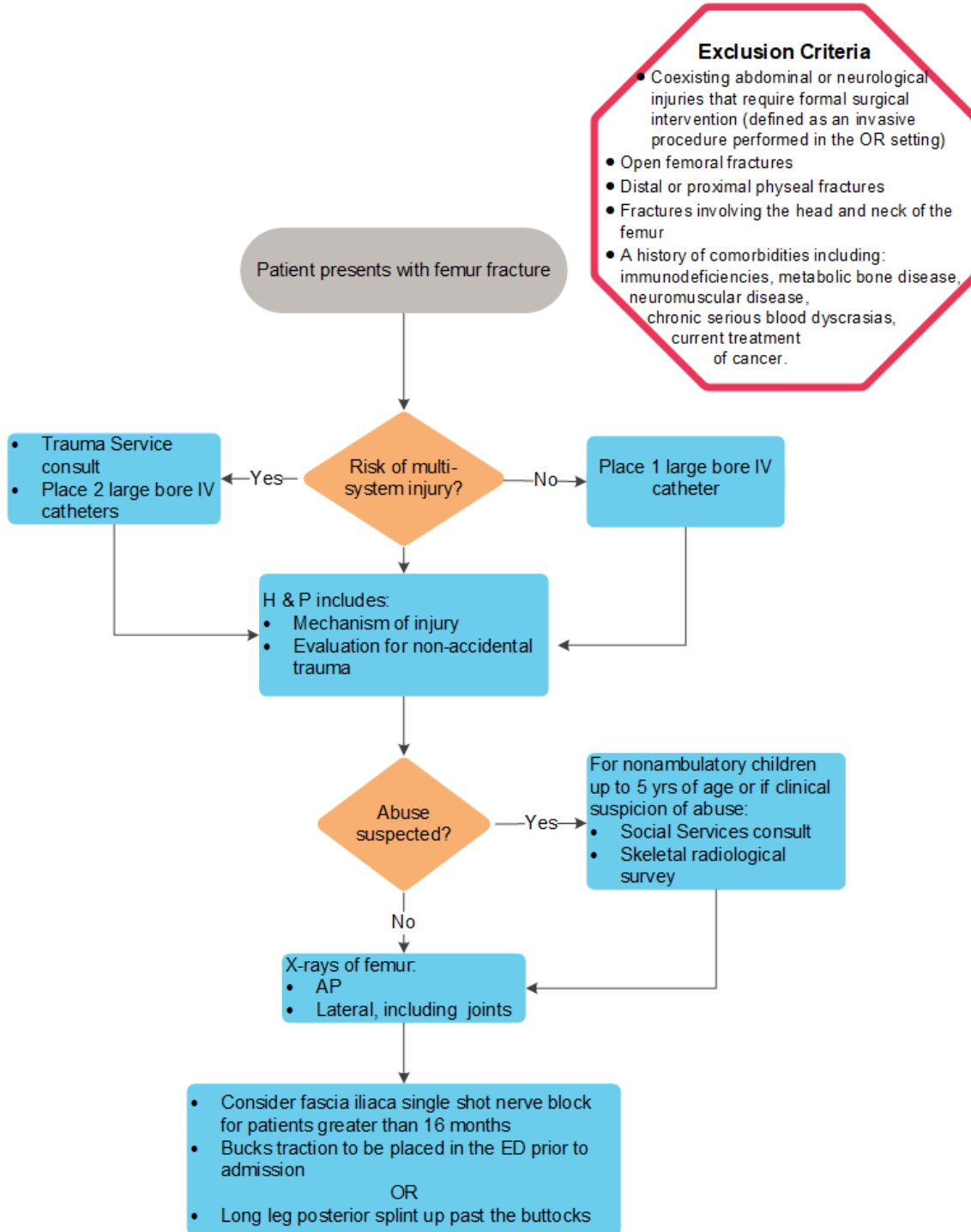


FEMORAL SHAFT FRACTURE

ALGORITHM- Initial Management of Femoral Shaft Fractures



SUMMARY

EVALUATION

- [History and Physical Exam](#)
 - History should include the mechanism of injury. Fractures may be caused by direct or indirect force, stress or fatigue of the bone, or they may be pathologic in origin
 - It is recommended, when abuse is suspected, that a consult with the Child Protection Team or medical social work be conducted to facilitate mandated reporting if necessary
 - Assess the patient for other signs of trauma, paying particular attention to the pelvic ring and consider the possibility of multi-system injury
 - Assess affected extremity with a complete neurovascular exam, including findings concerning for compartment syndrome and confirmation that the fracture is not open (see open fracture protocol)

CLINICAL MANAGEMENT

- [Pre-operative/Pre-procedure Immediate Management](#)
 - It is recommended that the emergency medicine physician, in coordination with Trauma Services, coordinate the care of the femur fracture patient who is in the emergency department (ED)
 - Immobilization should be applied as soon as possible with appropriate analgesia
 - Buck's traction
 - Or long leg posterior splint past the buttocks in patients
- Operative/Procedural Selection
 - Selection of treatment option should be guided by the patient's age, weight, and degree of skeletal maturity
- Timing of Surgical Repair (not applicable for spica casting)
 - Surgical intervention should be completed following appropriate clearance for surgery based on:
 - Trauma status, anesthesia risk, and assembly of appropriate members of the surgical team
 - Definitive fixation should occur within 18 hours of the injury
- Post-operative Activity (not applicable for spica casting)
 - Physical therapy session(s) should begin once the patient has returned to the hospital room and has fully recovered from anesthesia

