



Evidence-Based Care Guideline

Femoral Shaft Fractures^a

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Target Population

Inclusions: These guidelines are intended for use in patients age 0 through 17 years of age who present with a closed femoral shaft fracture as their primary injury.

Exclusions: 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 OR 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

Target Users

Include but are not limited to (in alphabetical order):

- Anesthesiologists
- Clinicians caring for inpatients
- Emergency Medicine physicians
- Orthopaedic surgeons
- Patient Care staff, including
 - nurse practitioners
 - nurses
 - physical therapists
 - social workers
- Patients and families
- Surgical residents

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Introduction

References in parentheses () Evidence strengths in brackets [] (See last page for definitions)

Femoral fractures are the most common reason for pediatric orthopaedic admission to the hospital (*Galano 2005 [D]*). The goal of treatment for a child with a femoral fracture is to safely achieve fracture union within acceptable limits of length and angulation while minimizing both hospitalization and family disruption (*Greene 1998 [S]*). Whether occurring in relative isolation or in conjunction with other musculoskeletal injuries, substantial health care resources are devoted to femoral shaft fracture care (*Galano 2005 [D]*, *Hinton 1999 [D]*).

The areas of uncertainty offering challenges in the management of femoral shaft fracture include:

- identification of possible child abuse
- selection of the procedure that optimizes outcomes for an individual patient
- selection of pain medication that adequately controls pain for an individual patient.

The objectives of this guideline are to:

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

Etiology

Femoral shaft fractures occur at a rate of approximately 18 to 21 per 100,000 children and are more common in boys than girls (*Rewers 2005 [D]*, *Hinton 1999 [D]*). The causes of femoral fractures are age-dependent, with falls being most likely in children one to six years of age; motor vehicle-pedestrian accidents common for children six to nine years old and motor vehicle accidents highest among adolescents (*Rewers 2005 [D]*, *Hinton 1999 [D]*). Other causes include child abuse, bicycle accidents and sports injuries. In children less than one year of age, child abuse is the leading cause of femoral fractures and abuse remains a significant concern in toddlers up to about five years of age (*Rewers 2005 [D]*, *Scherl 2000 [D]*, *Schwend 2000 [D]*, *King 1988 [D]*, *Beals 1983 [D]*, *Anderson 1982 [D]*, *Brown 2004 [O]*).

Guideline Recommendations

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 LFT's, hematuria or abdominal bruising;
 - any other mechanism that may place the patient at risk for multi-system injury

(Dowd 2000 [C], ACS 2004 [E]).

Note: Trauma services have been shown to decrease required treatment time and improve survival of pediatric trauma patients (Vernon 1999 [C], Petrie 1996 [C], Roberts 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 1992 [D], Beals 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 1996 [D], Kowal-Vern 1992 [D], Beals 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 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 2000 [D], King 1988 [D], Beals 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 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 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 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 2001 [D], Plancher 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 2001 [D], Beals 1983 [D], Sane 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 1987 [C], Ciarallo 1996 [D]).

Note: Hypotension and significant decreases in hematocrit have not been shown to occur in this

patient population (*Unal 2006 [C], Barlow 1987 [C], Chu 2003 [D], Ciarallo 1996 [D], Lynch 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 2005 [C], Lerman 2002 [C], Pencharz 2001 [C], Local Expert Consensus [E]*).

Note 1: The PODCI is a validated instrument for evaluating outcomes in pediatric orthopedics (*Lerman 2005 [C], Lerman 2002 [C], Pencharz 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 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 1989 [C], Skevington 2005 [O], Russak 2003 [O,S], Wolfe 1999 [S,E], Higginson 2001 [E], Pincus 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 2003 [D]*),
- 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 orthopaedic consult for:
 - any fracture requiring splinting, or
 - any improperly applied splint (such as Hare or Sager splint) (*Chu 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, and
 - 1 PIV for children whose femur fracture is caused by a low energy trauma, such as a fall at play (*Maksoud 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 2000 [C], Infante 2000 [C], Czertak 1999 [C], Sugi 1987 [C], Irani 1976 [C], Cassinelli 2005 [D], Podeszwa 2004 [D], Stannard 1995 [D], Martinez 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 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 1995 [C], Kruse 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 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, and
- ease of feeding, bonding with, and changing diapers on the infant

(Podeszwa 2004 [D], Stannard 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 1997 [B], Flynn 2004 [C], Kissel 1989 [C], Bhatt 2005 abstract [D], Buechsenschuetz 2002 [D]). See Table 1.

