



## Complete Summary

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### GUIDELINE TITLE

Evidence-based care guideline for femoral shaft fractures.

### BIBLIOGRAPHIC SOURCE(S)

Cincinnati Children's Hospital Medical Center. Evidence-based care guideline for femoral shaft fractures. Cincinnati (OH): Cincinnati Children's Hospital Medical Center; 2006 Dec. [141 references]

### GUIDELINE STATUS

This is the current release of the guideline.

The guideline was reviewed for currency in December 2006, using updated literature searches and was determined to be current.

## COMPLETE SUMMARY CONTENT

SCOPE  
METHODOLOGY - including Rating Scheme and Cost Analysis  
RECOMMENDATIONS  
EVIDENCE SUPPORTING THE RECOMMENDATIONS  
BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS  
QUALIFYING STATEMENTS  
IMPLEMENTATION OF THE GUIDELINE  
INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES  
IDENTIFYING INFORMATION AND AVAILABILITY  
DISCLAIMER

## SCOPE

### DISEASE/CONDITION(S)

Femoral shaft fracture

### GUIDELINE CATEGORY

Assessment of Therapeutic Effectiveness  
Management  
Treatment

### CLINICAL SPECIALTY

Anesthesiology  
Emergency Medicine  
Family Practice  
Nursing  
Orthopedic Surgery  
Pediatrics  
Radiology

### **INTENDED USERS**

Advanced Practice Nurses  
Nurses  
Patients  
Physical Therapists  
Physician Assistants  
Physicians  
Social Workers

### **GUIDELINE OBJECTIVE(S)**

To decrease the use of unnecessary therapies, maintain or improve short-term functional outcomes, and maintain or improve family satisfaction

### **TARGET POPULATION**

Patients age 0 through 17 years of age who present with a closed femoral shaft fracture as their primary injury

These guidelines are NOT intended for use in patients with the following:

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

### **INTERVENTIONS AND PRACTICES CONSIDERED**

#### **Evaluation**

1. History and physical examination
2. Radiologic assessment of fracture
3. Laboratory studies (not routinely recommended)
4. Quality of life assessment

#### **Management**

1. Preoperative/pre-procedure immediate management, including coordination of care
2. Operative/procedural selection guided by patients patient's age, weight and degree of skeletal maturity
3. Prompt surgical repair (usually within 24 hours of the injury)
4. Procedure-specific pain management
5. Surgical site infection prophylaxis
6. Post-operative activity, including physical therapy
7. Procedure-specific nursing care
8. Treatment of compartment syndrome
9. Education of patient and family
10. Use of appropriate discharge criteria
11. Outpatient quality of life assessment
12. Procedure-specific outpatient orthopedic follow-up
13. Procedure-specific implant/cast removal

**Note:** Septic workup for temperature spikes to 38.2 degrees C was considered but not recommended.

## **MAJOR OUTCOMES CONSIDERED**

- Length of treatment time
- Length of hospital stay
- Need for cast immobilization
- Level of pain
- Incidence and severity of complications
- Incidence of surgical site infection
- Quality of life
- Length of time to procedure-specific mobility goals
- Successful fracture union

## **METHODOLOGY**

### **METHODS USED TO COLLECT/SELECT EVIDENCE**

Searches of Electronic Databases

### **DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE**

To select evidence for critical appraisal by the group, the Medline, EmBase, and the Cochrane databases were searched for dates of July 2002 through April 2006 for this revision, and for dates 1980 through 2002 for the original version of this guideline, to generate an unrefined, "combined evidence" database using a search strategy focused on answering clinical questions relevant to femoral shaft fracture and employing a combination of Boolean searching on human-indexed thesaurus terms (Medical Subject Heading [MeSH] headings using an OVID Medline interface) and "natural language" searching on words in the title, abstract, and indexing terms. The citations were reduced by eliminating duplicates, review articles, non-English articles, and adult articles. The resulting abstracts were reviewed by a methodologist to eliminate low quality and irrelevant citations. During the course of the guideline development, additional clinical questions were

generated and subjected to the search process, and some relevant review articles were identified. All citations in the original publication were reviewed for appropriateness to this revision.

### **December 2006 Review**

A search using the above criteria was conducted from April 2006 through September 2006. Eight relevant articles were selected as potential future citations for the guideline. However, none of these references required changes to be made to the July 2006 version of the recommendations.

### **NUMBER OF SOURCE DOCUMENTS**

195

### **METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE**

Not stated

### **RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE**

Not applicable

### **METHODS USED TO ANALYZE THE EVIDENCE**

Review  
Review of Published Meta-Analyses  
Systematic Review

### **DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE**

Not stated

### **METHODS USED TO FORMULATE THE RECOMMENDATIONS**

Expert Consensus

### **DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS**

Recommendations have been formulated by a consensus process directed by best evidence, patient and family preference, and clinical expertise. During formulation of these guidelines, the team members have remained cognizant of controversies and disagreements over the management of these patients. They have tried to resolve controversial issues by consensus where possible and, when not possible, to offer optional approaches to care in the form of information that includes best supporting evidence of efficacy for alternative choices.