LABORATORY STUDIES | IMAGING

- [Laboratory studies](#)
 - Routine lab testing and crossmatch are not recommended for otherwise healthy patients with isolated femoral shaft fractures
- [Imaging](#)
 - Obtain an anterior-posterior (AP) view x-ray of the femur, including the joints above and below the suspected fracture
 - Obtain an AP pelvis x-ray in children 6-18 years of age weighing greater than 18kg if surgery is being considered
 - When abuse is suspected, obtain a skeletal survey in children less than 3 years of age or for selected children 0 to 5 years of age

THERAPEUTICS

- [Pain Management](#)
 - Fascia iliac compartment nerve block or femoral nerve block may be considered for patients ≥ 16 months with the exception of multiple injured patients or fractures involving the head or neck of the femur
 - See Table 1 for summary of recommended pain medications and doses

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TARGET POPULATION

Inclusion Criteria

- Patients who present with a closed femoral shaft fracture as their primary injury

Exclusion Criteria

Patients with:

- Coexisting abdominal or neurological injuries that require formal surgical intervention (defined as an invasive procedure performed in the OR setting)
- Unstable multitrauma
- Open femoral fractures
- Fractures involving the head and neck of the femur, distal femur articular or physeal fractures.
- A history of comorbidities including: immunodeficiencies, metabolic bone disease, neuromuscular disease, chronic serious blood dyscrasias, current treatment of cancer

INITIAL EVALUATION

History and Physical Exam

- It is recommended that Trauma Services be consulted when the nature of the injury includes¹⁻³:
 - motor vehicle collision (greater than 40 mph), unrestrained passenger
 - motor vehicle vs. pedestrian or bike
 - fall greater than 2 meters
 - possible child abuse including elevated LFT's, hematuria or abdominal bruising
 - any other mechanism that may place the patient at risk for multi-system injury⁴
- History should include the mechanism of injury. Fractures may be caused by direct or indirect force, stress or fatigue of the bone, or they may be pathologic in origin^{5,6}.
- It is recommended, when abuse is suspected, that a consult with the Child Protection Team or medical social work be conducted to facilitate mandated reporting if necessary⁵⁻⁸.

- The following circumstances are cause for suspicion of abuse:
 - discrepancy between the history and the degree of injury
 - inconsistencies in the history
 - delay seeking medical advice
 - repeated trauma, especially when treatment is sought in different locations
 - inappropriate parental response or noncompliance^{6,8}
- No significant difference in femur fracture patterns has been found when proven cases of child abuse are compared to a control group^{6,9-11}
- Among young children who sustain femoral shaft fractures, the likelihood of child abuse is much higher in non-walking children (42%), than in walking toddlers up to four years of age (2.6%)¹²
- Assess the spine, pelvis and the possibility of multi-system injury and document findings prior to fracture reduction¹³
 - Spinal injury must be assumed to be present in the child with multiple injuries until proven otherwise via clinical criteria in all cases and radiographic examination in selected cases¹³

CLINICAL MANAGEMENT

Preoperative/Pre-Procedure Immediate Management

- It is recommended that the emergency medicine physician, in coordination with Trauma Services, coordinate the care of the femur fracture patient who is in the emergency department (ED). This includes:
 - Establishing and monitoring effective pain management ²¹
 - at all handoff of care, communicate and continue use of the same age-appropriate pain score
 - Fascia iliaca compartment nerve block²³ (may be considered) for patients ≥ 16 months of age
 - Establishing intravenous (IV) access and fluid management,
 - Obtaining appropriate consultation based upon clinical presentation, and
 - Collaborating with and supporting the attending surgeons/physicians who provide definitive care
 - Early evaluation of splinting applied in the pre-hospital setting, and an orthopedic consult for:
 - any fracture requiring splinting, or
 - any improperly applied splint ²¹
 - Traction splints applied in the field should be removed as soon as possible to reduce the risk of nerve palsy and skin breakdown (E)
 - Patients should not be in Hare traction for >6 hours. Depending on the age of the child, location of fracture, and attending provider preference, patient may be placed in Buck's traction or splint
 - If patient is placed in Buck's traction, please consult the policy and procedure document for Skin Traction for Femur Fractures
 - Recommended traction weight by age (E):
 - 0 to 3 years: 1 to 2 pounds
 - 4 to 10 years: 2 to 5 pounds
 - Greater than 10 years: 5 to 10 pounds
 - Alternatively, a long leg splint that extends proximally past the buttock is acceptable
 - Depending on the age of child, gender (consider for all females), and anticipated time until surgical correction of fracture, consider placing indwelling urinary catheter
- Place 2 large-bore peripheral intravenous catheters (PIV)

- 2 PIV for children who have risk of multiple trauma or hypovolemia, in order to minimize risk and to facilitate a well-hydrated status, and
- 1 PIV for children whose femur fracture is caused by a low energy trauma, such as a fall at play²⁴

