H03: Head Trauma

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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]