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 2003 [C], Kanlic 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 2005 abstract [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 2005 [B]).

C. patients 13 to 18 years old and body weight > 45.5 kg (100 lbs):

- antegrade locked intramedullary nailing (Buford 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 1998 [D], Greene 1998 [S], McCartney 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 2006 [C], Buford 1998 [C], Gordon 2004 [D], Gordon 2003 [D], Momberger 2000 [D], Townsend 2000 [D], Buess 1998 [D], Gonzalez-Herranz 1995 [D], Beaty 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 2005 abstract [D], Buechsenschuetz 2002 [D]).

Table 1: Failure Rate Of Flexible IM Nailing

Study	Age (yrs)	Failure Rate: Study Definition of Failure
(Bar-On 1997 [B])	6.9-13.2	0%: Angulation > 5°
(Buechsenschuetz 2002 [D])	5.25-14.92	19%: Angulation > 15° ages 3 to 5 yrs >10° ages 5 to 9 yrs > 5° age > 9 yrs
(Carey 1996 [D])	5.9-10.9	8%: Angulation > 5°
(Cramer 2000 [C])	5-14	7.5%: Any angulation > 0°
(Kissel 1989 [C])	8-13	7.1%: Angulation/ Malunion
(Ligier 1988 [C])	5-16	22.5%: Angulation > 5°

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, and
- assembly of appropriate members of the surgical team

(usually within 24 hours of the injury) (Kutscha-Lissberg 2001 [D], Hedequist 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 1999 [D]).

Table 2: Pain Medications

Medication	Indication	Dose	Frequency	Route	Maximum dose	Comments
Bupivacaine 0.25%	local anesthetic at conclusion of surgical procedure	up to 1.0 ml / kg	once	infiltrate incision	2.5 mg / kg	
Bupivacaine 0.5%	post-operative pain control	1-1.5 mg / kg	once	femoral nerve block injection	175 mg	Provides relief up to 8 hrs post-op
Morphine sulfate (> 6 months of age)	- perioperative, around-the-clock analgesia - patients on NPO	0.1 to 0.2 mg / kg	every 2 to 4 hrs	IV	15 mg	In opioid naïve patients, start with lower dose and repeat if needed
Morphine sulfate (< 6 months of age)	- perioperative, around-the-clock analgesia - patients on NPO	0.03 to 0.05 mg / kg	observe closely, repeating doses based on observed effects	IV	15 mg	Reduced clearance of morphine in this age group
Ketorolac	- perioperative, around-the-clock analgesia - patients on NPO	0.5 mg / kg	every 6 hrs	IV	15 mg	
Acetaminophen	mild pain	10 to 15 mg / kg	every 4 to 6 hrs	oral	5 doses in a 24 hour period	
Acetaminophen with codeine	moderate-severe pain	0.5 to 1 mg / kg (codeine)	every 4 to 6 hrs	oral	5 doses in a 24 hour period	
Oxycodone	moderate-severe pain in patients allergic to or unable to tolerate codeine	0.05 to 0.15 mg /kg	every 4 to 6 hrs	oral	10 mg	
Ibuprofen	- mild to moderate pain - adjunct for more severe pain	5 to 10 mg / kg	every 6 to 8 hrs	oral	400 mg	
Diazepam	muscle spasms	0.1 mg / kg	every 4 to 6 hrs	IV or IM (intra-muscular)	5 mg	Use with caution in neonates and young infants

(Formulary 2006 [X])

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 for summary of recommended doses for pain medications.

14. It is recommended that pain be routinely assessed using standard age appropriate scales (Salantera 1999 [C], AAP 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 2001 [S], Haberkern 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 2001 [S], Finley 1998 [S], AAP 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 2000 [C], Krauss 2006 [S], Murat 2003 [S], McCarty 1999 [S], AAP 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 2006 [S], Murat 2003 [S], Goldschneider 2001 [S], Dalens 1995 [S], Berde 1989 [S]).