Operative/Procedural Selection

- Selection of treatment option should be guided by the fracture pattern, patient's age, weight, and degree of skeletal maturity:
 - Patients less than 5 years of age and body weight usually less than 18 kg (40 lbs):
 - Immobilization via spica casting or other fracture brace²⁵⁻²⁹

Note 1: Waterproof cast liners may be used under spica casts. These liners have been shown to improve skin condition by decreasing maceration as well as improve hygiene by enhancing the ability to clean the cast effectively. Disadvantages include increased cost and the care that must be taken to prevent cutting the waterproof liner with the cast saw because it melts at high temperatures.²⁵⁻²⁹

Note 2: Acceptable outcomes have been observed in selected patients discharged immediately to home from the Emergency Department. In a review of 145 femoral shaft fracture patients treated with spica cast placement, 33% met discharge criteria which required that the patient:

- be awake
- be alert
- tolerate oral intake
- have no concurrent social issues
- have no other injuries requiring admission or observation, and
- sustained a low energy mechanism of injury, not requiring extended observation³⁵.

Note 4: In infants less than 6 months, a Pavlik harness is an option for immediate mobilization. Infants 6-12 months can be placed into a Rhino brace. Advantages of these include:

- decreased risk of skin complications,
- ease of application without general anesthesia,
- minimal hospitalization,
- ability to adjust the harness/brace
- minimal cost, and
- ease of feeding, bonding with, and changing diapers on the infant³⁶⁻³⁷.
- Patients 3 to 8 years of age
 - Various options can be considered including spica casting, fracture bracing, flexible nailing or submuscular plating based on surgeon preference and shared decision-making with family
- Patients 8 years of age and older

Flexible intramedullary nailing, submuscular plating or lateral entry rigid intramedullary nailing

Note 1: Flexible intramedullary nailing results in equivalent or superior clinical and functional outcomes while minimizing hospital stay and the need for cast immobilization²⁵⁻²⁹.

Note 2: Certain patients in this treatment category may have complex and/or comminuted femoral shaft fractures. In these situations, bridge plating of the femoral shaft fracture may be considered²⁵⁻²⁹(E).

Note 3: The decision to use antegrade locked intramedullary nails (versus flexible intramedullary nailing) is made based upon the patient's weight and adequate bone maturity, as assessed by radiographic exam^{8, 25-29}.

Note 4: In those patients with an open growth plate adjacent to the capital femoral epiphysis (generally this includes girls under the age of 13 years and boys under the age of 15 years) the possibility of avascular necrosis of the femoral head may be minimized if the greater trochanter is used as a starting point instead of the piriformis fossa²⁵⁻²⁹(E).

- flexible intramedullary nailing may be selectively used in this group with good clinical results²⁵⁻²⁹.

Timing of Surgical Repair

(Not applicable for spica casting or bracing)

- Surgical intervention should be completed following appropriate clearance for surgery based on:
 - trauma status,
 - anesthesia risk, and
 - assembly of appropriate members of the surgical team (usually within 18hours of the injury)^{13, 25-29}(E).

Note 1: A delay of surgical repair beyond 24 hours of the injury may be associated with pulmonary complications, especially for patients with multiple injuries²⁵⁻²⁹

Note 2: Prompt stabilization and reduction of a femoral fracture can decrease pain, decrease length of stay (LOS) and avoid complications²⁵⁻²⁹.

Postoperative Activity

(Not applicable for spica casting or bracing)

- Physical therapy session(s) should begin once the patient has returned to a hospital room and has fully recovered from anesthesia^{25-29, 75-79}.

Note: Converting PIVs to saline locks as soon as possible in the postoperative period will increase mobility and ease instruction.

- Physical therapy sessions for surgical patients should include instruction on:
 - transfer training;
 - bed mobility;
 - exercise (ankle pumps, quadriceps sets, gluteal sets, internal and external hip rotation, hip abduction/adduction in supine, and straight leg raises); and
 - wheelchair management and/or mobility training⁷⁵⁻⁷⁸.
- Mobilization with physical therapy is recommended on post-operative day 1 with toe touch weight bearing as tolerated based on the surgeon's assessment of post-operative stability.
- It is recommended that patients be discharged to home with a wheelchair postoperatively for long distances if appropriate.

Nursing Care – procedure specific

- In order to prevent skin breakdown, promote comfort and prevent cast soiling in children with a spica cast:
 - Elevate the head and upper body to allow gravity to pull urine and stool away from the cast,
 - Reposition patient periodically, and
 - "Petal" the edges of the cast⁸⁰
- Elevate the fractured extremity to decrease pain and swelling⁸¹⁻⁸³.

Treatment of Elevated Temperature

- It is recommended that a septic workup **not** be completed for patients with temperature spikes to 38.5° C (101.3° F) or less.

Note: Hematomas associated with femoral shaft fracture has been shown to be a common cause of temperature elevation.

Compartment Syndrome

- If the diagnosis of compartment syndrome is suspected based on clinical examination, the orthopedic team should be notified to evaluate the patient promptly.

Note 1: Compartment syndrome occurs when local nerve and muscle becomes ischemic as a result of increased interstitial tissue pressure preventing capillary perfusion.

Note 2: Compartment syndrome is characterized by a tense swollen thigh, increasing pain (out of proportion to the injury), paresthesia, paresis, and increased compartment pressure.

