



James M. Anderson Center for Health
Systems Excellence

Evidence-Based Care Guideline

Post-Operative Management of Legg-Calve-Perthes Disease

In children aged 3 to 12 years^a

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Target Population

Inclusions:

Children ages 3 to 12 years old with diagnosis of Legg-Calve-Perthes disease (LCP) stages 1 to 4 status-post surgical intervention.

- Stage 1: Femoral head becomes more dense with possible fracture of supporting bone;
- Stage 2: Fragmentation and reabsorption of bone;
- Stage 3: Reossification when new bone has regrown;
- Stage 4: Final shape of the femoral head develops once skeletal growth is complete.

Exclusions:

Children with the following:

- Conservative management of LCP
- Other diagnosis of avascular necrosis in hip
- Femoral head injury or fracture
- Slipped capital femoral epiphysis
- Femur fracture
- Acetabular or pelvis fracture
- LCP present with other hip condition
- Acetabular labral tear
- Cancer or bone tumor in femur
- Arthritis in hip
- Hip dysplasia
- Cerebral palsy

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Target Users

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

- Athletic Trainers
- Community-based caregivers (e.g. physical education teachers, school personnel)
- Nurses
- Patients and families
- Physical Therapist Assistants
- Physical Therapists
- Primary care providers

Introduction

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

LCP disease progresses through four stages as seen on radiographs using Modified Waldenstrom Classification. The duration of each stage varies.

Stage 1-Initial Stage

The capital epiphysis of the femoral head stops growing causing a smaller ossific nucleus. Waldentrom's sign, or a fracture in the subchondral area of the femoral head, can be seen on frog leg radiographs in this stage. The femoral head appears to be denser. There are cysts and lucencies in the metaphysis that can also be seen on radiographs. The initial stage ends when the lucencies are in the ossific nucleus. Mean duration of this stage is 6 months (Herring 2001 [5b]).

Stage 2-Fragmentation Stage

Some areas of the femoral head are sclerotic, while lucencies remain in other areas. A central area of the femoral head separates from the medial and lateral portions. The acetabulum also becomes more irregular. The end of this stage occurs when new bone begins to develop in the subchondral areas of the femoral head. Mean duration of this stage is 8 months (Herring 2001 [5b]).

Stage 3-Rossification Stage

Healing of the femoral head begins. New subchondral bone develops in the head of the femur, beginning in the center and extending out. The last area to reossify is often the anterior segment of the femoral head. Eventually the femoral head is replaced with woven bone, which then remodels to trabecular bone. The flattening of the femoral head may improve. This stage ends when the entire head has reossified and is typically the longest of the four, with a mean duration of 51 months (Herring 2001 [5b]).

Stage 4-Residual Stage

There are no changes in the density of the bone, but the shape of the femoral head can change during this phase. The final shape of the femoral head is developed once skeletal growth is complete. The femoral head may vary widely in shape, from normal to flat, at the conclusion of this stage. The acetabulum can also change in shape during this stage. Over growth of the greater trochanter can occur due to disruption of growth in the capital physis (Herring 2001 [5b]).

The desired outcome of treatment of children with LCP is to contain the femoral head in the acetabulum to maximize a spherical shape of the femoral head for good joint congruency (Wenger 1991 [5a], Leach 2006 [5b]). However, there has been lack of agreement in effective treatment interventions in children with LCP to achieve this outcome (Weinstein 1997 [5a]). Treatment has ranged from observation only, use of range of motion (ROM) exercises, use of Petrie casts, use of braces, to surgical intervention (Wenger 1991 [5a], Leach 2006 [5b]). Evidence in the literature has been inconclusive regarding the success of conservative treatment only versus surgical intervention (Brech 2006 [3b], Herring 2004 [3b], Canavese 2008 [4b]). The orthopedic surgeon may determine that femoral head containment would best be achieved by surgical methods. There is a variety of surgical procedures that have been used alone or in combination to achieve containment including:

- Muscular release followed by application of Petrie cast (Salter 1984 [5a], Tamai 2004 [5b])
- Chiari pelvic osteotomy (Wenger 2010 [4b])
- Greater trochanter epiphysiodesis (Joseph 2003 [4b], Salter 1984 [5a])
- Proximal femoral varus osteotomy (Wenger 2010 [4b], Joseph 2003 [4b], Salter 1984 [5a], Tamai 2004 [5b])
- Salter innominate osteotomy (Wenger 2010 [4b], Salter 1984 [5a])
- Salter innominate osteotomy in combination with femoral varus osteotomy (Wenger 2010 [4b])
- Shelf acetabuloplasty (Hsu 2011 [1b])
- Staneli shelf acetabuloplasty (Wenger 2010 [4b])
- Triple pelvic osteotomy (Wenger 2010 [4b])
- Triple pelvic osteotomy in combination with varus femoral osteotomy (Wenger 2010 [4b])
- Placement of a hip spica cast for 6 weeks following the bony procedure (Wenger 2010 [4b]).

There is limited evidence regarding physical therapy (PT) treatment pathways post-operatively for these patients. The objectives of this guideline are to:

- Guide and support consistency in delivery of PT services for post-operative management of patients with LCP;
- Promote and optimize ROM, strength, and joint preservation to minimize impairments and maximize function;
- Maintain and improve patient and family satisfaction.

Etiology

LCP affects children 3 to 12 years old and is most common in children 5 to 7 years old (Wenger 1991 [5a], Leach 2006 [5b]). Males are affected 3 to 5 times more than females. There is bilateral hip involvement in 10% to 20% of cases (Wenger 1991 [5a]). Children with LCP disease typically present with a limp, which is a combination of an antalgic and a Trendelenburg type gait pattern. Pain is often present in the hip or referred to the thigh or knee (Tamai 2004 [5b]). Limp and pain are commonly made worse with strenuous activities (Tamai 2004 [5b]). ROM of the hip is limited, with the greatest limitations typically in hip abduction and internal rotation (Wenger 1991 [5a], Tamai 2004 [5b]).

The disease process involves avascular necrosis of the femoral head due to a loss of blood supply (Leach 2006 [5b]). As a result, growth is disturbed in the epiphyseal and physeal plates, resulting in premature closure. This can lead to a shortened femoral neck and trochanteric overgrowth. There is an asymmetric repair process causing deformity in the femoral head. The deformed femoral head then leads to a deformed acetabulum, especially in the lateral aspect (Weinstein 1997 [5a]). The etiology of the disease is unclear, but one theory is onset of the disease following an episode of transient synovitis of the hip (Wenger 1991 [5a], Leach 2006 [5b]). Children who present with LCP are typically small for their age and have delayed bone age (Weinstein 1997 [5a], Wenger 1991 [5a], Leach 2006 [5b]). Maintaining the femoral head in the acetabulum during the repair process should yield a more spherical femoral head and overall a more congruous joint (Wenger 1991 [5a]).

Prognosis

Prognosis of the disease has been determined using several criteria, including age of onset of the disease (Weinstein 1997 [5a], Wenger 1991 [5a], Leach 2006 [5b]), extent of involvement of the femoral head (Wenger 1991 [5a], Leach 2006 [5b]), amount of incongruity between the femoral head and acetabulum (Leach 2006 [5b]), and amount of hip joint deformity (Weinstein 1997 [5a]). Onset at a young age, minimal epiphyseal involvement, and short duration of the disease are favorable prognostic factors. Onset at an older age, greater epiphyseal involvement, lateral subluxation of the femoral head, and longer duration of the disease make up some of the poor prognostic factors (Tamai 2004 [5b]).