### **RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS**

Not applicable

## **COST ANALYSIS**

A formal cost analysis was not performed and published cost analyses were not reviewed.

## **METHOD OF GUIDELINE VALIDATION**

External Peer Review  
Internal Peer Review

## **DESCRIPTION OF METHOD OF GUIDELINE VALIDATION**

The guidelines have been reviewed by clinical experts not involved in the development process, senior management, and other individuals as appropriate to their intended purposes.

# **RECOMMENDATIONS**

## **MAJOR RECOMMENDATIONS**

Each recommendation is followed by an evidence classification identifying the type of supporting evidence. Definitions for the types of evidence are presented at the end of the "Major Recommendations" field.

### **Assessment**

#### **History and Physical Exam**

1. It is recommended that Trauma Services be consulted when the nature of the injury includes:
  - Motor vehicle collision (>40 mph), unrestrained passenger
  - Motor vehicle vs. pedestrian or bike
  - Fall >20 feet
  - Possible child abuse including elevated liver function tests (LFTs), hematuria, or abdominal bruising
  - Any other mechanism that may place the patient at risk for multi-system injury

(Dowd et al., 2000 [C]; American College of Surgeons [ACS], 2004 [E]).

**Note:** Trauma services have been shown to decrease required treatment time and improve survival of pediatric trauma patients (Vernon et al., 1999 [C]; Petrie, Lane, & Stewart, 1996 [C]; Roberts et al., 1996 [C]).

2. It is recommended that the history 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 (Kowal-Vern et al., 1992 [D]; Beals & Tufts, 1983 [D]).

3. It is recommended, when abuse is suspected, that a consult with Social Services be conducted for all children less than two years of age and for selected children two to five years of age (Blakemore, Loder, and Hensinger, 1996; [D]; Kowal-Vern et al., 1992 [D]; Beals & Tufts, 1983 [D]; Anderson, 1982 [D]; Greene, 1998 [S]; ACS 2004 [E]).

**Note 1:** 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

(Beals & Tufts, 1983 [D]; Greene, 1998 [S]; ACS, 2004 [E])

**Note 2:** No significant difference in femur fracture patterns has been found when proven cases of child abuse are compared to a control group (Scherl et al., 2000 [D]; King et al., 1988 [D]; Beals & Tufts, 1983 [D]; Anderson, 1982 [D]).

**Note 3:** 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%) (Schwend, Werth, & Johnston, 2000 [D]).

**Note 4:** See Cincinnati Children's Hospital Medical Center (CCHMC) Nursing Policies, Procedures and Standards: F-114 Child Abuse Assessments/Evaluations.

4. It is recommended that the cervical spine and the possibility of multi-system injury be assessed and documented prior to fracture reduction (Wilbur & Thompson, 1998 [S]; Cramer, 1995 [S]; ACS, 2004 [E]; Joint Task Force in Advanced Pediatric Life Support 2004 [E]).

**Note 1:** At CCHMC, documentation of this assessment is conducted by:

- Trauma Services: for children who meet the criteria for trauma service evaluation, or
- Emergency Medicine: for children whose injuries do not necessitate Trauma Service activation

**Note 2:** 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 cases (Wilbur & Thompson, 1998 [S]; Cramer, 1995 [S]; ACS, 2004 [E]; Joint Task Force in Advanced Pediatric Life Support, 2004 [E]).

## **Radiologic Assessment**

5. It is recommended that an anterior-posterior (AP) view x-ray and a lateral view x-ray of the femur be obtained, including the joints above and below the suspected fracture (Routt, 1998 [S]; ACS, 2004 [E]).
6. It is recommended, in children age 6 to 18 years and weight >18 kg [>40 lbs] (for whom surgery is being considered, see recommendation #12), that an AP pelvis x-ray also be obtained, 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 (Tortolani et al., 2001 [D]; Plancher and Donshik, 1997 [S]).
7. It is recommended, when abuse is suspected, that a standard skeletal survey be obtained for all children less than two years of age and for selected children two to five years of age (Belfer, Klein, & Orr, 2001 [D]; Beals & Tufts, 1983 [D]; "Diagnostic imaging of child abuse," 2000 [E]).

### **Laboratory Assessment**

8. It is recommended, for otherwise healthy patients with isolated femoral shaft fractures, that routine laboratory testing and crossmatch **not** be conducted (Barlow et al., 1987 [C]; Ciarallo & Fleisher, 1996 [D]).

**Note:** Hypotension and significant decreases in hematocrit have not been shown to occur in this patient population (Unal et al., 2006 [C]; Barlow et al., 1987 [C]; Chu, Browne, & Lam 2003 [D]; Ciarallo & Fleisher, 1996 [D]; Lynch, Gardner, & Gains, 1996 [D]; Anderson, 1982 [D]).