Note 3: It has been shown that compartment syndrome may occur in conjunction with femoral shaft fractures in children.

LABORATORY STUDIES | IMAGING

Laboratory Assessment

- Routine laboratory testing and crossmatch are not recommended for otherwise healthy patients with isolated femoral shaft fractures^{18,19}.

Note: Hypotension and significant decreases in hematocrit have not been shown to occur in this patient population^{11,18-22}.

Radiologic Assessment

- Obtain an anterior-posterior (AP) view x-ray and a lateral view x-ray of the femur, including the joints above and below the suspected fracture.
- Also obtain an AP pelvis x-ray in children age 6 to 18 years with a weight greater than 18 kg (40 lbs) (for whom surgery is being considered, see recommendation #12), to evaluate the status of growth plates near the proximal femur as well as to aid in ruling out the presence of femoral neck fracture^{14 15}.
- When abuse is suspected, in children less than 3 years of age or for selected children 0 to five years of age^{6,16,17}. Obtain a standard skeletal survey
- Obtain an anterior-posterior (AP) view x-ray and a lateral view x-ray of the uninjured femur at the discretion of the attending orthopedic surgeon.

THERAPEUTICS

Pain Management

See Table 1 for summary of recommended doses for pain medications.

- It is recommended that pain be routinely assessed using standard age appropriate scales⁴¹⁻⁴².
 - Valuable information regarding pain management may also be obtained through the measurement of physiologic changes, behavioral observation, and caregiver/parental input⁴².

Procedure specific recommendations for pain management

- Spica cast or bracing:
- Pharmacologic sedation should be used for children undergoing fracture reduction with a spica cast. In selected cases the treating surgeon may also opt for other methods including fascia iliaca compartment or femoral nerve block, hematoma block and/or general anesthesia⁴³⁻⁴⁶.
- Surgical incision:
 - For patients whose treatment includes surgical incision, the incision should be infiltrated with a local anesthetic at the conclusion of the surgical procedure^{43-44,47}.

Note 1: Wound infiltration with local anesthetic has been shown to decrease postoperative analgesic requirements⁴⁷.

Note 2: In children undergoing elastic stable intramedullary nailing, a hematoma block (with ropivacaine) can effectively aid in early postoperative pain control⁴⁸.

- For the mid-shaft femur fracture, fascia iliaca compartment nerve blocks (FICNB) or femoral nerve blocks (FNB) using ropivacaine should be considered an appropriate adjunct for aiding in the control of postoperative pain for up to eight hours⁴⁹⁻⁵¹.

Note 1: FNB are more effective for mid-shaft than for proximal or distal femoral fractures because the ends of the femur receive additional innervation from the sciatic and obturator nerves⁴⁹⁻⁵¹.

Note 2: If several administrations of local anesthetic are considered (e.g. hematoma block and wound infiltration), total dose of all injections must be calculated to avoid toxicity.

- It is recommended that around-the-clock analgesia dosing be used rather than a pro re nata (PRN) schedule. Around-the-clock dosing has been associated with more effective analgesia and increased patient satisfaction^{47,52}.

Note: Infants less than three to six months of age have reduced clearance of morphine and may be at higher risk for adverse effects than older children⁵³.

- For patients who can take medications by mouth (PO), consider:
 - mild pain – administer acetaminophen
 - moderate-severe pain – administer acetaminophen and oxycodone
 - mild to moderate pain, and as an adjunct for more severe pain – consider ibuprofen administration^{42,54}.

Note 1: Adequate pain management may necessitate the coordination of activities among healthcare professionals such as premedicating for pain before a physical therapy session (E).

- For children who are unable to take medications by mouth (NPO) or require additional pain control, consider:
 - IV opioid medications^{47,62};
 - IV ketorolac^{54,63-65} ;
 - hematoma block (with bupivacaine)⁴⁸;
 - indwelling femoral nerve catheter (E);
 - multi-modal therapy (E).

Note: The co-administration of ketorolac with morphine may result in decreased use of opioids and in improved pain relief⁶³.

- It is recommended that diazepam be administered as needed to relieve muscle spasms.

Note: Use with caution in neonates and young infants as metabolism of diazepam is decreased. The active metabolite, desmethyldiazepam, can accumulate with repeated use causing increased toxicity^{66,67}.

Consideration should be made for post-discharge opioid pain management per the Opioid Prescribing Practices Clinical Pathway.

Surgical Site Infection Prophylaxis

(Not applicable for spica casting)

- It is recommended that one dose of IV cefazolin, 30 mg/kg of body weight (maximum dose 2000 mg), be administered 0 to 60 minutes prior to incision to decrease the risk of surgical site infection⁶⁸⁻⁷².

This recommendation follows the principles of antibiotic prophylaxis:

- This procedure is classified as a Class I – clean wound as per CDC Guidelines;
- Cefazolin is long-acting, safe, and inexpensive⁷².

Note 1: There is no evidence that additional reduction in risk of infection is realized with multiple, versus single, preoperative dosing of prophylactic antibiotics^{68,69}.

Note 2: For patients with penicillin allergy, it is recommended that IV clindamycin, 10 mg/kg of body weight (maximum dose 900 gm), be the alternative antibiotic of choice⁷². Vancomycin use is discouraged as it promotes emergence of vancomycin-resistant organisms⁷³.

