases, or with multiple injuries, splint the injured leg to the opposite leg and use a clamshell to immobilize.

Referral Information

- Patients with a limb threatening injury must be transported to a trauma center. Follow local guidelines for orthopedic trauma for fractures.
- Isolated knee or ankle injuries may be evaluated using the Ottawa Knee and Ankle Rules, and may not require transport.
  - Ottawa Ankle Rule: bone tenderness at the posterior edge, or tip, of either the lateral or the medial malleolus, or the inability to bear weight for four steps (both immediately after injury and in the emergency department) requires imaging to assess.
  - Ottawa Knee Rules: knee x-rays are required if:
    - Patient age > 55, or
    - Isolated tenderness of the patella and no bone tenderness of knee other than the patella, or
    - Tenderness at the head of the fibula, or
    - The patient is unable to flex the knee to 90 degrees, or
    - The patient is unable to bear weight for four steps (both immediately after injury and in the emergency department), or
    - The patient is unable to transfer weight twice onto each lower limb, regardless of whether they are limping.

General Information

- Fractures are a condition in which there is a break in the continuity of a bone. It may be caused by direct force or indirect impact. The aging process causes significant changes to the skeletal system; bones become less flexible, more brittle, and more susceptible to fractures. As well, pathological conditions such as tumours of the bone, periosteum, or cartilage or other diseases can also increase the likelihood of fractures.
- Fractures are characterized by deformity, swelling, pain, bruising, crepitus, and instability.
- Fractures are categorized as:
  - Closed; surrounding skin remains intact☐
  - Open/Compound; disruption in the surrounding skin with or without protruding bone ends
- Dislocations are a separation of two bones where they meet at a joint. In a complete displacement of a bone end from its normal joint position, the bone sits in an abnormal position. Risks associated with dislocations include trapping, compressing, or tearing of the blood vessels and nerves. Dislocations are usually characterized by obvious deformity, pain, swelling, and immobility of the joint.
  - Paramedics should exercise a high degree of suspicion with possible knee dislocations (as distinct from patellar dislocations): assume that a significant underlying arterial injury exists, requiring careful management. Consultation with CliniCall is encouraged.

Interventions

First Responder

- Control life threatening bleeding
- Direct pressure to sites of obvious ongoing blood loss
- Rapid application of tourniquet for catastrophic extremity injury or significant bleeding uncontrollable through direct pressure
  - → PR03: Tourniquets
- Stabilize obvious fractures

Emergency Medical Responder – All FR interventions, plus:

- Consider wound packing to control ongoing bleeding
  - → PR04: Wound Packing
- Splinting
- Consider traction splint for isolated mid-third femur fracture with prolonged transport

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider vascular access and fluid replacement
  - → D03: Vascular Access
- Consider tranexamic acid
- Provide analgesia as required.
  - → E08: Pain Management

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Consider procedural sedation for re-positioning fractures
  - → PR17: Procedural Sedation

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Consider blood products for significant hemorrhage

Evidence Based Practice

Extremity Trauma

Limb Amputation / Mangled / Major Hemorrhage

References

1. International Trauma Life Support. Utilization of traction splints with open femur fractures. 2011. [Link]
2. The Ottawa Rules. [Link]

H10: Burns

Tom Zajac

Updated: December 07, 2020
Reviewed:

Introduction

Burns are the result of damage to cellular membranes, producing widespread injury to the integumentary system. This damage can cause severe fluid loss, place patients at heightened risk for infections, and lead to hypothermia. Soft tissue burns can be caused by thermal injuries, chemical exposure, electrical contact, and exposure to ionizing radiation. The mainstay of treatment for burns involves cooling, fluid resuscitation, and pain management. Burns are optimally managed at an appropriate trauma receiving hospital.