Note 1: Wound infiltration with local anesthetic has been shown to decrease postoperative analgesic requirements (Goldschneider 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 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 1989 [C], Tondare 1982 [C], Denton 1988 [D], McCarty 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 1989 [C], Tondare 1982 [C], Denton 1988 [D], McCarty 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 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 2001 [S], Kart 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 2001 [S])
 - mild to moderate pain, and as an adjunct for more severe pain – consider ibuprofen administration (Souter 1994 [S])
- (AAP 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 2001 [M], Reuben 2005 [B], Glassman 1998 [D], Gajraj 2003 [S], Altman 1995 [F], Ho 1995 [F], Huo 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 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 1991 [S], Berde 1989 [S]);
- IV ketorolac (Sutters 1999 [B], Eberson 1999 [C], Forrest 1997 [S], Souter 1994 [S]);
- hematoma block (with bupivacaine) (Herrera 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 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 1984 [C], Morselli 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 2004 [M]*, *Southwell-Keely 2004 [M]*, *Classen 1992 [C]*, *ASHP 1999 [S,E]*, *Mangram 1999 [S]*).

This recommendation follows the principles of antibiotic prophylaxis:

- this procedure is classified as a Class I – clean wound as per 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 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 2004 [M]*, *Southwell-Keely 2004 [M]*).

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 choice (*Mangram 1999 [S]*). Vancomycin use is discouraged as it promotes emergence of vancomycin-resistant organisms (*Medical Letter 1999 [E]*).

Note 3: Reduced risk of wound infection has been demonstrated with prophylactic antibiotics administered up to two hours before surgery (*Classen 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 1985 [B]*, *Mangram 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 1997 [B]*, *Cramer 2000 [C]*, *Brumback 1999 [C,F]*, *McGraw 1997 [C]*, *Carey 1996 [D]*, *Timmerman 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); and
 - wheelchair management and/or mobility training (*Cramer 2000 [C]*, *McGraw 1997 [C]*, *Carey 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 1997 [B]*, *Cramer 2000 [C]*, *Ligier 1988 [C]*, *Carey 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 1999 [C,F]*, *Carey 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, and
 - that the edges of the cast be “petaled” (except for waterproof-lined casts)
- (*Shesser 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 1996 [C]*, *Omer 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° C (101° 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° C (101° F) occurring within the first seven days (*Clarke 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 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 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 1985 [C], Schwartz 1989 [D], Janzing 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 1996 [O], Tarlow 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 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 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 1995 [C], Shesser 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 1999 [S], AAP 1999 [E], Bull 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), and
- make arrangements for home tutoring if the school is unable to accommodate the child's medical needs (*Hughes 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, and
- 12 months

for comparison with data collected at presentation (see assessment recommendation #9) (*Lerman 2005 [C], Lerman 2002 [C], Pencharz 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 1989 [C], Skevington 2005 [O], Russak 2003 [O,S], Wolfe 1999 [S,E], Higginson 2001 [E], Pincus 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 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 2004 [C], Ligier 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 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 1988 [C], Local Expert Consensus [E]*).

Note: The flexible intramedullary nail system currently in use is not designed for permanent implantation (*Ligier 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]*).