Note 3: Reduced risk of wound infection has been demonstrated with prophylactic antibiotics administered up to two hours before surgery⁷⁰.

- It is recommended, to assure adequate blood levels, that a second dose of antibiotics be administered after three hours of operating time prior to wound closure^{72,74}.

DISCHARGE CRITERIA

- Discharge to home is appropriate when the following criteria have been met:
 - adequate pain management;
 - family/caregivers demonstrate ability and willingness to care for child at home including safe transfers;
 - necessary home equipment delivered;
 - absence/resolution of postoperative complications;
 - tolerating diet;
 - able to void;
 - Social Services notified for safe discharge for suspected child abuse cases and others as appropriate.
- It is recommended, when possible, that follow-up appointments with Orthopedic Surgery (and Physical Therapy for patients with flexible intramedullary nailing) be scheduled before discharge, and when not possible, that the family be counseled regarding the need to schedule these appointments as soon as possible.

FOLLOW-UP

First Outpatient Visit – procedure specific

- It is recommended that patients be seen for orthopaedic outpatient follow up (to include biplanar x-rays of the fractured femur) within 2 to 6 weeks of the day of their injury, depending on fracture pattern and stability.

PATIENT | FAMILY EDUCATION

- Education for the patient and family should:
 - begin upon admission and continue throughout the hospital course;
 - be geared to the developmental age of the patient and the learning abilities of the family/caregivers;
 - promote understanding of treatment options, care of the child after discharge and activity alterations⁸⁰⁻⁸³;
 - include assessment of the accessibility of the bathroom and sleeping area in the home as well as access to school and requirements for individual school's home tutoring;
 - address relevant topics including treatment plan, cast care, diapering/toileting, pain management, skin care, nutrition, repositioning, recreational activities, use of automobile restraint, selection of durable medical equipment (DME), school coordination and follow up⁸⁰.
- It is recommended that all children, including those who undergo spica casting or bracing as part of their femur fracture care, utilize automotive restraint systems appropriate for age and weight.
- **Note:** If a disability parking placard is needed by the family, a prescription may be written certifying that the patient has an "orthopaedic condition" for a specific time duration.
- It is recommended that families of all children with fractured femurs be advised to provide 24-hour attendance through the recovery course, since limited mobility increases the risk of further accidental injury. The child may overestimate his/her own ability, be overzealous in interactions with siblings/peers and have limited ability to react to home disasters such as fires.
- It is recommended that children be re-entered into the school system as soon as possible in order to maintain school performance:
 - address explicit concerns regarding accessibility (stairs, toileting, etc), and
 - make arrangements for home tutoring if the school is unable to accommodate the child's medical needs.

TABLE 1. PAIN MEDICATIONS AND DOSING

Medication	Indication	Dose	Frequency	Route	Maximum Dose (the lowest of either the mg/kg/dose or mg/dose)	Comments
Morphine (less than 6 months of age)	<ul style="list-style-type: none"> Perioperative, around-the-clock analgesia Patients on NPO status 	0.03 to 0.05 mg/kg	Observe closely, repeating doses based on observed effects	IV	0.1mg/kg/dose	Reduced clearance of morphine in this age group
Morphine (greater than 6 months of age)	<ul style="list-style-type: none"> Perioperative, around-the-clock analgesia Patients on NPO status 	0.05 to 0.1 mg/kg starting dose 0.2 mg/kg max	Every 2 to 4 hours	IV	Infants: 2 mg Children: 1 to 6 years: 5 mg Children 7 to 12 years: 8 mg Adolescents: 15 mg	In opioid naïve patients, start with lower dose and repeat if needed
Ketorolac	<ul style="list-style-type: none"> Perioperative, around-the-clock analgesia Patients on NPO status 	0.5 mg/kg	Every 6 hours	IV	30 mg or 0.5 mg/kg/dose	Maximum duration = 48 hours
Acetaminophen	Mild pain	Per standardized dosing		Oral	Oral : 500 mg Rectal: 650 mg	Use as adjuvant for moderate to severe pain.
Oxycodone	Moderate to severe pain	0.05 to 0.15 mg/kg	Every 4 hours	Oral	10 mg/dose or 0.15 mg/kg/dose	
Ibuprofen	<ul style="list-style-type: none"> Mild to moderate pain Adjunct for more severe pain 	5 to 10 mg/kg	Every 6 to 8 hours	Oral	800 mg/dose or 3200 mg/day or 10 mg/kg/dose	
Diazepam	Muscle spasms	0.1 mg/kg	Every 4 to 6 hours	Oral or IV	5 mg/dose or 0.2 mg/kg/dose	Use with caution in neonates and young infants
Ondansetron	Post-operative nausea/vomiting	Per standardized dosing	Every 6 hours	Oral or IV	4 mg or 0.15 mg/kg/dose	
Ropivacaine 0.2% or Bupivacaine 0.25% with epinephrine 1:200K	Local anesthetic for fascia iliac compartment nerve block	Children less than 20 kg: 0.75 mL/kg Children greater than 20 kg: 0.5mL/kg	Once		0.75 mL/kg or 30 mL for patients less than 20 kg 0.5mL/kg or 30 mL for patients greater than 20kg	In order to detect inadvertent intravascular injection, the therapeutic dose should be preceded by a test dose of 0.1mL/kg of 0.25% bupivacaine (or 1-1.5% lidocaine) with 1:200k epinephrine; ECG should be monitored for T wave changes for 30 seconds. The therapeutic dose should be injected with a 22g B-bevel (block or short bevel) needle incrementally with frequent pauses and aspirations, and ECG continually monitored.
Ropivacaine 0.2% or Bupivacaine 0.25% with epinephrine 1:200K	Local anesthetic at conclusion of surgical procedure	0.3-0.4 mL/kg	Once		0.5mL/kg or 30 mL for patients greater than 20kg	In order to detect inadvertent intravascular injection, the therapeutic dose should be preceded by a test dose of 0.1mL/kg of 0.25% bupivacaine (or 1-1.5% lidocaine) with 1:200k epinephrine; ECG should be monitored for T wave changes for 30 seconds. The therapeutic dose should be injected with a 22g B-bevel (block or short bevel) needle incrementally with frequent pauses and aspirations, and ECG continually monitored.