### **Quality of Life Assessment**

9. It is recommended that a quality of life assessment using the Pediatric Outcomes Data Collection Instrument (PODCI) be conducted:
  - On presentation, and
  - In outpatient follow up (see outpatient recommendation #36)

(Lerman et al., 2005 [C]; Lerman, Sullivan, & Haynes, 2002 [C]; Pencharz et al., 2001 [C]; Local Expert Consensus [E])

**Note 1:** The PODCI is a validated instrument for evaluating outcomes in pediatric orthopedics (Lerman et al., 2005 [C]; Lerman, Sullivan, & Haynes 2002 [C]; Pencharz et al., 2001 [C]). Though other instruments are available for pediatric quality of life evaluation, the Child Health Questionnaire Parent Form (CHQ-PF-28) does not discriminate well for severity in orthopaedic patients and the Activities Scales for Kids (ASK) instrument does not contain a pain scale (Pencharz et al., 2001 [C]).

**Note 2:** Use of quality of life instruments to assess functional status as an adjunct to clinical, radiographic, and laboratory assessment in patient care may be cost-effective and improve the patient's experience (Pincus et al., 1989 [C]; Skevington et al., 2005 [O]; Russak et al., 2003 [O,S]; Wolfe & Pincus, 1999 [S,E]; Higginson & Carr, 2001 [E]; Pincus & Wolfe, 2000 [E]; Local Expert Consensus [E]).

### **Hospital Management**

## Preoperative/Pre-Procedure Immediate Management

10. 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 (Chu, Brown, & Lam, 2003 [D])
  - Establishing intravenous (IV) access and fluid management
  - Obtaining appropriate consultation based upon clinical presentation
  - Collaborating with and supporting the attending surgeons/physicians who provide definitive care
  - Early evaluation of splinting applied in the pre-hospital setting, and an orthopaedic consult for:
    - Any fracture requiring splinting
    - Any improperly applied splint (such as Hare or Sager splint) (Chu, Brown, & Lam, 2003 [D])

(Local Expert Consensus [E])

11. It is recommended that large-bore peripheral intravenous catheters (PIV) be placed:
- 2 PIV for children who have risk of multiple trauma or hypovolemia, in order to minimize risk and to facilitate a well-hydrated status
  - 1 PIV for children whose femur fracture is caused by a low energy trauma, such as a fall at play

(Maksoud, Moront, & Eichelbeger, 1995 [S]; ACS, 2004 [E]; Local Expert Consensus [E])

## Operative/Procedural Selection

12. It is recommended that the selection of the treatment option be guided by the patient's age, weight, and degree of skeletal maturity:
- A. Patients <6 years of age and body weight usually <18 kg (40 lbs):
- Immediate immobilization via spica casting or other similar type of immobilization (Wright, 2000 [M]; Ferguson & Nicol, 2000 [C]; Infante et al., 2000 [C]; Czertak & Hennrikus, 1999 [C]; Sugi & Cole, 1987 [C]; Irani, Nicholson, & Chung, 1976 [C]; Cassinelli et al., 2005 [D]; Podeszwa et al., 2004 [D]; Stannard, Christensen, & Wilkins, 1995 [D]; Martinez et al., 1991 [D])

**Note 1:** Among 117 patients <6 years of age and treated with immediate immobilization via spica casting, 90.6% met defined parameters for successful reduction based on final x-rays (Cassinelli et al., 2005 [D]).

**Note 2:** 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 (Wolff & James, 1995 [C]; Kruse et al., 1991 [C]).

**Note 3:** 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 observation

(Cassinelli et al., 2005 [D])

**Note 4:** In infants, a Pavlik harness is an appropriate choice for immediate mobilization. Advantages of its use may include:

- Decreased risk of skin complications
- Ease of application without general anesthesia
- Minimal hospitalization
- Ease of reduction
- Ability to adjust the harness (and therefore the fracture alignment) if the reduction is lost
- Minimal cost
- Ease of feeding, bonding with, and changing diapers on the infant

(Podeszwa et al., 2004 [D]; Stannard, Christensen, & Wilkins, 1995 [D])

B. Patients 6 to 12 years of age and body weight usually 18 to 45.5 kg (40 to 100 lbs):

- Flexible intramedullary nailing results in equivalent or superior clinical and functional outcomes while minimizing hospital stay and the need for cast immobilization (Bar-On, Sagiv, & Porat, 1997 [B]; Flynn et al., 2004 [C]; Kissel & Miller, 1989 [C]; Bhatt et al., 2005 [D]; Buechsenschuetz et al., 2002. [D]). See Table 1 in the original guideline document.

**Note 1:** 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 considered (Agus et al., 2003 [C]; Kanlic et al., 2004 [D]; Local Expert Consensus [E]).