Expected Outcomes

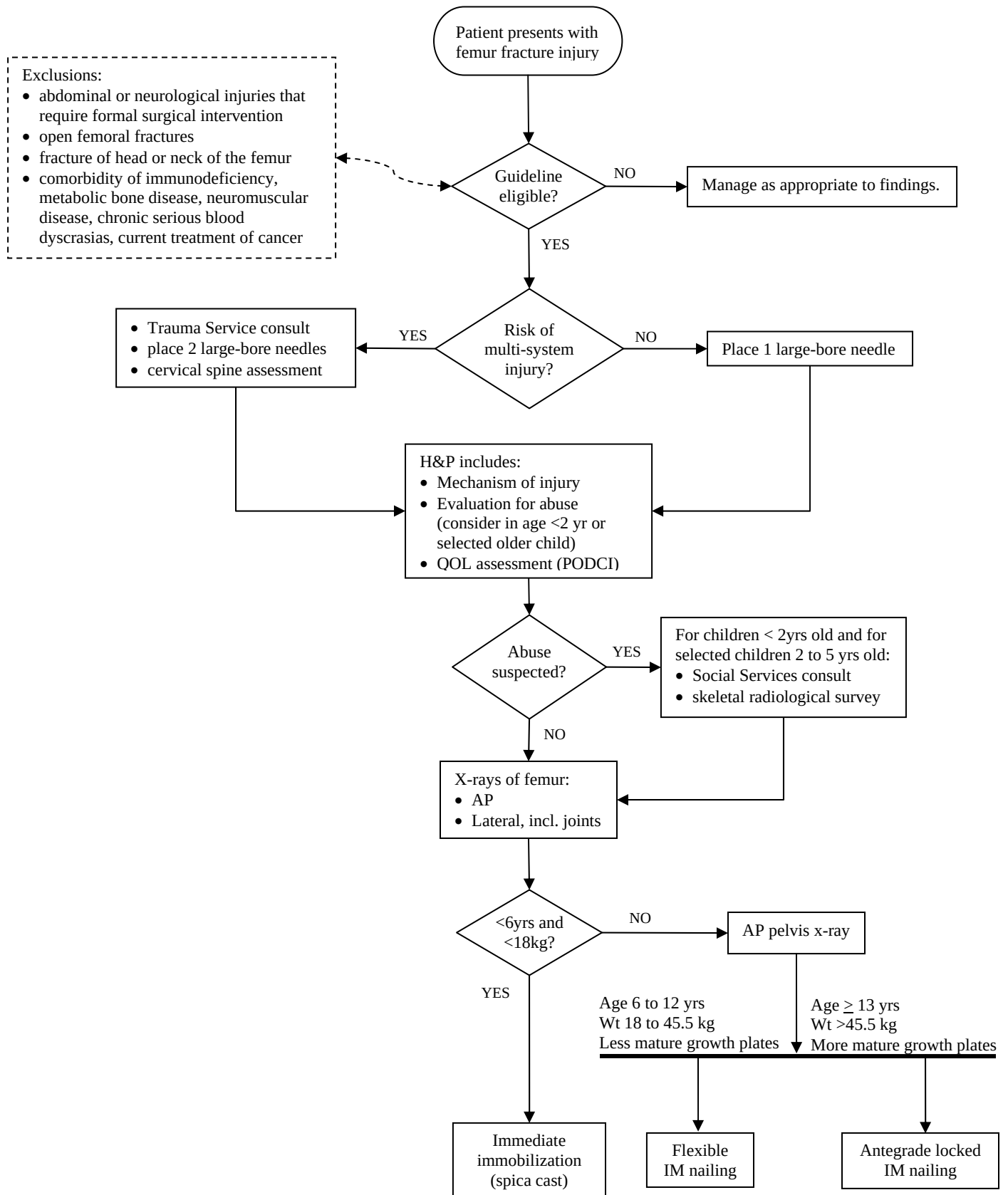
Short and long term expected outcomes for all patients include:

- age- and treatment-appropriate independent ambulation with an assistive device three to four weeks postoperatively;
- no significant alteration in pre-injury leg length;
- resolution of abnormal gait pattern by 12 months post-injury.

Future Research Agenda

1. What is the ideal peri-surgical protocol to minimize surgical site infection in children undergoing intramedullary nailing for femoral shaft fracture?
2. What is the reliability of acetaminophen with codeine in controlling moderate to severe postoperative pain in children, considering genetic variability of codeine metabolism?
3. For femoral shaft fracture patients monitored with the PODCI for quality of life outcomes, what is the overall patient/family and clinician satisfaction with the use of this instrument, and what benefits or adverse consequences of its use have not been previously identified?
4. What are the root causes of unscheduled returns to the operating room for children who have had intramedullary nailing for femoral shaft fracture?