References

1. Dowd MD, McAneney C, Lacher M, Ruddy RM. Maximizing the sensitivity and specificity of pediatric trauma team activation criteria. *Acad Emerg Med* 2000;7:1119-25.
2. Vernon DD, Furnival RA, Hansen KW, et al. Effect of a pediatric trauma response team on emergency department treatment time and mortality of pediatric trauma victims. *Pediatrics* 1999;103:20-4.
3. Petrie D, Lane P, Stewart TC. An evaluation of patient outcomes comparing trauma team activated versus trauma team not activated using TRISS analysis. *Trauma and Injury Severity Score. J Trauma* 1996;41:870-3; discussion 3-5.
4. Roberts I, Campbell F, Hollis S, Yates D. Reducing accident death rates in children and young adults: the contribution of hospital care. Steering Committee of the Major Trauma Outcome Study Group. *BMJ* 1996;313:1239-41.
5. Kowal-Vern A, Paxton TP, Ros SP, Lietz H, Fitzgerald M, Gamelli RL. Fractures in the under-3-year-old age cohort. *Clin Pediatr (Phila)* 1992;31:653-9.
6. Beals RK, Tufts E. Fractured femur in infancy: the role of child abuse. *J Pediatr Orthop* 1983;3:583-6.
7. Blakemore LC, Loder RT, Hensinger RN. Role of intentional abuse in children 1 to 5 years old with isolated femoral shaft fractures. *J Pediatr Orthop* 1996;16:585-8.
8. Greene WB. Displaced fractures of the femoral shaft in children. Unique features and therapeutic options. *Clin Orthop Relat Res* 1998;86-96.
9. Scherl SA, Miller L, Lively N, Russinoff S, Sullivan CM, Tornetta P, 3rd. Accidental and nonaccidental femur fractures in children. *Clin Orthop Relat Res* 2000;96-105.
10. King J, Diefendorf D, Aphthorp J, Negrete VF, Carlson M. Analysis of 429 fractures in 189 battered children. *J Pediatr Orthop* 1988;8:585-9.
11. Anderson WA. The significance of femoral fractures in children. *Ann Emerg Med* 1982;11:174-7.
12. Schwend RM, Werth C, Johnston A. Femur shaft fractures in toddlers and young children: rarely from child abuse. *J Pediatr Orthop* 2000;20:475-81.
13. Cramer KE. The pediatric polytrauma patient. *Clin Orthop Relat Res* 1995:125-35.
14. Tortolani PJ, Ain MC, Miller NH, Brumback RJ, Sponseller PD. Tibial nails for femoral shaft fractures in adolescents: "off-label" usage. *Orthopedics* 2001;24:553-7.
15. Plancher KD, Donshik JD. Femoral neck and ipsilateral neck and shaft fractures in the young adult. *Orthop Clin North Am* 1997;28:447-59.
16. Belfer RA, Klein BL, Orr L. Use of the skeletal survey in the evaluation of child maltreatment. *Am J Emerg Med* 2001;19:122-4.
17. Diagnostic imaging of child abuse. *Pediatrics* 2000;105:1345-8.
18. Barlow B, Niemirska M, Gandhi R, Shelton M. Response to injury in children with closed femur fractures. *J Trauma* 1987;27:429-30.
19. Ciarallo L, Fleisher G. Femoral fractures: are children at risk for significant blood loss? *Pediatr Emerg Care* 1996;12:343-6.
20. Unal VS, Gulcek M, Unveren Z, Karakuyu A, Ucaner A. Blood loss evaluation in children under the age of 11 with femoral shaft fractures patients with isolated versus multiple injuries. *J Trauma* 2006;60:224-6; discussion 6.
21. Chu RS, Browne GJ, Lam LT. Traction splinting of femoral shaft fractures in a paediatric emergency department: time is of the essence? *Emerg Med (Fremantle)* 2003;15:447-52.
22. Lynch JM, Gardner MJ, Gains B. Hemodynamic significance of pediatric femur fractures. *J Pediatr Surg* 1996;31:1358-61.
23. Wathen JE, Gao D, Merritt G, Georgopoulos G, Battan FK. A randomized controlled trial comparing a fascia iliaca compartment nerve block to a traditional systemic analgesic for femur fractures in a pediatric emergency department. *Ann Emerg Med* 2007;50:162-71, 71 e1.
24. Maksoud JG, Jr., Moront ML, Eichelberger MR. Resuscitation of the injured child. *Semin Pediatr Surg* 1995;4:93-9.
25. Kocher, M.S., Sink, E.L., Blasler, D.R., Luhmann, S.J., Mehlman, C.T., Scher, D.M., Matheney, T., Sanders, J.O., Watters, W.C., Goldberg, M.J., Keith, M.W., Haralson, R.H., Turkelson, C.M., Wies, J.L., Sluka, P., & Hitchcock, K. (2009). Treatment of pediatric diaphyseal femur fractures. *Journal of the American Academy of Orthopaedic Surgeons*, 17(11), 718-725. <https://doi.org/10.5435/00124635-200911000-00006>
26. Greenhill, D. A., Riccio, A. I., & Herman, M. J. (2024). Treatment of Length-Unstable Pediatric Femur Fractures in Children Aged 5 to 11 years: A Focused Review. *Journal of the American Academy of Orthopaedic Surgeons*, 32(9), 373–380. <https://doi.org/10.5435/jaaos-d-23-00995>
27. Greenhill, D. A., & Herman, M. J. (2022). Treatment of pediatric femoral shaft fractures. *Journal of the American Academy of Orthopaedic Surgeons*. <https://doi.org/10.5435/jaaos-d-22-00415>
28. Churchill, J. L., Kronk, T. A., Adamczyk, M. J., Brown, M. F., Ritzman, T. F., & Floccari, L. V. (2023). Waterproof hip Spica casts for pediatric femur fractures. *Journal of Pediatric Orthopaedics*, 44(1), e20–e24. <https://doi.org/10.1097/bpo.0000000000002541>

