Johns Hopkins All Children’s Hospital

Care of Extremity Fractures
Clinical Pathway

Table of Contents
1. Rationale
2. Background
3. Diagnosis
4. Clinical Management
5. Emergency Center Management
   a. Hand
   b. Arm
   c. Shoulder
   d. Pelvis
   e. Femur
   f. Lower Leg
   g. Ankle
   h. Foot
6. Open Long Bone Extremity Fractures
   a. Antibiotics for Open Fractures
7. Discharge from the Emergency Center
8. Admission
9. Inpatient
10. References
11. Outcome Measures
12. Clinical Pathways Team Information

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 patients based on the patient’s individualized circumstances and the practitioner’s professional judgment.
Johns Hopkins All Children's Hospital
Care of Extremity Fractures Clinical Pathway

Rationale

This clinical pathway was developed by a consensus group of JHACH physicians, advanced practice providers, and nurses to standardize the management of children with extremity fractures. Fracture in children is a common injury and understanding what x-rays to order coupled with comprehensive assessment for nerve and vascular injury is imperative to ensure correct treatment and best long term outcome for the patient.

This clinical guideline will:
1. Define the major orthopedic injuries that will be seen in trauma patients.
2. Provide a list of some radiographic studies that may be used to define specific injuries.
3. Enumerate immobilization and reduction techniques that can be applied in the trauma room until definitive treatment can be undertaken.
4. Provide a list of potential definitive orthopedic procedures that will be considered for each injury.

Background

Extremity fractures are a very common occurrence in children. Although complications are rare, it is imperative that children undergo a comprehensive assessment to determine if there are other unseen injuries and to determine the extent of the injured extremity. Neurovascular complication can be a devastating complication of extremity fractures.

Diagnosis

Diagnosis of extremity injuries will be based on clinical presentation and diagnostic testing.

Radiologic studies: X-rays, CT scans, MRI

Diagnostics
1. Image affected limb – 2 orthogonal views (AP and lateral)
2. Consider imaging joints above and below the injury site
3. Consult orthopedics of abnormality noted on imaging or concern for compartment syndrome.
4. Consider CTA, angiogram, and/or trauma consult if vascular injury suspected

Clinical Management

Interventions:
1. Remove jewelry and/or constrictive clothing as soon as possible.
2. RICE – rest, ice, compression, elevation.
3. Dress open wounds – give Td as indicated.
4. Splint injured site to prevent further injury or allow patient to hold extremity in position of comfort.
5. Reevaluate neurovascular status after interventions provided to injured part.

Emergency Center Management
Assessment
• Obtain time and mechanism of injury and any associated injuries.
• Note obvious swelling, deformity, tissue integrity, dislocation, or inability to bear weight or move affected extremity. Compare to uninjured extremity.
• Assess the five P’s of compartment syndrome (see guideline); document quality and severity pain.
  Pain
  Pulses
  Paresthesia
  Paralysis
  Pallor
• Assess potential for compartment syndrome.
  - Taut, firm extremity
  - Pain unrelieved by narcotics
  - Extreme pain elicited by passive stretch
  - Paresthesia
  - Anxiety
  - Agitation
• Determine past history, including previous fracture or injury; if female – possible pregnancy status; tetanus immunization status; last meal; etc.
• Document treatment PTA – self-treatment, at outlying facility, or pre-hospital personnel.

HAND:

<table>
<thead>
<tr>
<th>INJURY</th>
<th>X-RAYS</th>
<th>REDUCTION IMMobilization</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIP or PIP dislocation</td>
<td>AP/Lat finger</td>
<td>Dorsal splint in extension, or Buddy tape</td>
<td>Closed reduction</td>
</tr>
<tr>
<td>Metacarpal fracture</td>
<td>AP/Lat hand</td>
<td>Dorsal-volar splint</td>
<td>Closed reduction, wires</td>
</tr>
</tbody>
</table>
## ARM:

<table>
<thead>
<tr>
<th>INJURY</th>
<th>X-RAYS</th>
<th>REDUCTION/IMMOBILIZATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrist</td>
<td>AP/Lat wrist</td>
<td>Dorsal-volar splint</td>
<td>Closed reduction</td>
</tr>
<tr>
<td>Distal radius</td>
<td>AP/Lat forearm</td>
<td>Sugar tong splint</td>
<td>Closed reduction, or ORIF</td>
</tr>
<tr>
<td>Forearm, radius and/or ulna</td>
<td>AP/Lat forearm</td>
<td>Sugar tong splint</td>
<td>Closed reduction, or plates</td>
</tr>
<tr>
<td>Radial head</td>
<td>AP/Lat Elbow AP/Lat forearm</td>
<td>Posterior elbow splint</td>
<td>Closed reduction, or ORIF</td>
</tr>
<tr>
<td>Olecranon</td>
<td>AP/Lat elbow AP/Lat forearm</td>
<td>Posterior elbow splint</td>
<td>ORIF</td>
</tr>
<tr>
<td>Distal humerus</td>
<td>AP/Lat elbow AP/Lat humerus</td>
<td>Posterior elbow splint Beware of vascular compromise</td>
<td>ORIF</td>
</tr>
<tr>
<td>Humeral shaft</td>
<td>AP/Lat humerus</td>
<td>Coaptation splint Beware of radial nerve compromise</td>
<td>Conservative ORIF</td>
</tr>
<tr>
<td>Proximal humerus (surgical and anatomic neck)</td>
<td>AP/axillary shoulder AP/Lat humerus</td>
<td>Coaptation splint Sling</td>
<td>Conservative ORIF</td>
</tr>
</tbody>
</table>

Beware of vascular compromise

Conservative ORIF
**SHOULDER:**

<table>
<thead>
<tr>
<th>INJURY</th>
<th>X-RAYS</th>
<th>REDUCTION/IMMOBILIZATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scapula</td>
<td>AP/axillary/scapular shoulder</td>
<td>Sling</td>
<td>Conservative ORIF</td>
</tr>
<tr>
<td>Clavicle</td>
<td>AP/axillary</td>
<td>Sling</td>
<td>Conservative</td>
</tr>
</tbody>
</table>

**PELVIS:**

<table>
<thead>
<tr>
<th>INJURY</th>
<th>X-RAYS</th>
<th>REDUCTION/IMMOBILIZATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior ring, pubic symphysis, rami</td>
<td>AP, inlet and outlet pelvis, CT scan</td>
<td>Initial bedrest</td>
<td>Non-operative or ORIF</td>
</tr>
<tr>
<td>Posterior ring, sacrum, SI fracture/dislocation, iliac wing</td>
<td>AP, inlet and outlet pelvis, CT scan</td>
<td>Initial bedrest. If hemodynamically unstable consider T-POD, angioembolization or external fixation</td>
<td>ORIF</td>
</tr>
<tr>
<td>Acetabulum</td>
<td>AP pelvis, Judet views, thin cut (3mm) CT scan</td>
<td>Distal femoral traction, Buck’s traction, tibial traction, or nothing</td>
<td>ORIF</td>
</tr>
</tbody>
</table>

**FEMUR:**

<table>
<thead>
<tr>
<th>INJURY</th>
<th>X-RAYS</th>
<th>REDUCTION/IMMOBILIZATION</th>
<th>TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femoral head</td>
<td>AP pelvis, AP/lat hip</td>
<td>Distal femoral traction, or nothing</td>
<td>ORIF</td>
</tr>
<tr>
<td>Location</td>
<td>X-Rays</td>
<td>Reduction/Immobilization</td>
<td>Treatment</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------------------</td>
<td>----------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Femoral neck</td>
<td>AP pelvis, AP/lat both hips (uninjured side)</td>
<td>Buck’s traction, or nothing</td>
<td>ORIF</td>
</tr>
<tr>
<td>Intratrochanteric femur</td>
<td>AP pelvis, AP/lat hip</td>
<td>Buck’s traction, or nothing</td>
<td>ORIF</td>
</tr>
<tr>
<td>Subtrochanteric femur</td>
<td>AP pelvis, AP/lat femur</td>
<td>Distal femoral traction, tibial traction</td>
<td>ORIF</td>
</tr>
<tr>
<td>Femoral shaft</td>
<td>AP/lat femur, AP/lat knee, AP pelvis</td>
<td>Hare traction splint, or Speed Splint</td>
<td>ORIF</td>
</tr>
<tr>
<td>Supracondylar femur</td>
<td>AP/lat femur, AP/lat knee, AP pelvis</td>
<td>Knee immobilizer, or tibial traction</td>
<td>ORIF</td>
</tr>
</tbody>
</table>