**Note 2:** In the setting of distal third pediatric femoral shaft fractures, in vitro biomechanical data suggest that retrograde flexible nail insertions could be beneficial (McDonald et al., 2005 [F]).

**Note 3:** Comparisons between external fixation and flexible intramedullary nailing related to malunion and other parameters have not been studied (Wright, 2000 [M]; Wright et al., 2005 [B]).

- C. Patients 13 to 18 years old and body weight > 45.5 kg (100 lbs):
- Antegrade locked intramedullary nailing (Buford, Christensen, & Weatherall, 1998 [C])

**Note 1:** 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 (Buess & Kaelin, 1998 [D]; Greene, 1998 [S]; McCartney, Hinton, & Heinrich, 1994 [S]).

**Note 2:** 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 fossa (Kanellopoulos, Yiannakopoulos, & Soucacos, 2006 [C]; Buford, Christensen, & Weatherall, 1998 [C]; Gordon et al., 2004 [D]; Gordon et al., 2003 [D]; Momberger et al., 2000 [D]; Townsend & Hoffinger, 2000 [D]; Buess & Kaelin, 1998 [D]; Gonzalez-Herranz et al., 1995 [D]; Beaty et al., 1994 [D]; Mehlman, 2006 [E]; Mehlman, 2004 [E]; Local Expert Consensus [E]).

- Flexible intramedullary nailing may be selectively used in this group with good clinical results (Bhatt et al., 2005 [D]; Buechsenschuetz et al., 2002 [D]).

### **Timing of Surgical Repair (not applicable for spica casting)**

13. It is recommended that surgical intervention be completed following appropriate clearance for surgery based on:

- Trauma status
- Anesthesia risk
- Assembly of appropriate members of the surgical team

(usually within 24 hours of the injury) (Kutscha-Lissberg et al., 2001 [D]; Hedequist et al., 1999 [D]; Cramer, 1995 [S]; Local Expert Consensus [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 injuries (Hedequist et al., 1999 [D]).

**Note 2:** Prompt stabilization and reduction of a femoral fracture can decrease pain, decrease length of stay (LOS) and avoid complications (Buckley, 1997 [S]).

## **Pain Management**

See Table 2 of the original guideline document for summary of recommended doses for pain medications.

14. It is recommended that pain be routinely assessed using standard age appropriate scales (Salantera et al., 1999 [C]; "The assessment and management of acute pain," 2001 [E]).

**Note 1:** At CCHMC, the accepted scales are:

- Birth to 1 year: Neonatal Infant Pain Scale
- 1 to 7 years: Children's Hospital of Eastern Ontario (CHEOPS)
- 3 to 12 years: OUCHER or visual analog scale (VAS)
- 8 years to adult: VAS

(Goldschneider, Mancuso, & Berde, 2001 [S]; Haberkern, Tyler, & Krane, 1991 [S])

**Note 2:** Valuable information regarding pain management may also be obtained through the measurement of physiologic changes, behavioral observation, and caregiver/parental input (Goldschneider, Mancuso, & Berde, 2001 [S]; Finley & McGrath, 1998 [S]; "The assessment and management of acute pain," 2001 [E]).

**Note 3:** See CCHMC Nursing Policies, Procedures and Standards: Pain Management.

15. Procedure specific recommendations for pain management:

### *Spica Cast*

- A. It is recommended that pharmacologic sedation be used for children undergoing fracture reduction with a spica cast. In selected cases the treating surgeon may also opt for other methods including femoral nerve block, hematoma block, and/or general anesthesia (McCarty et al., 2000 [C]; Krauss & Greene, 2006 [S]; Murat, Gall, & Tourniaire, 2003 [S]; McCarty, Mencio, & Greene, 1999 [S]; "Guidelines for monitoring and management," 2002 [E]; AAP, 1992 [E]).

### *Surgical Incision*

- B. It is recommended, for patients whose treatment includes surgical incision, that the incision be infiltrated with a local anesthetic at the conclusion of the surgical procedure (Krauss & Greene, 2006 [S]; Murat, Gall, & Tourniaire, 2003 [S]; Goldschneider, Mancuso, & Berde, 2001 [S]; Dalens, 1995 [S]; Berde, 1989 [S]).

**Note 1:** Wound infiltration with local anesthetic has been shown to decrease postoperative analgesic requirements (Goldschneider, Mancuso, & Berde, 2001 [S]; Dalens, 1995 [S]; Berde, 1989 [S]).

**Note 2:** In children undergoing elastic stable intramedullary nailing, a hematoma block (with bupivacaine) can effectively aid in early postoperative pain control (Herrera, Wall, & Foad, 2004 [C]).