29. Sutphen, S. A., Mendoza, J. D., Mundy, A. C., Yang, J. G., Beebe, A. C., Samora, W. P., & Klingele, K. E. (2016). Pediatric diaphyseal femur fractures: submuscular plating compared with intramedullary nailing. *Orthopedics*, 39(6), 353–358. <https://doi.org/10.3928/01477447-20160719-03>
30. Salantera S, Lauri S, Salmi TT, Aantaa R. Nursing activities and outcomes of care in the assessment, management, and documentation of children's pain. *J Pediatr Nurs* 1999;14:408-15.
31. The assessment and management of acute pain in infants, children, and adolescents. *Pediatrics* 2001;108:793-7.
32. Krauss B, Green SM. Procedural sedation and analgesia in children. *Lancet* 2006;367:766-80.
33. Murat I, Gall O, Tourniaire B. Procedural pain in children: evidence-based best practice and guidelines. *Reg Anesth Pain Med* 2003;28:561-72.
34. American Academy of Pediatrics Committee on Drugs: Guidelines for monitoring and management of pediatric patients during and after sedation for diagnostic and therapeutic procedures. *Pediatrics* 1992;89:1110-5.
35. Guidelines for monitoring and management of pediatric patients during and after sedation for diagnostic and therapeutic procedures: addendum. *Pediatrics* 2002;110:836-8.
36. Berde CB. Pediatric postoperative pain management. *Pediatr Clin North Am* 1989;36:921-40.
37. Herrera JA, Wall EJ, Foad SL. Hematoma block reduces narcotic pain medication after femoral elastic nailing in children. *J Pediatr Orthop* 2004;24:254-6.
38. Ronchi L, Rosenbaum D, Athouel A, et al. Femoral nerve blockade in children using bupivacaine. *Anesthesiology* 1989;70:622-4.
39. Tondare AS, Nadkarni AV. Femoral nerve block for fractured shaft of femur. *Can Anaesth Soc J* 1982;29:270-1.
40. Denton JS, Manning MP. Femoral nerve block for femoral shaft fractures in children: brief report. *J Bone Joint Surg Br* 1988;70:84.
41. Higgins SS, Turley KM, Harr J, Turley K. Prescription and administration of around the clock analgesics in postoperative pediatric cardiovascular surgery patients. *Prog Cardiovasc Nurs* 1999;14:19-24.
42. Kart T, Christrup LL, Rasmussen M. Recommended use of morphine in neonates, infants and children based on a literature review: Part 2--Clinical use. *Paediatr Anaesth* 1997;7:93-101.
43. Souter AJ, Fredman B, White PF. Controversies in the perioperative use of nonsteroidal antiinflammatory drugs. *Anesth Analg* 1994;79:1178-90.
44. Macario A, Lipman AG. Ketorolac in the era of cyclo-oxygenase-2 selective nonsteroidal anti-inflammatory drugs: a systematic review of efficacy, side effects, and regulatory issues. *Pain Med* 2001;2:336-51.
45. Reuben SS, Ekman EF. The effect of cyclooxygenase-2 inhibition on analgesia and spinal fusion. *J Bone Joint Surg Am* 2005;87:536-42.
46. Glassman SD, Rose SM, Dimar JR, Puno RM, Campbell MJ, Johnson JR. The effect of postoperative nonsteroidal anti-inflammatory drug administration on spinal fusion. *Spine (Phila Pa 1976)* 1998;23:834-8.
47. Gajraj NM. The effect of cyclooxygenase-2 inhibitors on bone healing. *Reg Anesth Pain Med* 2003;28:456-65.
48. Altman RD, Latta LL, Keer R, Renfree K, Hornicek FJ, Banovac K. Effect of nonsteroidal antiinflammatory drugs on fracture healing: a laboratory study in rats. *J Orthop Trauma* 1995;9:392-400.
49. Ho ML, Chang JK, Wang GJ. Antiinflammatory drug effects on bone repair and remodeling in rabbits. *Clin Orthop Relat Res* 1995:270-8.
50. Huo MH, Troiano NW, Pelker RR, Gundberg CM, Friedlaender GE. The influence of ibuprofen on fracture repair: biomechanical, biochemical, histologic, and histomorphometric parameters in rats. *J Orthop Res* 1991;9:383-90.
51. Haberkern CM, Tyler DC, Krane EJ. Postoperative pain management in children. *Mt Sinai J Med* 1991;58:247-56.
52. Sutters KA, Shaw BA, Gerardi JA, Hebert D. Comparison of morphine patient-controlled analgesia with and without ketorolac for postoperative analgesia in pediatric orthopedic surgery. *Am J Orthop (Belle Mead NJ)* 1999;28:351-8.
53. Ebersson CP, Pacicca DM, Ehrlich MG. The role of ketorolac in decreasing length of stay and narcotic complications in the postoperative pediatric orthopaedic patient. *J Pediatr Orthop* 1999;19:688-92.
54. Forrest JB, Heitlinger EL, Revell S. Ketorolac for postoperative pain management in children. *Drug Saf* 1997;16:309-29.
55. Nau H, Luck W, Kuhn W. Decreased serum protein binding of diazepam and its major metabolite in the neonate during the first postnatal week relate to increased free fatty acid levels. *Br J Clin Pharmacol* 1984;17:92-8.
56. Morselli PL, Principi N, Tognoni G, et al. Diazepam elimination in premature and full term infants, and children. *J Perinat Med* 1973;1:133-41.
57. Gillespie WJ, Walenkamp G. Antibiotic prophylaxis for surgery for proximal femoral and other closed long bone fractures. *Cochrane Database Syst Rev* 2001:CD000244.
58. Southwell-Keely JP, Russo RR, March L, Cumming R, Cameron I, Brnabic AJ. Antibiotic prophylaxis in hip fracture surgery: a metaanalysis. *Clin Orthop Relat Res* 2004:179-84.
59. Classen DC, Evans RS, Pestotnik SL, Horn SD, Menlove RL, Burke JP. The timing of prophylactic administration of antibiotics and the risk of surgical-wound infection. *N Engl J Med* 1992;326:281-6.




