6330.03 EXTREMITY TRAUMA

INTRODUCTION

Trauma to the extremities can result in a wide array of injuries, ranging from small abrasions and lacerations to fractures, dislocations, sprains, strains, amputations, and compartment syndrome. Clinicians should not be distracted by trauma to the extremities, but rather maintain priorities in terms of imminent life threats (e.g. airway obstruction or hemodynamic instability). Though many extremity injuries are extremely painful, few are truly life-threatening. Extremity injuries that pose the highest threat are usually due to internal or external blood loss. Early and appropriate management eases pain and helps to prevent long term morbidity and disability.

SAFETY

Ensure that the cause of the trauma is of no threat to the other responders on scene. Activate the appropriate resources if required.

As trauma can result in varying amounts of blood loss, appropriate PPE should be used to protect from direct or indirect contact with blood.

ASSESSMENT

A trauma assessment should be conducted as outlined in the General Trauma Clinical Practice Guideline as appropriate. Assess for any signs of massive external bleeding from an extremity as part of the primary survey, as this represents a life threatening injury and will need to be addressed immediately. Non-life-threatening injuries should be managed only after the critical concerns are ruled out or managed.

After the initial trauma assessment, a focused history and physical exam associated with the injured extremity should be completed. Assess for signs and symptoms of fracture, dislocation or other musculoskeletal injury. Expose the entire limb, taking care not to cause unnecessary movement. On inspection, look for deformity, discoloration, swelling, or soft-tissue injuries that may suggest further injury below the skin surface. Assess for unusual limb position, asymmetry or inequality by comparing to the other limb. If a fracture is suspected, take note of any overlying punctures/wounds in the skin that may not be obvious but would indicate an “open” fracture. Also take note of any tension in the overlying skin that would suggest a fracture is threatening to open.

After inspection, the entire limb can be palpated to help localize pain, and assess for instability, deformity, unusual movement, muscle tone, and swelling.

Vascular injuries can often be associated with extremity trauma and this should be regarded as a time-sensitive emergency. Vascular injuries may present with severe pain, a cool extremity, pallor, and/or weak or absent peripheral pulses. It is important to assess for these findings.

Extremity trauma may also be complicated by peripheral nerve injuries. Check that the patient has grossly normal sensation (e.g. can feel an object touching their hand or foot) and if sensation is present, check motor response by asking them to squeeze your hands or push down with their foot against your hand.

The “6 Ps” may also be used to help recall important details of the general limb assessment.

Pain/Pressure: Is there pain at rest? With movement? With palpation?
Paresthesia: Is there any numbness or tingling?
Poikilothermia: Is the extremity cool? Is it cooler than the unaffected side?
Pallor: Is the skin pale? Flushed? Is capillary refill delayed?
Pulse: Is the distal pulse present? Absent? Weak? Strong?
Paralysis: Can the patient move the extremity? Is it difficult to move?

Keep in mind that some patients have pre-existing conditions, such as osteoporosis or cancer, that lead to an increased risk of bony injuries. Patients with such conditions can suffer injuries (such as fractures) with less force than would be required in a healthy adult.

Compartment Syndrome

For any extremity trauma, particularly when the presentation is delayed, clinicians must consider compartment syndrome as a possible complication. There is little space within muscle compartments for expansion due to bone and surrounding tissues. Swelling within the compartment may lead to increased pressure, vascular compromise, and

muscle necrosis. Classically compartment syndrome presents with pain out of proportion to the injury and no improvement with reduction and splinting. This pain is often in the muscle and increases with palpation, active contraction or passive stretching of the area. The “6 Ps” can also be used to assess for findings of compartment syndrome. It is important to note that pulselessness is a late sign and reflects complete occlusion of arterial circulation. Compartment syndrome is a time sensitive limb-threatening emergency.