- C. It is recommended, for the mid-shaft femur fracture, that femoral nerve blocks (FNB) using bupivacaine be considered an appropriate adjunct for aiding in the control of postoperative pain for up to eight hours (Ronchi et al., 1989 [C]; Tondare & Nadkarni, 1982 [C]; Denton & Manning, 1988 [D]; McCarty, Mencio, & Greene, 1999 [S]).

**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 nerves (Ronchi et al., 1989 [C]; Tondare & Nadkarni, 1982 [C]; Denton & Manning, 1988 [D]; McCarty, Mencio, & Greene, 1999 [S]).

**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 (Local Expert Consensus [E]).

16. 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 (Higgins et al., 1999 [D]; Berde, 1989 [S]).

**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 children (Goldschneider, Mancuso, & Berde, 2001 [S]; Kart, Christrup, & Rasmussen, 1997 [S]).

17. It is recommended, to address the needs for pain relief in a patient who can take medications by mouth (PO), that for:
- Mild pain - administer acetaminophen
  - Moderate-severe pain - administer acetaminophen with codeine
  - Patients allergic to codeine or who cannot tolerate it, administer oxycodone (Goldschneider, Mancuso, & Berde, 2001 [S])
  - Mild to moderate pain, and as an adjunct for more severe pain - consider ibuprofen administration (Souter, Fredman, & White, 1994 [S])

("The assessment and management of acute pain," 2001 [E])

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

**Note 2:** While there are no pediatric fracture studies regarding the osteogenic effect of nonsteroidal anti-inflammatory drugs (NSAIDs), studies on adult spinal fusion and animals raise concerns that NSAIDs may inhibit the likelihood of successful fusion (Macario & Lipman, 2001 [M]; Reuben & Ekman, 2005 [B]; Glassman et al., 1998 [D]; Gajraj, 2003 [S]; Altman et al., 1995 [F]; Ho, Chang, and Wang, 1995 [F]; Huo et al., 1991 [F]).

**Note 3:** The effects of codeine to decrease pain may be related to genetic variation of cytochrome P450 enzyme CYP2D6, which metabolizes codeine into morphine. In 4% of patients, no morphine was detected after treatment with codeine (Williams, Patel, & Howard, 2002 [B]).

18. It is recommended, as options for children who are unable to take medications by mouth (NPO) or require additional pain control:

- IV opioid medications (Haber Kern, Tyler, & Krane, 1991 [S]; Berde, 1989 [S])
- IV ketorolac (Sutters et al., 1999 [B]; Ebersson, Pacicca, & Ehrlich, 1999 [C]; Forrest, Heitlinger, & Revell, 1997 [S]; Souter, Fredman, & White, 1994 [S])
- Hematoma block (with bupivacaine) (Herrera, Wall, & Foad, 2004 [C])
- Indwelling femoral nerve catheter (Local Expert Consensus [E])

**Note:** May be considered for complex fractures with greater than expected or prolonged pain (Local Expert Consensus [E]).

- Multi-modal therapy (Local Expert Consensus [E])

**Note:** The coadministration of ketorolac with morphine may result in decreased use of opioids and in improved pain relief (Sutters et al., 1999 [B]).

19. It is recommended that diazepam be administered as needed to relieve muscle spasms (Local Expert Consensus [E]).

**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 (Nau, Luck, & Kuhnz, 1984 [C]; Morselli et al., 1973 [C]).

### **Surgical Site Infection Prophylaxis (not applicable for spica casting)**

20. It is recommended that one dose of IV cefazolin, 40 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 infection (Gillespie & Walenkamp, 2000 [M]; Southwell-Keely et al., 2004 [M]; Classen et al., 1992 [C]; American Society of Health-System Pharmacists [ASHP], 1999 [S,E]; Mangram et al., 1999 [S]).

This recommendation follows the principles of antibiotic prophylaxis:

- This procedure is classified as a Class I - clean wound as per Center for Disease Control and Prevention (CDC) Guidelines.
- Cefazolin is a narrow spectrum antibiotic that covers the most probable contaminants, including *Staphylococcus aureus*, the most common organism associated with surgical site infection in orthopaedic procedures.
- Cefazolin is long-acting, safe, and inexpensive.

(Mangram et al., 1999 [S])

**Note 1:** There is no evidence that additional reduction in risk of infection is realized with multiple, versus single, preoperative dosing of prophylactic antibiotics (Gillespie & Walenkamp, 2000 [M]; Southwell-Keely et al., 2004 [M]).

**Note 2:** For patients with penicillin allergy, it is recommended that IV clindamycin, 10 mg/kg of body weight (maximum dose 900 g), be the alternative antibiotic of choice (Mangram et al., 1999 [S]). Vancomycin use is discouraged as it promotes emergence of vancomycin-resistant organisms ("Antimicrobial prophylaxis," 1999 [E]).

**Note 3:** Reduced risk of wound infection has been demonstrated with prophylactic antibiotics administered up to two hours before surgery (Classen et al., 1992 [C]).