60. ASHP Therapeutic Guidelines on Antimicrobial Prophylaxis in Surgery. American Society of Health-System Pharmacists. *Am J Health Syst Pharm* 1999;56:1839-88.
61. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee. *Infect Control Hosp Epidemiol* 1999;20:250-78; quiz 79-80.
62. Antimicrobial prophylaxis in surgery. *Med Lett Drugs Ther* 1999;41:75-9.
63. DiPiro JT, Vallner JJ, Bowden TA, Jr., Clark BA, Sisley JF. Intraoperative serum and tissue activity of cefazolin and cefoxitin. *Arch Surg* 1985;120:829-32.
64. Cramer KE, Tornetta P, 3rd, Spero CR, Alter S, Miraliakbar H, Teefey J. Ender rod fixation of femoral shaft fractures in children. *Clin Orthop Relat Res* 2000:119-23.
65. Brumback RJ, Toal TR, Jr., Murphy-Zane MS, Novak VP, Belkoff SM. Immediate weight-bearing after treatment of a comminuted fracture of the femoral shaft with a statically locked intramedullary nail. *J Bone Joint Surg Am* 1999;81:1538-44.
66. McGraw JJ, Gregory SK. Ender nails: an alternative for intramedullary fixation of femoral shaft fractures in children and adolescents. *South Med J* 1997;90:694-6.
67. Carey TP, Galpin RD. Flexible intramedullary nail fixation of pediatric femoral fractures. *Clin Orthop Relat Res* 1996:110-8.
68. Timmerman LA, Rab GT. Intramedullary nailing of femoral shaft fractures in adolescents. *J Orthop Trauma* 1993;7:331-7.
69. Shesser LK, Kling TF, Jr. Practical considerations in caring for a child in a hip spica cast: an evaluation using parental input. *Orthop Nurs* 1986;5:11-5.
70. Metzman L, Gamble JG, Rinsky LA. Effectiveness of ice packs in reducing skin temperature under casts. *Clin Orthop Relat Res* 1996:217-21.
71. Omer GE, Jr., Brobeck AG. An evaluation of ice application with postoperative dressings. *Clin Orthop Relat Res* 1971;81:117-21.
72. Hocutt JE, Jr. Cryotherapy. *Am Fam Physician* 1981;23:141-4.

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Clinical Pathway Council – January 27, 2025
 Pharmacy and Therapeutics – January 8, 2025

MANUAL/DEPARTMENT	Clinical Pathways/Quality
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LAST DATE OF REVIEW OR REVISION	January 27, 2025
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REVIEW | REVISION SCHEDULE

Scheduled for full review on January 27, 2028

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