Suspension Trauma

This is an evolving burden of illness in Nova Scotia where patients sustain injuries to their limbs when suspended from a harness (e.g. window washers, miners, etc.). Suspension trauma, which is also known as "orthostatic shock while suspended", “harness hang syndrome (HHS)”, and “orthostatic intolerance”, occurs when the human body is held upright without any movement for a period of time. This can cause both central symptoms (e.g. orthostatic syncope) and extremity symptoms (e.g. acute aterial occlusion and physiology similar to compartment syndrome). Occupational first responders have been trained in structured protocols for awake and cooperative patients to minimize the risk of HHS, including incremental takedowns and periods of positioning the patient. Awareness of these protocols and working with the local OHS response is critical to ensure patient safety. For unstable patients, standard EHS guidelines apply.

MANAGEMENT

Always manage concerns with the ABCDE priority approach to trauma. Once immediate life-threats are managed, the extremity injury can be treated. Keep in mind that severe exsanguinating hemorrhage from an injured extremity may represent the most imminent life threat, and in this case the extremity is treated as part of the ABC’s as a threat to circulation.

The first goal of treatment is to address any extremity injuries that may actually be imminently life-threatening (e.g. wound causing significant external hemorrhage). Next manage injuries that may become life-threatening (e.g. internal or external blood loss due to a femur fracture). Injuries that may be limb-threatening are then addressed (e.g. a pulseless limb in the setting of a suspected fracture). The clinician should administer analgesia, care for wounds, and splint injuries at the appropriate time during patient management.

Attempt to control external hemorrhage with effective first aid practices: covering open wounds with sterile gauze, applying direct pressure (**PEP 2 supportive**) and elevating the extremity.

For life-threatening external arterial bleeding or severe venous bleeding that cannot be controlled with effective first aid practices (gauze, direct pressure, elevation), the clinician should consider applying a commercial tourniquet (**PEP 1 neutral**). If a tourniquet is used, the time it was applied and duration it was on should be clearly and carefully documented. The tourniquet should be clearly visible at all times so it is not forgotten. Complications from tourniquets can include limb necrosis, nerve damage, and muscle injury (contractures, rhabdomyolysis, and compartment syndrome). When indicated, tourniquets can be left in place up to two hours with little risk of permanent injury. A tourniquet should not be released prior to hospital arrival. In the setting of a life-threatening bleed, activate the trauma team or AMT early.

Fractures of the lower limb may contribute to hemorrhagic shock, as it is possible to lose significant volumes of blood internally from a femur (1-2 L which is at least 20% of normal circulating blood volume) or tibial shaft fracture. The clinician should apply longitudinal traction (**PEP white**), reduction and splinting of lower limb fractures. A traction splint should be used for mid-shaft femur fractures (**PEP white**) unless there is also knee, ankle or pelvic injury. Traction splints decrease blood loss by reducing venous disruption, as well as decreasing the potential space for bleeding from a large sphere to a smaller cylinder. These principles also apply to open fractures, where the risk of significant blood loss is even greater.

Immobilize (**PEP white**) all painful, swollen and/or deformed extremity injuries (e.g. fractures, sprains, strains and/or dislocations) involving joints. In addition to the benefits outlined above, early splinting provides pain control, and can also decrease the risk of further injury (e.g. preventing a closed fracture from becoming an open fracture) and embolization of bone marrow (e.g. fat, bone

fragments, etc.). It is also important to always assess circulation, sensation, and motor response before and after splinting. Open wounds should also be covered prior to splinting.

In the case of an abnormally positioned limb due to suspected long bone fracture, **one attempt** should be made to realign the limb into a more anatomically correct position prior to splinting. Reduction or realignment of a limb is most important when limb circulation is impaired. Appropriate analgesia and sedation should be provided prior to attempting realignment. To realign a limb apply gentle traction along the longitudinal axis of the extremity distal to the injury until a pulse is restored and the limb is placed in a more anatomic position. If repositioning causes a loss of distal pulses, the limb should be returned to the original position and splinted. Refer to Figure 1 for an approach to limb immobilization after any life-threatening concerns have been managed.