21. 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 (DiPiro et al., 1985 [B]; Mangram et al., 1999 [S]).

### **Postoperative Activity (not applicable for spica casting)**

22. It is recommended that physical therapy session(s) begin once the patient has returned to a hospital room and has fully recovered from anesthesia (Bar-On, Sagiv, & Porat, 1997 [B]; Cramer et al., 2000 [C]; Brumback et al., 1999 [C,F]; McGraw & Gregory, 1997 [C]; Carey & Galpin, 1996 [D]; Timmerman & Rab, 1993 [D]).

**Note:** Converting PIVs to saline locks as soon as possible in the postoperative period will increase mobility and ease instruction (Local Expert Consensus [E]).

23. It is recommended that physical therapy sessions for surgical patients 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)
  - Wheelchair management and/or mobility training

(Cramer et al., 2000 [C]; McGraw & Gregory, 1997 [C]; Carey & Galpin, 1996 [D])

24. It is recommended, for patients undergoing reduction with flexible intramedullary nails, that non-weightbearing (NWB) transfers-only status be maintained for a period of two to three weeks postoperatively to increase patient comfort and foster early fracture callus organization (Bar-On, Sagiv, & Porat, 1997 [B]; Cramer et al., 2000 [C]; Ligier et al., 1988 [C]; Carey & Galpin, 1996 [D]).
25. It is recommended, for patients undergoing reduction with locked intramedullary nails, that gait training be initiated once the patient has recovered from anesthesia.

Toe touch weightbearing (TTWB) status on the involved lower extremity may be initiated immediately postoperatively. These patients may advance to full weightbearing over a period of two to three weeks (Brumback et al., 1999 [C,F]; Carey & Galpin, 1996 [D]).

### **Nursing Care - procedure specific**

26. It is recommended for children with a spica cast, in order to prevent skin breakdown, promote comfort and prevent cast soiling, that:
- The head and upper body be kept elevated to allow gravity to pull urine and stool away from the cast
  - That the patient be repositioned periodically
  - That the edges of the cast be "petaled" (except for waterproof-lined casts)

(Shesser & Kling, 1986 [E]; Local Expert Consensus [E])

27. It is recommended, for children undergoing surgery, that the fractured extremity be elevated, with application of ice both pre- and postoperatively, to promote vasoconstriction and to decrease pain (Metzman, Gamble, & Rinsky, 1996 [C]; Omer & Brobeck, 1971 [C]; Hocutt, 1981 [E]).

### **Treatment of Elevated Temperature**

28. It is recommended that a septic workup **not** be completed for patients with temperature spikes to 38.2 degrees C (101 degrees F) or less (Local Expert Consensus [E]).

**Note:** Hematomas associated with femoral shaft fractures have been shown to be a common cause of temperature elevation, with a peak temperature of about 38.2 degrees C (101 degrees F) occurring within the first seven days (Clarke et al., 1983 [D]).

### **Compartment Syndrome**

29. It is recommended, if the diagnosis of compartment syndrome is suspected based on clinical examination, that appropriate intracompartmental pressure

monitoring be undertaken (Russell, Apyan, & Burnes, 1985 [C]; Hensinger, 1998 [S]).

**Note 1:** Compartment syndrome occurs when local nerve and muscle becomes ischemic as a result of increased interstitial tissue pressure preventing capillary perfusion (Willis & Rorabeck, 1990 [S]; ACS, 2004 [E]).

**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 (Russell, Apyan, & Burnes, 1985 [C]; Schwartz et al., 1989 [D]; Janzing, Broos, & Rommens, 1996 [O]; Hensinger, 1998 [S]; ACS, 2004 [E])

**Note 3:** It has been shown that compartment syndrome may occur in conjunction with femoral shaft fractures in children (Janzing, Broos, & Rommens, 1996 [O]; Tarlow et al., 1986 [O]; Hensinger, 1998 [S]).

### **Patient/Family Education**

30. It is recommended that education for the patient and family:
- 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 alterations (Shesser & Kling, 1986 [E]; Cuddy, 1986 [X])
  - 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 (Hughes, Sponseller, & Thompson, 1995 [C])
  - 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 up (Hughes, Sponseller, & Thompson, 1995 [C]; Shesser & Kling, 1986 [E]; Cuddy, 1986 [X])
31. It is recommended that all children, including those who must wear a body cast (spica cast) as part of their femur fracture care, utilize automotive restraint systems appropriate for age and weight (Talty et al., 1999 [S]; AAP, 1999 [E]; Bull et al., 1989 [F]).
- 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.
32. 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 (Local Expert Consensus [E]).

33. 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).
  - Make arrangements for home tutoring if the school is unable to accommodate the child's medical needs.

(Hughes, Sponseller & Thompson, 1995 [C])

### **Discharge Criteria**

34. 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

(Local Expert Consensus [E])

35. It is recommended, when possible, that follow-up appointments with Orthopaedic 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 (Local Expert Consensus [E]).