Essentials

- It is critically important to maintain the airway. Burned patients should receive supplemental oxygen, and paramedics must be keenly aware of the potential for rapid development of airway compromise, either from upper airway obstruction or pulmonary edema. Signs of airway burns include cough, voice changes, and soot in the mouth or nose, or in the sputum. Consider early advanced airway management in these cases.
- Patients must be decontaminated where applicable. Remove clothes and flush burns with sterile saline if possible. Hair, hands, and face should be cleaned with water and baby shampoo.
- Cooling burns quickly may limit the extent of injury. Avoid cooling the entire patient, as this may result in hypothermia. Limit cooling to 1 to 2 minutes.
- Burned patients lose fluids rapidly. In the immediate aftermath of a burn, patients should receive up to 2 liters of fluid to maintain a systolic blood pressure above 120 mmHg.
- For partial thickness or deeper burns, estimate the body surface area involved using the Lund and Browder chart.

Additional Treatment Information

- Burns are often associated with other types of trauma. Fluid therapy to manage shock due to blood loss must strike a balance between the patient's fluid requirements resulting from the burn and the need to not promote further bleeding from the traumatic injury.
- In any fire environment carbon monoxide is a by-product of combustion and is one of the many chemical products in smoke. Carbon monoxide poisoning should be suspected in any patient who was in an enclosed space. Provide high-flow supplemental oxygen, and monitor SpCO where available.
- Critical care paramedics should follow Trauma Services BC's Provincial Burn CPG (available from the Trauma Services BC Web site).

Referral Information

All patients with major burns should be transported to the closest appropriate trauma receiving hospital per local trauma destination guidelines.

General Information

- Trauma Services BC defines a major burn as any of the following:
  - > 20% TBSA partial and/or full thickness, any age
  - > 10% TBSA partial and/or full thinkness age < 10 or > 50
  - Burns to hands, face, feet, genitalia, or joints
  - Full thickness burns > 5% TBSA, any age
  - Electrical burns
  - Chemical burns
  - Inhalation injury

- Any burns associated with major trauma

- The American Burn Association classifies burns as minor, moderate, and major, based upon burn depth and size. The traditional classification of burn depth as first, second, third or fourth degree is being replaced by a system reflecting the future treatment requirements in the continuum of care, although "fourth degree" is still used to describe the most severe burns.
- Superficial burns involve only the epidermal layer of the skin and are painful, dry, red and blanche with pressure. Superficial partial-thickness burns involve the epidermis and superficial portions of the dermis and are painful, red and weeping, usually from blisters, and also blanch with pressure.
- Deep partial-thickness burns extend into deeper dermis, damaging hair follicles and glandular tissue. They are painful to pressure only, and almost always blister, are wet or waxy dry, and have variable colour from patchy white to red.
- Full thickness burns extend through and destroy the dermis – they are usually painless. The skin can vary in appearance from waxy white to leathery grey, to charred and black.
- Fourth degree burns extend through the skin to underlying tissues of the fascia or muscle.

Interventions

First Responder

- Maintain awareness of airway patency
  - → B01: Airway Management
- Remove burned clothes and decontaminate patient as required
  - → J01: Approach to Toxic Exposures
  - → PR05: Patient Decontamination
- Cool burned areas for 1-2 minutes using normal saline. Avoid cooling the entire patient to prevent hypothermia.
- Provide supplemental oxygen for patients with potential airway burns or inhalation injuries
  - → A07: Oxygen and Medication Administration

Emergency Medical Responder – All FR interventions, plus:

- Estimate total surface area
- Consider ACP intercept

Primary Care Paramedic – All FR and EMR interventions, plus:

- Obtain vascular access
  - → D03: Vascular Access
- If hypotensive:
  - Consider other causes of shock
  - Fluid bolus 500 mL up to maximum of 2 L
  - Consider use of Ringers Lactate instead of normal saline
- In prolonged transport cases:
  - Ongoing fluid maintenance calculation
    - (Patient weight in kg) x (total burned surface area in %) x 1.5 ml = (volume to be administered over eight hours)
- Analgesia as required:
  - → E08: Pain Management
  - If no inhalation injury, nitrous oxide to effect
  - Intranasal KetAMINE

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Provide analgesia as required:
  - FentaNYL