Algorithm for Initial Care in the Management of Femoral Shaft Fractures in children 0 through 17 years of age



Members of the Femoral Shaft Fracture Guideline Team 2006

CCHMC Physicians

*Charles Mehlman DO, MPH, Orthopaedic Surgery
Chair
*Kenneth Goldschneider MD Pain Service
Gregg DiGiulio, MD Emergency Medicine
Stephen Muething, MD Gen. & Comm. Pediatrics

Patient Services

Heidi Malott, MSW Social Services
Kimberly Mason, RN, MSN Orthopaedic Nursing
*Dawn Butler, Pharm.D. Pharmacy
*Tammy Lingsch, RN Inpatient Surgical Nursing
*Barbara Nolte, PT Physical Therapy
Carie Norris, RN Outpatient Orthopaedic Nursing
Kaaren Shebesta, RN Trauma Services
Mariann Strenk, PT, MHS Occupational/Physical Therapy
Margot Daugherty, RN, MSN Trauma Services
Kristi Schroeder, RN Post Anesthesia Care Unit

Division of Health Policy Clinical Effectiveness Support

*Edward Donovan, MD Medical Director, Clinical Effectiveness
Eloise Clark, MPH Facilitator
Danette Stanko, MA, MPH Epidemiologist
*Kate Rich Lead Decision Support Analyst
Deborah Hacker, RN Medical Reviewer
Eduardo Mendez, RN, MPH Dir. Evidence-Based Care
Carol Tierney, RN, MSN Education Specialist

All Team Members and Clinical Effectiveness support staff listed above have signed a conflict of interest declaration.

Ad Hoc Advisors

*Richard Azizkhan, MD Chief of Surgery
*Thomas DeWitt, MD General/Community Peds
*Michael Farrell, MD Chief of Staff
*Victor Garcia, MD Trauma Services
Bob Shapiro, MD Mayerson Center for Safe and Healthy Children
*Uma Kotagal, MBBS, MSc VP, Division Director
Barbarie Hill Pratt Library
Eric Wall, MD Director, Orthopaedic Surgery
Richard Ruddy, MD Emergency Medicine, Director
Cheryl Hoying, RN, MS VP, Patient Services

*On original guideline development Team.

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

Appropriate companion documents have been developed to assist in the effective dissemination and implementation of the guideline. Experience with implementation of the original publication of this guideline has provided learnings which have been incorporated into this revision.

Proposed clinical outcome measures are:

- percent of patients able to transfer with assistance on post-operative day one (spica cast and flexible IM rod)
- percent of patients able to ambulate independently on post-operative day two (antegrade locked IM rod)
- percent of patients with improved pain scores within 24 hours of arrival on inpatient unit

Proposed process outcome measures are:

- percent of patients have patient controlled analgesia discontinued within 12 hours of arrival on inpatient unit
- percent of patients with home assessment completed within eight hours of arrival on inpatient unit
- percent of patients with medical equipment delivered to their inpatient room within 24 hours after surgical procedure
- percent of patients with medical equipment documented as delivered to home (if not using same equipment as inpatient)
- percent of patients with casting procedure beginning within four hours of triage in the emergency department
- percent of patients who have no other injuries arriving in operating room within 24 hours of triage in the emergency department
- percent of patients with baseline quality of life survey completed
- percent of patients with femoral shaft fracture order set utilized

Development Process

The process by which this guideline was developed is documented in the [Guideline Development Process Manual](#); a Team Binder maintains minutes and other relevant development materials. The recommendations contained in this guideline were formulated by an interdisciplinary working group which performed systematic and critical literature reviews, using the grading scale that follows, and examined current local clinical practices.

Once the guideline has been in place for three years, the development team reconvenes to explore the continued validity of the guideline. This phase can be initiated at any point that evidence indicates a critical change is needed.

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.

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.

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

Copies of this Evidence-Based Care Guideline (EBCG) and its companion documents are available online and may be distributed by any organization for the global purpose of improving child health outcomes. Website address: <http://www.cincinnatichildrens.org/svc/alpha/h/health-policy/ev-based/default.htm>. Examples of approved uses of the EBCG include the following:

- copies may be provided to anyone involved in the organization's process for developing and implementing evidence-based care guidelines;
- hyperlinks to the CCHMC website may be placed on the organization's website;
- the EBCG may be adopted or adapted for use within the organization, provided that CCHMC receives appropriate attribution on all written or electronic documents; and
- copies may be provided to patients and the clinicians who manage their care.

Notification of CCHMC at HPCEInfo@cchmc.org for any EBCG, or its companion documents, adopted, adapted, implemented or hyperlinked by the organization is appreciated.

NOTE: 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.

For more information about these guidelines, their supporting evidences and the guideline development process, contact the Health Policy & Clinical Effectiveness office at: 513-636-2501 or HPCEInfo@cchmc.org.

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