Johns Hopkins All Children’s Hospital
Extremity Vascular Injury Clinical Pathway

Table of Contents
1. Rationale
2. Background
3. Diagnosis
4. Clinical Management with Algorithm/Clinical Pathway
5. Emergency Center
6. References
7. Outcome Measures
8. Clinical Pathways Team Information

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This pathway is intended as a guide for physicians, physician assistants, nurse practitioners and other healthcare providers. It should be adapted to the care of specific patient based on the patient’s individualized circumstances and the practitioner’s professional judgment.
Rationale:

This clinical pathway was developed by a consensus group of JHACH physicians, advanced practice providers, and nurses to standardize the management of children presenting with blunt or penetrating injury to an extremity with concern for vascular injury.

This guideline defines suggested diagnostic and treatment approaches to blunt and penetrating extremity trauma with concern for vascular injury.

Background

Any injured extremity should be thoroughly evaluated for a possible vascular injury. The presence of obvious arterial injury from a blunt and/or penetrating mechanism rarely requires imaging and should not delay emergent operative exploration.

Diagnostics

Radiologic studies: X-ray, CT angiography (first line), doppler US and/or formal angiography in IR or OR used in select cases.

Clinical Management

The presence of “hard signs” strongly supports vascular injury and typically necessitates emergent repair. These “hard signs” are:

1. Bruit/Thrill
2. Active/Pulsatile hemorrhage
3. Pulsatile/Expanding hematoma
4. Signs of limb ischemia and or compartment syndrome including the 5 "P's" - pallor, paresthesia, pulse deficit, paralysis, and pain on passive extension of the compartment (pain on passive extension is the earliest and most sensitive physical finding)
5. Diminished or absent pulses with + Doppler signals (*this is not a sensitive prognostic finding, as up to 30% of patients with major vascular injuries requiring repair have normal pulses or Doppler signals distal to the injury due to collateral flow*)[1].

A simpler classification of extremity vascular injury types, by ischemic versus hemorrhagic signs, has also been proposed by Romagnoli et al [8].

- Hemorrhagic signs: active external hemorrhage or expanding hematoma
- Ischemic signs: absent/diminished pulses

The Ankle Brachial Index, ABPI, or Arterial Perfusion Index, API, is a validated tool for screening for peripheral vascular injury [2]. This is performed by placing a blood pressure cuff above the ankle or on the bicep of the limb of concern. The systolic pressure is determined with a Doppler probe at the dorsalis pedis or brachial artery. Repeat this procedure on the ipsilateral
uninjured limb. The API is calculated by dividing the systolic pressure in the injured limb by the systolic pressure in the uninjured limb. An API < 0.9 has a sensitivity of 95% and specificity of 97% for a major arterial extremity injury. In a study on blunt orthopedic extremity injuries the negative predictive value is 100% for an API > 0.9 to exclude an arterial injury [3-5].

In patients where the “hard” signs are NOT present it is still important to maintain a high suspicion of peripheral vascular injury in the injured extremity [2, 6, 7]. If “hard signs” are not present but peripheral vascular injury is suspected then expedient consultation with General/Trauma Surgery is indicated and the use of imaging, per General/Trauma Surgery, should be liberal to avoid missed injuries.

**How to perform ABPI**

**Upper Extremity Injury:**
1. Place patient in supine position.
2. Place manual BP cuff distal to injury.
3. Listen for brachial/radial artery (depends on cuff placement) with doppler.
4. Inflate the cuff until the audible Doppler signal disappears.
5. Slowly release the pressure in the cuff just until the brachial/radial signal returns and record this systolic pressure.
6. Repeat entire process using brachial artery on opposite uninjured upper extremity.

**Lower Extremity Injury:**
1. Place patient in supine position.
2. Place manual BP cuff distal to injury.
3. Listen to the dorsalis pedis pulse with Doppler.
4. Slowly release the pressure in the cuff just until the pedal signal returns and record this systolic pressure.
5. Repeat this procedure using the posterior tibialis pulse.
6. Repeat entire process on opposite extremity.
7. The blood pressure is also measured at the brachial artery in an uninjured upper extremity.