- KetAMINE

- Consider induction and anesthesia maintenance strategy if airway management is predicted. Ketamine is the preferred induction agent. Phenylephrine must be available for peri-intubation hypotension. Post-induction analgesia is likely to be required.
  - → PR18: Anesthesia Induction
- Consider early surgical airway (FONA) if deterioration predicted.
  - → PR22: Surgical Airways

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Norepinephrine to maintain MAP > 65 mmHg
- Change to balanced fluids (Plasmalyte / Ringers)
- Neuromuscular blockade as required for induction and to facilitate mechanical ventilation. Rocuronium is the preferred agent.
  - Warning: succinylcholine is contraindicated in burns over 24 hours old.
- Suspect cyanide toxicity and provide hydroxycobalamin if two of the following are present:
  - SBP < 90 mmHg
  - Lactate > 9 mmol/L
  - Decreased level of consciousness
  - Measured cyanide > 39
- Apply Trauma BC provincial burn guidelines for interfacility transports in consultation with transport advisor

Evidence Based Practice

Burns (fire/flame)

Chemical Splash/Burn

Electrocution/Electrical Burns

Possible Airway Burns

References

1. Alberta Health Services. AHS Medical Control Protocols. 2020. [Link]
2. Alberta Health Services. AHS Medical Control Protocols: Algorithm #5 - Burns. 2020. [Link]
3. BC Emergency Medicine Network. Major Burns Trauma. [Link]
4. Vancouver General Hospital. Burn CPGs. [Link]

H11: Electrical Injuries

Ryan Ackerman

Updated: December 07, 2020
Reviewed:

Introduction

Electrical injuries are typically categorized as either high voltage (>1000 volts), low voltage (<1000 volts) or lightning injuries. High voltage injuries typically involve subcutaneous fat, muscle and even bones. Current flow, arcs, or flames from the ignition of nearby material may cause injuries. Voltage, amperage, type of current (AC vs DC), path of current flow and duration of contact all play a role in the severity of the injuries.

Low voltage injuries present with similar patterns but typically have a lesser degree of injury.

Lightning strikes can conduct millions of volts of electricity very rapidly yet often result in lesser physical injury than high voltage contact. Lightning frequently results in cardiorespiratory arrest for which prompt CPR/defibrillation is often successful.

Essentials

PARAMEDIC SAFETY IS CRITICAL: DO NOT APPROACH ELECTRICAL SOURCES OR DOWNED POWER LINES UNTIL QUALIFIED PERSONNEL HAVE DEEMED THE SCENE SAFE.

- Reverse triage victims of a lightning strike: patients in cardiac or respiratory arrest should be treated first.
- Cardiac arrest is the most immediate threat in both high and low voltage electrical injuries. Follow standard cardiac arrest guidelines.
- Secondary trauma from falls after electrical shock is common.
- Continuous cardiac monitoring is indicated, if available.

Additional Treatment Information

- External burn size is a poor indicator of the extent of internal injuries
- Fluid resuscitation needs are often higher for electrical injuries than for thermal burns
- High voltage electrical injury patients are at risk for developing rhabdomyolysis. Early fluid resuscitation can limit the associated renal damage. Rhabdomyolysis may also lead to hyperkalemia.

General Information

- Lightning produces incredibly high voltage and amperage over a very short duration of contact with the patient. Current, in a lightning strike, tends to flow around the outside of the body, and as a result internal electrical injuries are rare. The most common injuries sustained in a lightning strike are "flashover burns," which happen when the direct current heats the skin and vaporizes any moisture on the victim's skin. These burns are typically superficial, and rarely require fluid resuscitation.
- Lightning does not need to directly strike the victim to cause injuries. It is common for entire groups of people standing near a lightning strike to be injured. In cases of triaging multiple patients, initial efforts should be focused on those in cardiac or respiratory arrest. Spontaneously breathing patients following a lightning strike have a high likelihood of survival without further intervention. Those in cardiac or respiratory arrest are likely to have good outcomes with prompt resuscitation.
- The extent of injury caused by electrocution is dependent on the following factors:
    1. The type and amount of current (AC vs DC, voltage and amperage)
    2. The route the current follows through the body
    3. The duration of contact with the energy source
- The most immediate life threat is a cardiac dysrhythmia. Usually ventricular tachycardia or ventricular fibrillation. Cardiac arrest following electrocution is generally a result of electrical disruption rather than damage or burns to the myocardium itself. Early, aggressive resuscitation efforts are often successful in restoring cardiac output as these patients are general younger and healthier.