### **Outpatient Management**

#### **Quality of Life Assessment**

36. It is recommended that quality of life be assessed periodically using the Pediatric Outcomes Data Collection Instrument (PODCI) conducted during the course of outpatient follow up at:
- 6 weeks
  - 3 months
  - 6 months
  - 12 months

for comparison with data collected at presentation (see assessment recommendation #9) (Lerman et al., 2005 [C]; Lerman, Sullivan, & Haynes, 2002 [C]; Pencharz et al., 2001 [C]; Local Expert Consensus [E])

**Note:** Use of quality of life instruments to assess functional status as an adjunct to clinical, radiographic, and laboratory assessment in patient care may be cost-effective and improve the patient's experience (Pincus et al., 1989 [C]; Skevington et al., 2005 [O]; Russak et al., 2003 [O,S]; Wolfe & Pincus, 1999 [S,E]; Higginson & Carr 2001 [E]; Pincus & Wolfe, 2000 [E]; Local Expert Consensus [E]).

### **First Outpatient Visit - procedure specific**

37. It is recommended that patients treated via immediate spica cast immobilization be seen for orthopaedic outpatient follow up (to include biplanar x-rays of the fractured femur) within 10 to 14 days of the day of their injury. This visit is aimed at identifying the small but real percentage of patients whose fracture will "slip" thus losing adequate reduction (Local Expert Consensus [E]).

**Note:** If adequate reduction is not confirmed, cast wedging in the clinic setting may be required or re-reduction and repeat casting under anesthesia may be required (Irani, Nicholson, & Chung, 1976 [C]; Local Expert Consensus [E]).

38. It is recommended that patients treated via flexible intramedullary nailing be seen for outpatient follow up with both Orthopaedics and Physical Therapy within three to four weeks of their injury. This outpatient visit to include:

- Biplanar x-rays of the fractured femur
- Orthopaedic evaluation, including assessment and instructions for appropriate degree of weightbearing
- Initiation of gait training by physical therapy (using crutches or walkers and limited weightbearing) (Flynn et al., 2004 [C]; Ligier et al., 1988 [C])

(Local Expert Consensus [E])

It is recommended that patients treated via locked intramedullary nailing be seen for outpatient orthopaedic follow up (to include biplanar x-rays of the fractured femur) within four to six weeks following their injury (Local Expert Consensus [E]).

### **Implant/Cast Removal - procedure specific**

39. It is recommended that children treated via immediate spica casting have their spica casts removed four to six weeks following injury with biplanar x-rays of the injured femur obtained out of cast (Local Expert Consensus [E]).

**Note:** Fractures in infants may heal more quickly than in older children (Skak & Jensen, 1988 [C]).

40. It is recommended that children treated via flexible intramedullary nailing have arrangements made for implant removal by the end of the third month or the beginning of the fourth month following surgery (Ligier et al., 1988 [C]; Local Expert Consensus [E]).

**Note:** The flexible intramedullary nail system currently in use is not designed for permanent implantation (Ligier et al., 1988 [C]).

41. It is recommended that children treated via locked intramedullary nailing be scheduled for implant removal on an individualized basis. Candidates for

implant removal are determined by a combination of patient, family, and pediatric orthopaedic surgeon factors which may include:

- Implant-associated pain
- Interest in enlisting in the military
- Patient/family preference
- Surgeon preference
- Surgery-associated risks, including infection

(Local Expert Consensus [E])

### **Definitions:**

### **Evidence Grading Scale:**

M: Meta-analysis or Systematic Review  
A: Randomized controlled trial: large sample  
B: Randomized controlled trial: small sample  
C: Prospective trial or large case series  
D: Retrospective analysis  
O: Other evidence  
S: Review Article  
E: Expert opinion or consensus  
F: Basic Laboratory Research  
L: Legal requirement  
Q: Decision analysis  
X: No evidence

### **CLINICAL ALGORITHM(S)**

An algorithm is provided in the original guideline document for initial care in the management of femoral shaft fractures in children 0 through 17 years of age.

## **EVIDENCE SUPPORTING THE RECOMMENDATIONS**

### **REFERENCES SUPPORTING THE RECOMMENDATIONS**

[References open in a new window](#)

### **TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS**

The type of evidence is classified for the recommendations (see "Major Recommendations").