**ABPI = Injured SBP / Uninjured brachial SBP**

- ABPI = the systolic pressure of the injured extremity (ankle or forearm) divided by the brachial systolic pressure in the uninjured extremity
- API > 0.9 is highly unlikely to have a vascular injury
- API < 0.9 indicates possible vascular injury: requires further evaluation.

**YouTube Links: How to Perform ABPI**
These videos refer to peripheral artery disease, but we are using in the setting of vessel compression/injury related to trauma.

https://www.youtube.com/watch?v=KnJDrmfIvGw
https://www.youtube.com/watch?v=0_0VLSTAAE
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Signs of Vascular Injury:
- Expanding/Pulsatile Hematoma
- Pulseless, pallor, paresthesia, pain, paralysis, poikilothermia
- Bruit/Thrill
- Absent Doppler Signals
- Arterial Pressure Index, API, (<0.9)

Any Sign of Extremity Vascular Injury

Trauma Team Activation
Level 1 if pulseless/traumatic amputation/hemorrhage
Level 2 if diminished pulses/neuro deficit only

Active hemorrhage/expanding hematoma?

Fracture?

Consult Orthopedics
Fracture Reduced?

Normal Pulses

Reduce Fracture Check Pulses & API

API Normal? (≥0.90)

Serial Exams

Exam Changes

API ≥0.90 and no concern for compartment syndrome?

Stat General/Trauma Surgery Evaluation

OR vs CTA vs Angiogram

Definitive treatment or transfer, per General/Trauma Surgery

Pulse/Doppler exam Check API (see video)

API Normal? (≥0.90)

Serial Exams

- Direct pressure/tourniquet
- Emergent OR for hemorrhage control
Emergency Center Management

1. Examine and maintain adequate ABC’s.

2. Control exsanguinating hemorrhage by direct pressure or tourniquet if needed.

3. Perform rapid physical exam, noting nature of distal pulses and neurologic findings.

4. Rapidly obtain X-ray of extremity, including entry and exit wounds; use wound markers.

5. Take the patient immediately to surgery for the following findings:
   a. Exsanguinating or uncontrolled hemorrhage from the injury.
   b. Rapidly expanding hematoma.
   c. Rapidly developing compartment syndrome.

6. Obtain angiogram, duplex scan or CT angiogram for:
   a. Diminished or absent distal pulses.
   b. ABI <0.9 (for leg injury).
   c. Difference in upper extremity systolic blood pressure >20 mmHg when upper extremity injury is suspected.
   d. Continued bleeding from wounds.
   e. Major nerve injury.
   f. Bruit or thrill.
   g. Proximity to a major vessel.

7. If neurologic deficit is present:
   a. Document level of deficit.
   b. Obtain orthopedic or neurosurgical consult.

8. Penetrating injuries with an absence of vascular injury on diagnostic studies and no neurologic injury can have the wound locally treated and be discharged.

9. Administer one dose of cefazolin intravenously for stab wounds. GSW without clothing contamination do not require antibiotics. NOTE: foreign matter must be debrided. Administer tetanus IM as needed.

10. Debride wound edges and close, or treat with dressings depending on clinical conditions.

11. Splint joints above and below with a bulky dressing.

Outcome Measures:

- Need for transfusion
- Unexpected mortality and morbidity
References


12. University of Kentucky [www.mc.uky.edu/traumaservices/PediatricTraumaCareGuidelines2011.pdf](http://www.mc.uky.edu/traumaservices/PediatricTraumaCareGuidelines2011.pdf)


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**Clinical Pathway Team**

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*Johns Hopkins All Children’s Hospital*

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**Disclaimer**

Clinical Pathways are intended to assist physicians, physician assistants, nurse practitioners and other health care providers in clinical decision-making by describing a range of generally acceptable approaches for the diagnosis, management, or prevention of specific diseases or conditions. The ultimate judgment regarding care of a particular patient must be made by the physician in light of the individual circumstances presented by the patient.

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