- Electrical arcing can generate temperatures in excess of 2,500° C. External burns are most often seen at the site of entry and exit and rarely provide an accurate representation of internal injury. Even small entry/exit wounds can be associated with significant internal tissue damage.
- The internal effects of high voltage electrocution can be grave. Muscle tissue, connective tissue, bones, blood vessels, nerves and organs in the path are all at risk for serious thermal injury. Muscle damage can lead to rhabdomyolosis as muscle cells rupture, spilling myoglobin and potassium into systemic circulation. Bones may be directly damaged or even fractured by violent sustained muscle contractions. Intravascular coagulation may occur as the current passes through major vessels. This occasionally results in secondary thrombotic events.
- Fluid resuscitation needs in electrical injuries are often higher than for isolated thermal injuries. Fluid volume calculations based on body surface area (BSA) burned are not accurate for electrical burns. An initial normal saline bolus of 5ml/kg followed by 100ml/hour is appropriate for normotensive patients in the pre-hospital setting. Extended care and inter-facility goals should titrate fluid to achieve a urine output of 0.5-1ml/kg/hour.

Interventions

First Responder

- Ensure scene safe from live electrical power
- Consider spinal motion restriction
- If in cardiac arrest: begin compressions and follow appropriate guidelines for resuscitation.
  - → N02: Adult Cardiac Arrest
  - → M06: Pediatric Cardiac Arrest
- Supplemental oxygen as required
  - → A07: Oxygen and Medication Administration
- Flush and decontaminate affected area with sterile saline
  - → PR05: Patient Decontamination
- Do not cool burns longer than 1-2 minutes, including decontamination time
- Dress injuries as required
- Identify type of current and duration of contact

Emergency Medical Responder – All FR interventions, plus:

- Rapid transport
- Consider analgesia
  - → E08: Pain Management
  - Nitrous oxide

Primary Care Paramedic – All FR and EMR interventions, plus:

- Obtain vascular access.
  - → D03: Vascular Access
- Fluid resuscitation: for high voltage injuries (>1000 Volts), initial bolus of 5 ml/kg followed by 100 ml/hour

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Consider analgesia:
  - KetAMINE
  - FentaNYL
- Treat known or suspected hyperkalemia
  - → E03: Hyperkalemia

Evidence Based Practice

Electrocution / Electrical Burns

Lightning

References

1. Gentges J et al. Electrical injuries in the emergency department: An evidence-based review. 2018. [Link]
2. Ritenour AE et al. Lightning injury: A review. 2008. [Link]
3. Blackwell N. A three year prospective audit of 212 presentations to the emergency department after electrical injury with a management protocol. 2002. [Link]
4. Arnoldo BD et al. Electrical injuries: a 20-year review: 2004. [Link]
5. Alson RL et al. International trauma life support for emergency care providers. 9th ed. 2020.
6. Sanford A et al. Lightning and thermal injuries. 2014. [Link]

H12: Drowning

Rob Evans

Updated: December 07, 2020
Reviewed:

Introduction

Drowning is a complicated clinical scenario for paramedics. It may involve mild symptoms to situations requiring prolonged resuscitation. Complications of submersion incidents can include atelectasis, pulmonary edema, infection, hypothermia, and trauma. In British Columbia, there are over 50 drowning fatalities every year, and an additional 40 near drowning cases requiring hospitalization. At least 20% of survivors experience permanent brain injury as a result of hypoxia, making early and appropriate prehospital management important in promoting favourable outcomes.