**LOWER LEG:**

<table>
<thead>
<tr>
<th>Injury</th>
<th>X-Rays</th>
<th>Reduction/Immobilization</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patella</td>
<td>AP/lat knee</td>
<td>Knee immobilizer</td>
<td>ORIF</td>
</tr>
<tr>
<td>Tibial plateau</td>
<td>AP/lat knee, CT scan (after spanning ex-fix)</td>
<td>Knee immobilizer</td>
<td>ORIF, or spanning ex-fix</td>
</tr>
<tr>
<td>Tibial shaft</td>
<td>AP/lat tibia</td>
<td>Posterior sugar tong splint</td>
<td>ORIF</td>
</tr>
</tbody>
</table>

**ANKLE:**

<table>
<thead>
<tr>
<th>Injury</th>
<th>X-Rays</th>
<th>Reduction/Immobilization</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilon</td>
<td>AP/lat ankle, mortise view, AP/lat tibia, or CT</td>
<td>Posterior sugar tong splint, calcaneal traction</td>
<td>ORIF</td>
</tr>
<tr>
<td>Malleolus (medial, lateral, posterior)</td>
<td>AP/lat ankle, mortise view</td>
<td>Posterior sugar tong splint</td>
<td>ORIF</td>
</tr>
</tbody>
</table>

**FOOT:**

<table>
<thead>
<tr>
<th>Injury</th>
<th>X-Rays</th>
<th>Reduction/Immobilization</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone</td>
<td>Imaging Description</td>
<td>Treatment</td>
<td>Procedure</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------------------------------------------</td>
<td>----------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Calcaneus</td>
<td>Lat foot, oblique foot, Harris heel view, thin cut CT (3mm)</td>
<td>Posterior sugar toe splint with toe plate</td>
<td>ORIF</td>
</tr>
<tr>
<td>Talus</td>
<td>Lat foot, oblique foot</td>
<td>Posterior sugar toe splint with toe plate</td>
<td>ORIF</td>
</tr>
<tr>
<td>Metatarsals and phalanx</td>
<td>AP/lat and oblique foot</td>
<td>Posterior sugar toe splint with toe plate</td>
<td>ORIF</td>
</tr>
</tbody>
</table>
Open Long Bone Extremity Fractures

Open long bone extremity fractures are associated with significant trauma. The expedient management of these injuries ensures the best possible fracture treatment outcome. The determination of the grade of open fracture is the responsibility of the orthopedic trauma service. The extent of the grade of open fractures often requires intra-operative evaluation.

OBJECTIVE:
1. Define the types of open fractures and prioritize injury management based on them.

Gustilo Open Fracture Classification

<table>
<thead>
<tr>
<th>Grade</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Open fracture, clean wound, wound &lt;1 cm in length</td>
</tr>
<tr>
<td>II</td>
<td>Open fracture, wound &gt; 1 cm in length without extensive soft-tissue damage, flaps, avulsions</td>
</tr>
<tr>
<td>III</td>
<td>Open fracture with extensive soft-tissue laceration, damage, or loss or an open segmental fracture. This type also includes open fractures caused by farm injuries, fractures requiring vascular repair, or fractures that have been open for 8 hr prior to treatment</td>
</tr>
<tr>
<td>IIIA</td>
<td>Type III fracture with adequate periosteal coverage of the fracture bone despite the extensive soft-tissue laceration or damage</td>
</tr>
<tr>
<td>IIIB</td>
<td>Type III fracture with extensive soft-tissue loss and periosteal stripping and bone damage. Usually associated with massive contamination. Will often need further soft-tissue coverage procedure (i.e. free or rotational flap)</td>
</tr>
<tr>
<td>IIIC</td>
<td>Type III fracture associated with an arterial injury requiring repair, irrespective of degree of soft-tissue injury.</td>
</tr>
</tbody>
</table>

GUIDELINES:
1. Follow ABC’s. Extremity fractures assume low priority in the multiply injured patient unless there is significant bleeding. Suspect open fracture is there is any bleeding or any wounds in the injured extremity.

2. When patient is stable, examine the fracture and document distal neurovascular status of limb. Wounds must be inspected/explored for communication with the fracture site.

3. Remove all gross contamination using sterile saline and cover all wounds with sterile dressing soaked in saline only.

4. Grossly align limb or reduce dislocation.
   a. Splint femur fractures with Speedsplint femoral traction (see guideline)
b. Splint other fractures with aluminum gutter or plaster, including joint above and below the fracture.

5. Radiographs in two planes, including joints above and below fracture.

6. Antibiotics: (see EAST Guidelines):
   a. Clean or Grade I or II wounds: cefazolin for 24hrs.
   b. Contaminated or Grade III wound: add additional Gram negative coverage (aminoglycoside NOT fluoroquinolones) for 72hrs or till flap coverage in place
   c. Soil contamination or barnyard wounds: add penicillin G 4-5 million units every 4 hours.