In cases where the injury involves or is close to a joint, the injury should be splinted in a position of comfort. Realignment of these types of injuries are often more complicated and require imaging prior to manipulation.

If there has been an amputation, manage the patient fully before managing the amputated part. The amputated part should be wrapped in clean dry dressings/cloths and kept cool (**PEP white**). Do not allow the amputated part to come in direct contact with ice as this can cause tissue damage. The body part should be transported to the hospital with the patient.

The Ottawa Ankle/Foot Rules

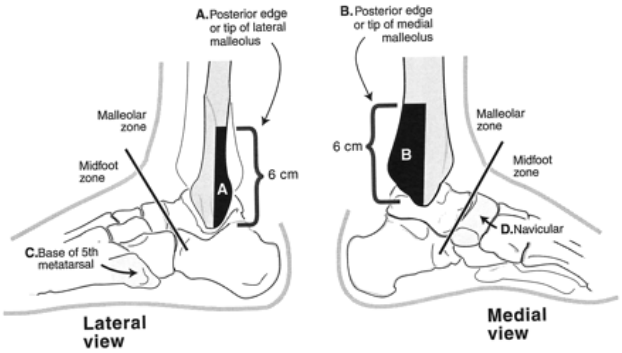
The Ottawa Ankle/Foot Rules are used to determine if patients require ankle or foot x-rays. These rules are not designed to determine if a patient with an ankle/foot injury should be transported or not. Patients who meet the criteria are more likely to have a fracture. The clinician should consider applying the Rules so the results can be provided early to the receiving facility. It is important to note that pregnant women, those unable to follow the test (e.g. intoxicated patients) or young children are excluded from this test.

The Ottawa Ankle Rule states that ankle X-ray is only required if there is any pain in the malleolar zone and any one of the following:

- Bone tenderness along the distal 6 cm of the posterior edge of the tibia or tip of the medial malleolus, OR
- Bone tenderness along the distal 6 cm of the posterior edge of the fibula or tip of the lateral malleolus, OR
- An inability to bear weight both immediately at the time of injury and during assessment for four steps total (2 on the affected limb).

The Ottawa Foot Rule indicates a foot x-ray is indicated if there is any pain in the midfoot zone and any one of the following:

- Bone tenderness at the base of the fifth metatarsal (for foot injuries), OR
- Bone tenderness at the navicular bone (for foot injuries), OR
- An inability to bear weight both immediately at the time of injury and during assessment for four steps total (2 on the affected limb).



Stiell IG, McKnight RD, et al. Implementation of the Ottawa Ankle Rules. JAMA. 1994; 271: 827-832

Analgesia

Consider administering pain management early. Opioid analgesics (**PEP 1 supportive**) can be given prior to manipulating the injury or moving the patient. Reassess pain after treatment and during transport. For less severe injuries NSAIDS and/or acetaminophen may be administered (**PEP 1 supportive**).

Fluid Resuscitation

In the setting of severe hemorrhage, fluid should only be given to maintain essential organ perfusion (maintaining a blood pressure of approximately 100

mmHg). Providing too much fluid can lead to increased bleeding and mortality. Tranexamic acid may also be indicated if severe hemorrhage is suspected (see General Major Trauma guideline).

In the case of a crush injury, muscle damage may lead to rhabdomyolysis and kidney failure. Fluid administration should be more aggressive in these patients and begin as early as possible (e.g. 20ml/kg bolus and repeat up to 2 times). Patients who have crush injuries require cardiac monitoring during fluid resuscitation.

Geriatric Extremity Trauma

Geriatric hip injuries are a common out of hospital occurrence. These injuries may include a dislocation and/or fracture and it is helpful for the clinician to differentiate between the two.