Essentials

- **Caution:** Ensure paramedic safety at all times around water. Wear lifejackets in accordance with High Risk Hazards policies and procedures.
- Cervical spine injury is uncommon in submersion incidents, but paramedics should be alert to the possibility of damage based upon the mechanism of injury
- All patients, including those with apparently minor injuries or symptoms, should be transported for observation due to the risk of development of secondary hypoxemia over subsequent hours
- The early use of CPAP and/or PEEP can be beneficial for patients with hypoxemia and respiratory distress
- Paramedics must ensure adequate oxygenation, and prevent both heat loss and aspiration

Additional Treatment Information

- Hypothermia should be managed in accordance with CPG I01: Hypothermia
- Be suspicious for traumatic injuries based on the history of events leading up to submersion. Apply spinal motion restriction as appropriate.
- Manage cardiac arrest in accordance with resuscitation CPGs, with particular focus on oxygenation and airway management
- Consider medical causes of cardiac arrest in patients where the mechanism of submersion does not appear to match the clinical presentation or severity of symptoms
- There is no difference in the management of patients submerged in fresh water versus salt water
- ***Cardiac arrest considerations:***
  - Although survival is uncommon in victims who have undergone prolonged submersion requiring protracted resuscitation, successful resuscitation (with full neurological recovery) has occasionally occurred after prolonged *immersion* in icy water (and in some instances, warm water). For this reason, scene resuscitation should be initiated, and victims transported to the emergency department unless there are obvious signs of death.

Referral Information

- CliniCall should be involved for guidance in managing prolonged or special resuscitation situations (e.g., hypothermic submersion)
- Contact CliniCall for assistance managing patients refusing transport with minor symptoms, and who are at risk for developing lung injury

General Information

- Water in the lungs results in alveolar collapse (atelectasis), which leads to ventilation and perfusion mismatch and impaired gas exchange. Lung injury may take up to six hours to develop following a submersion incident.
- Monitor patients for non-specific symptoms such as productive cough, tachypnea, or mild crackles on

auscultation. These can be warning signs of deterioration.

- It is important to differentiate "immersion" from "submersion": a submersion involves the whole body, including the airway, being submerged in water. Immersion does not necessarily imply submersion.
- Hypothermia can be present in both situations and it can be difficult to differentiate whether cardiac arrest is due to primary immersion (i.e. hypothermia) or submersion (hypoxemia).
- Swimming induced pulmonary edema (SIPE) is a phenomenon seen in individuals undertaking strenuous surface swimming in cold water (i.e. triathletes or rescue personnel). Symptoms include dyspnea, hypoxemia and possible hemoptysis with a presentation similar to cardiogenic pulmonary edema. Treatment consists of oxygen administration, CPAP, and advanced airway management and/mechanical ventilation as needed to correct hypoxemia.

Interventions

First Responder

- Apply spinal motion restriction as indicated based on the mechanism of injury
- Keep the patient at rest
- Position the patient sitting up
- Remove wet clothing and dry the patient
- If the patient is in cardiac or respiratory arrest-immediately commence resuscitation according to the appropriate guideline.
  - → N02: Adult Cardiac Arrest
  - → M06: Pediatric Cardiac Arrest
- Supplemental oxygen as required
  - → A07: Oxygen and Medication Administration

Emergency Medical Responder – All FR interventions, plus:

- In the setting of hypothermic cardiac arrest-contact EPOS early for guidance and treat in accordance with the hypothermic cardiac arrest guideline
- Obtain vital signs and treat hypothermia according to the hypothermia practice guideline
  - → I01: Hypothermia
- Administer supplemental oxygen as indicated
  - → A07: Oxygen and Medication Administration
- Perform basic airway management and initiate intermittent positive pressure ventilations (IPPV) if required to support failing respirations
  - → B01: Airway Management
- Treat associated traumatic injuries according to the relevant practice guideline

Primary Care Paramedic – All FR and EMR interventions, plus:

- Consider Continuous Positive Airway Pressure (CPAP) for management of hypoxemia secondary to pulmonary edema/atelectasis
  - → PR09: Continuous Positive Airway Pressure
  - REQUIRES CLINICALL CONSULTATION (1-833-829-4099)
- Consider placement of a supraglottic airway for ongoing resuscitation according to the resuscitation guideline.
  - → PR08: Supraglottic Airways
- If providing IPPV consider application of a PEEP valve to assist with alveolar recruitment and oxygenation
  - → PR10: Positive End Expiratory Pressure

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- Consider advanced airway management to support ventilation/oxygenation/management of contaminated airway
  - → PR18: Anesthesia Induction

- If the patient is unconscious, consider placement of a gastric tube to decompress the stomach and facilitate airway management
  - → PR14: Orogastic Tube Placement

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Consider mechanical ventilation to optimize oxygenation and ventilation
- Conduct point of care testing as indicated to guide mechanical ventilation strategy
- Consider invasive temperature monitoring in the setting of hypothermia

Evidence Based Practice

Near Drowning

References

1. Alberta Health Services. AHS Medical Control Protocols. 2020. [Link]
2. BC Injury Research and Prevention Unit. Drowning. 2020. [Link]
3. Michelet P, et al. Acute respiratory failure after drowning: a retrospective multicenter survey. 2017. [Link]
4. Parenteau LM, et al. Joint trauma sytem clinical practice guideline: drowning management. 2017. [Link]
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H13: Soft Tissue Trauma

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Introduction

Paramedics may be called upon to care for patients with a variety of soft tissue injuries related to both minor and major trauma. The term encompasses a broad range of conditions such as contusions, sprains, strains, tendinitis and bursitis. The most commonly injured soft tissues include muscles, tendons and ligaments; complex injuries may involve multiple structures. Common causes include falls, sports injuries, motor vehicle accidents or assaults.

Essentials

- Paramedics should differentiate between acute and chronic injuries. The latter are likely due to overuse, or may indicate a chronic pain syndrome. Acute pain is generally less than six weeks duration. Careful history taking is recommended.
- In acute injuries, maintain high index of suspicion for an associated fracture or dislocation
- If a fracture or dislocation is suspected, apply appropriate splinting and transport promptly
- Assess for neurovascular impairment and transport promptly if present
- In the case of head, back or neck injury apply spinal motion restriction guidelines as indicated

Additional Treatment Information

- Primary treatment consists of rest, ice, compression and elevation
- If open wounds are associated with the injury, irrigate with sterile saline and before applying appropriate sterile dressings
- Consider paramedic scope appropriate analgesia as indicated

Referral Information

Patients with minor injuries may meet local transport criteria for waiting room offload as directed by current policy.

General Information

- Conduct ongoing monitoring of neurovascular function and observe for signs of compartment syndrome
  - The anterior compartment of the lower leg is the most common site for development of compartment syndrome
  - The 6 P's of compartment syndrome are a late sign (pain, pallor, pulselessness, paresthesia, paralysis, and pokilothermia)
- Avoid applying ice packs directly to the skin
- If the injury involves an ankle, assess using the Ottawa Ankle Rules

Interventions

Emergency Medical Responder – All FR interventions, plus:

- Assess affected area closely and monitor for signs of neurovascular impairment
- Provide spinal motion restriction if indicated
  - → H05: Spinal Cord Injuries
- Irrigate any associated wounds with sterile saline and dress with appropriate sterile dressings
- If an associated fracture or dislocation is suspected, provide appropriate splinting
- Apply RICE (Rest/Ice/Compression/Elevation) if applicable to anatomical site of injury

- Consider analgesia
  - → E08: Pain Management

Evidence Based Practice

Minor Trauma

References

1. Alberta Health Services. AHS Medical Control Protocols. 2020. [Link]
2. Greaves I et al., editors. The trauma care pre-hospital manual. 2018.
3. Campbell JE et al. International trauma life support for emergency care providers. 8th ed. 2016.
4. Ambulance Victoria. Clinical Practice Guidelines: Ambulance and MICA Paramedics. 2018. [Link]