<table>
<thead>
<tr>
<th>Open Fracture Grade</th>
<th>Antibiotic Treatment</th>
<th>Antibiotic Treatment if PCN Allergic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>Kefzol 25 mg/kg IV q8h x 24h</td>
<td>Clindamycin 10 mg/kg IV q6 x 24h</td>
</tr>
<tr>
<td>Grade II</td>
<td>Kefzol 25 mg/kg IV q8h x 24h</td>
<td>Clindamycin 10 mg/kg IV q6 x 24h</td>
</tr>
<tr>
<td>Grade III</td>
<td>Kefzol 25 mg/kg IV q8h x 24h + Gentamicin 2.5 mg/kg/d x 48h</td>
<td>Clindamycin 10 mg/kg IV q6 x 48 + Gentamicin 2.5 4mg/kg/d x 48h</td>
</tr>
</tbody>
</table>

If patient exposed to barn or farm wound contamination then add high dose PCN x 24 hours (Grade I and II) or 48 hours in Grade III.

Open fracture management and evaluation, including antibiotics should be initiated as soon as possible from the time of injury, not based on arrival to ER.

If a patient gets an operation on this open fracture after completion of the above duration of antibiotics is given they should get only a perioperative dose.

7. Tetanus prophylaxis if indicated.

8. Consult orthopedics.
   a. Surgical irrigation and debridement within 6-24 hours of injury. Early fixation according to orthopedic protocols.
   b. Repeat surgical debridements every 24-36 hours until wound clean or all devitalized tissue removed.
   c. Formal wound closure when wound is stable by whatever method necessary (delayed primary closure, STSG, rotational or free tissue transfer).
   d. For Grade III injuries with pulseless distal part, perform emergent surgical intervention with intra-op angiogram if limb salvage is planned. Use of the MESS
Score may help in these decisions. Scores >7 have a greater than 95% predictive value of amputation.
http://www.mdcalc.com/mangled-extremity-severity-score-mess-score/

Mandatory documentation of neurovascular exam is required in all extremity injuries pre and post extremity fracture care. Frequent neurovascular examinations are required before and after fracture management to detect extremity compartment syndrome. The LAST clinical finding lost in developing compartment syndrome is the pulse. The body has evolved to perfuse cells until the very end so it makes sense that the pulse is the last clinical finding to be lost in developing compartment syndrome.

** All open fractures must be evaluated by the Orthopaedic Service for proper management (stabilization, wound management, further fracture grading, and definitive fracture management).

**

Discharge from the Emergency Center
Under the guidance of the orthopedic team, patients with isolated extremity fractures that do not require operative intervention can be discharged from the emergency center.

Admission
Patients with isolated orthopedic injuries can be admitted to the orthopedic service. Patients with multisystem injury will be admitted to the trauma service with orthopedics providing care and guidance for all orthopedic injuries. Operative interventions and care will be collaborative and coordinated under the leadership of the trauma attending. Patients will receive orders for a rehabilitation screen on admission to assist with discharge planning.

Inpatient Management
All patient with orthopedic injuries will have the appropriate rehabilitation teams evaluate and assist with safe discharge needs.

Outcome Measures:

- Team compliance with guidelines
- Unexpected mortality and morbidity
References


Upstate University Hospital GoLisano Children’s Hospital

University of Kentucky
[www.mc.uky.edu/traumасervices/PediatricTraumaCareGuidelines2011.pdf](http://www.mc.uky.edu/traumасervices/PediatricTraumaCareGuidelines2011.pdf)
Clinical Pathway Team
Care of Extremity Fractures Clinical Pathway
Johns Hopkins All Children’s Hospital

Owner(s): Orthopedics
Also Reviewed by:

Clinical Pathway Management Team: Joseph Perno, MD; Courtney Titus, PA-C
Date Approved by JHACH Clinical Practice Council:
Date Available on Webpage:
Last Revised:

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.

The information and guidelines are provided "AS IS" without warranty, express or implied, and Johns Hopkins All Children’s Hospital, Inc. hereby excludes all implied warranties of merchantability and fitness for a particular use or purpose with respect to the information. Johns Hopkins All Children’s Hospital, Inc. shall not be liable for direct, indirect, special, incidental or consequential damages related to the user's decision to use the information contained herein.