### **Evidence Grading Scale:**

M: Meta-analysis or Systematic Review  
A: Randomized controlled trial: large sample  
B: Randomized controlled trial: small sample  
C: Prospective trial or large case series  
D: Retrospective analysis

- O: Other evidence
- S: Review Article
- E: Expert opinion or consensus
- F: Basic Laboratory Research
- L: Legal requirement
- Q: Decision analysis
- X: No evidence

## BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

### POTENTIAL BENEFITS

- Appropriate evaluation and treatment of femoral shaft fractures
- Fracture union within acceptable limits of length and angulation
- Minimization of hospital length of stay
- Minimization of family disruption

### POTENTIAL HARMS

- 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 children.
- While there are no pediatric fracture studies regarding the osteogenic effect of nonsteroidal anti-inflammatory drugs (NSAIDs), studies on adult spinal fusion and animals raise concerns that NSAIDs may inhibit the likelihood of successful fusion.
- Diazepam should be used with caution in neonates and young infants, as metabolism of diazepam is decreased. Metabolism of diazepam is decreased in neonates and young infants. The active metabolite, desmethyldiazepam, can accumulate with repeated use causing increased toxicity.

## QUALIFYING STATEMENTS

### QUALIFYING STATEMENTS

These recommendations result from review of literature and practices current at the time of their formulations. This protocol does not preclude using care modalities proven efficacious in studies published subsequent to the current revision of this document. This document is not intended to impose standards of care preventing selective variances from the guidelines to meet the specific and unique requirements of individual patients. Adherence to this pathway is voluntary. The physician in light of the individual circumstances presented by the patient must make the ultimate judgment regarding the priority of any specific procedure.

## IMPLEMENTATION OF THE GUIDELINE

### DESCRIPTION OF IMPLEMENTATION STRATEGY

Appropriate companion documents have been developed to assist in the effective dissemination and implementation of the guideline.

## **IMPLEMENTATION TOOLS**

Chart Documentation/Checklists/Forms  
Clinical Algorithm  
Foreign Language Translations  
Patient Resources  
Quality Measures  
Quick Reference Guides/Physician Guides

For information about [availability](#), see the "Availability of Companion Documents" and "Patient Resources" fields below.

## **INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES**

### **IOM CARE NEED**

Getting Better

### **IOM DOMAIN**

Effectiveness  
Patient-centeredness  
Safety  
Timeliness

## **IDENTIFYING INFORMATION AND AVAILABILITY**

### **BIBLIOGRAPHIC SOURCE(S)**

Cincinnati Children's Hospital Medical Center. Evidence-based care guideline for femoral shaft fractures. Cincinnati (OH): Cincinnati Children's Hospital Medical Center; 2006 Dec. [141 references]

### **ADAPTATION**

Not applicable: The guideline was not adapted from another source.

### **DATE RELEASED**

2002 Dec 9 (revised 2006 Jul 21; reviewed 2006 Dec)

### **GUIDELINE DEVELOPER(S)**

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### **SOURCE(S) OF FUNDING**

Cincinnati Children's Hospital Medical Center

## **GUIDELINE COMMITTEE**

Femoral Shaft Fracture Guideline Team 2006

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### **FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST**

The guideline was developed without external funding. All Team Members and Clinical Effectiveness support staff listed declared whether they have any conflict of interest and none were identified.

### **GUIDELINE STATUS**

This is the current release of the guideline.

The guideline was reviewed for currency in December 2006, using updated literature searches and was determined to be current.

### **GUIDELINE AVAILABILITY**

Electronic copies: Available from the [Cincinnati Children's Hospital Medical Center Web site](#).

Print copies: For information regarding the full-text guideline, print copies, or evidence-based practice support services contact the Children's Hospital Medical Center Health Policy and Clinical Effectiveness Department at [HPCEInfo@chmcc.org](mailto:HPCEInfo@chmcc.org).

## **AVAILABILITY OF COMPANION DOCUMENTS**

The following is available:

- Femoral shaft fractures. Guideline highlights. Cincinnati (OH): Cincinnati Children's Hospital Medical Center; 2006 Jul. 1 p. Electronic copies: Available in Portable Document Format (PDF) from the [Cincinnati Children's Hospital Medical Center Web site](#).

Order sets and clinical pathways are also available from the [Cincinnati Children's Hospital Medical Center Web site](#).

## **PATIENT RESOURCES**

The following is available:

- Broken bones and sprains. Cincinnati (OH): Cincinnati Children's Hospital Medical Center; 2005 May. 1 p. Electronic copies: Available from the [Cincinnati Children's Hospital Medical Center Web site](#). Also available in Spanish from the [Cincinnati Children's Hospital Medical Center Web site](#).

Please note: This patient information is intended to provide health professionals with information to share with their patients to help them better understand their health and their diagnosed disorders. By providing access to this patient information, it is not the intention of NGC to provide specific medical advice for particular patients. Rather we urge patients and their representatives to review this material and then to consult with a licensed health professional for evaluation of treatment options suitable for them as well as for diagnosis and answers to their personal medical questions. This patient information has been derived and prepared from a guideline for health care professionals included on NGC by the authors or publishers of that original guideline. The patient information is not reviewed by NGC to establish whether or not it accurately reflects the original guideline's content.

## **NGC STATUS**

This NGC summary was completed by ECRI on October 18, 2006. The information was verified by the guideline developer on November 15, 2006.

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