Differentiating a dislocated hip form a fractured hip can be simplified by the resting position of the involved limb. A dislocated hip most commonly moves posteriorly, causing leg shortening and the limb to assume an interior rotated position (i.e. the foot is curved inwards). A fractured hip causes the limb to become shortened and externally rotated. This is because the fractured hip causes bleeding into the hip capsule leading to swelling and the passive rotation of the hip into an externally rotated position.

It is important to note that an anterior dislocated hip may present with leg shortening and external rotation, but these are exceedingly rare. Moreover, an anterior dislocated hip is extremely painful as the displaced femoral head causes compression on the femoral nerve and femoral artery (causing acute limb ischemia).

The resting position of the injured hip helps the ED prepare for the arrival of the patient. An internally rotated hip may translate to the patient requiring procedural sedation and reduction, whereas an externally rotated hip may only require pain control and splinting.

TRANSFER OF CARE

When describing the injury to the receiving facility, the following points should be included:

- What time did the injury occur?
- Is the injury open or closed
  - If closed, is there tenting of overlying skin?
- Is there any neurovascular compromise?
- How much blood loss was there?
- What time was the tourniquet applied (if applicable)?
- What is the location? (Refer to other anatomic reference points)
- Is there any shortening?
- Is there any angulation?
- Is there any rotation?
- What treatments were provided?
- When did the patient last have anything to eat or drink?

CHARTING

In addition to the mandatory fields it is important to document the following in the ePCR text fields:

- ✓ Initial presentation and time of injury, including mechanism of injury and estimate of the amount of blood lost
- ✓ Any indications of vascular injury
- ✓ Pertinent negative findings
- ✓ Treatment provided
- ✓ Time of tourniquet application (if applicable)
- ✓ Time splint applied (if applicable)
- ✓ Reassessment findings

Key Points – Extremity Trauma

Ensure any life-threatening concerns are managed first

Control external hemorrhage then splint the area if required

Traction splinting a mid-shaft femur fracture will significantly reduce internal and external hemorrhage

Assess and reassess distal neurovascular status before and after treatment

Provide analgesia early

KNOWLEDGE GAPS

Evidence-based recommendations for the use of commercial tourniquets by civilian EMS are strengthening. However the safety and efficacy of non-commercial tourniquets are unknown.

Evidence is accumulating that dressings impregnated with hemostatic agents are effective for terminating severe external bleeding. Most research is from animal and military studies. The role of this intervention in EMS settings still requires further research.

The Ottawa Ankle/Foot Rules have yet to be validated in the prehospital setting.

Management of dislocations by EMS remains controversial.

EDUCATION

Clinicians should continuously practice a general trauma assessment to maintain proficiency in the ABCDE systematic approach, and to ensure good communication with other clinicians.

QUALITY IMPROVEMENT

In the setting of major extremity trauma, scene times should be limited, and if at all possible, procedures should be done en route to definitive care unless required for a life-threatening condition. Analgesia should be administered to patients with pain due to torso or pelvic trauma unless contraindicated.

Request for LifeFlight, Trauma Team, and/or notification to the receiving facility should be done early in the setting of major extremity trauma.

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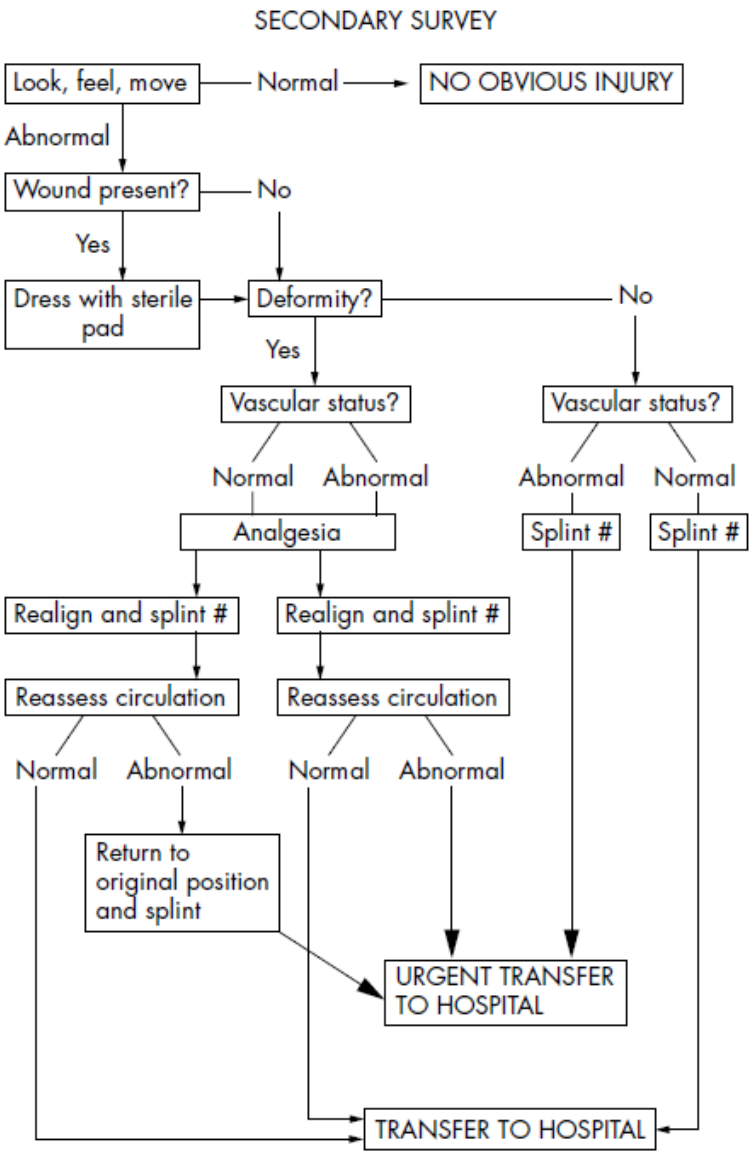

Figure 1: Algorithm for the management of extremity fractures*

*From Lee C, & Porter K. Prehospital management of lower limb fractures. Emerg Med J. 2005; 22: 660-663

PEP 3x3 TABLES for EXTREMITY 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**rotocols Project.

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 Evidence Assessments for Extremity Trauma Interventions, as of 2022/10/24. PEP is continuously updated. See: https://emspep.cdha.nshealth.ca/TOC.aspx for latest recommendations, and for individual appraised articles.

Extremity Trauma

Recommendation		RECOMMENDATION FOR INTERVENTION			
		SUPPORTIVE (Green)	NEUTRAL (Yellow)	AGAINST (Red)	NOT YET GRADED (White)
STRENGTH OF EVIDENCE FOR INTERVENTION	1 (strong evidence exists)		• Procedural Sedation		• Immobilize • Traction Splint for femur
	2 (fair evidence exists)				
	3 (weak evidence exists)	• Antibiotic (open fracture)			

Limb Amputation/Mangled/Major Hemorrhage

Recommendation		RECOMMENDATION FOR INTERVENTION			
		SUPPORTIVE (Green)	NEUTRAL (Yellow)	AGAINST (Red)	NOT YET GRADED (White)
STRENGTH OF EVIDENCE FOR INTERVENTION	1 (strong evidence exists)	• Tranexamic Acid	• Tourniquet (limb)		• Vascular Clamps • Wrap saline gauze-sterile bag-ice water
	2 (fair evidence exists)	• Direct Pressure • Hemostatic dressing • Pre-alert (massive transfusion protocol)			
	3 (weak evidence exists)	• Wound packing	• Tourniquet (junctional)		

Dislocation

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)				
	3 (weak evidence exists)	• Reduction			

6330.03 EXTREMITY TRAUMA

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