Guideline Recommendations

Inpatient Management Recommendations

1. It is recommended that a thorough history and examination be completed to establish an impairment based PT diagnosis and individualized plan of care (APTA 2001 [5b]).
2. It is recommended that transfer training and evaluation for medical equipment be performed for the patient referred to inpatient PT post-soft tissue release and application of a Petrie cast (Local Consensus [5]).
Note: Patient will be discharged from inpatient PT post-soft tissue release and Petrie cast application when patient and family are independent and safe with transfers (Local Consensus [5]).
3. It is recommended that the patient is referred to inpatient PT post-soft tissue release and removal of the Petrie cast, but prior to bony surgery to restore hip, knee, and ankle ROM and to maximize joint mobility to allow for adequate ROM for ease of surgical intervention (Local Consensus [5]).
4. It is recommended that the following are assessed at initial evaluation and at discharge from inpatient PT post soft tissue release and removal of the Petrie cast:
 - Pain using the Oucher Pain Scale (Beyer 2005 [4a]) or Numerical Rating Scale (NRS) (Williamson 2005 [1b], von Baeyer 2009 [4b])
 - Qualitative skin integrity assessment (Local Consensus [5])
 - Lower extremity (LE) passive range of motion (PROM)

Note 1: LE PROM assessment to include:

- Hip flexion
- Hip extension to no further than 0°
- Hip adduction
- Hip abduction
- Hip internal rotation (IR) with hip flexed to 90°
- Hip external rotation (ER) with hip flexed to 90°
- Knee flexion
- Knee extension
- Ankle dorsiflexion
- Ankle plantarflexion

(Local Consensus [5]).

Note 2: A fluid filled goniometer is to be used to measure ROM (Rao 2001 [4b]). However, use of a linear goniometer is also acceptable (Rao 2001 [4b], Clapper 1988 [4b], Local Consensus [5]).

5. It is recommended that the goals for inpatient PT post-soft tissue release and Petrie cast removal but prior to bony surgery include:
 - Hip flexion to 120°
 - Maximize hip abduction, hip IR, and hip ER ROM
 - Hip extension to no further than 0°
 - Knee flexion to 120°
 - Maximize ankle plantarflexion and dorsiflexion
 - Maximize integrity of the skin
 - Minimize pain(Local Consensus [5]).
6. It is recommended that the following treatment interventions be utilized for impairments found during initial assessment:
 - Pain management
 - Warm whirlpool (Local Consensus [5]), cryotherapy, or hot pack based on patient preference (Nadler 2004 [5a])
 - Gentle PROM (Local Consensus [5])
 - Improving ROM
 - Gentle passive static stretching for LE musculature (Moseley 2005 [2a], Bandy 1998 [2a], Davis 2005 [2b])
 - Warm whirlpool (Local Consensus [5]) or hot pack for muscle relaxation and pain management with stretching (Taylor 1995 [2b], Nadler 2004 [5a])

- Perform active range of motion (AROM) and active assistive range of motion (AAROM) following passive stretching to maintain newly gained ROM (*Depino 2000 [2b]*)
 - Improving Skin Integrity
 - A warm whirlpool may be utilized to promote improved skin integrity (*Local Consensus [5]*).
7. It is recommended that patients are discharged from inpatient PT post-soft tissue release and removal of the bony cast when the bony surgical procedure is performed (*Local Consensus [5]*).
Note: Transfer training and evaluation for medical equipment following the bony surgery and application of the hip spica cast may be completed if needed (*Local Consensus [5]*).

Outpatient Management Recommendations

Clinical Assessment

8. It is recommended that patients begin post-operative PT following bony surgery one week after removal of the cast (*Local Consensus [5]*).
Note: Individuals who participate in supervised clinic visits demonstrate greater improvement in muscle strength, functional mobility, gait speed, and quality of exercise performance than those who receive a home exercise program (HEP) alone or no instruction at all (*Friedrich 1996 [2b]*). Individuals who receive regular positive feedback from PT are more likely to be compliant with a supplemental HEP (*Sluijs 1993 [4b]*).
9. It is recommended that a second thorough history and examination be completed to establish an outpatient impairment based PT diagnosis and individualized plan of care (*APTA 2001 [5b]*).
Note: Obtaining a pertinent history includes communication with the referring physician regarding the surgical procedure, associated precautions, and physician preferences (*Local Consensus [5]*).
10. It is recommended that the following are assessed at the initial evaluation, on a monthly basis or more frequently if the patient demonstrates a change in status, and at discharge:
- Pain and symptoms
 - LE PROM and AAROM and/or AROM
 - LE strength
 - Gait

- Balance
- Patient reported outcome measures

(*Local Consensus [5]*).

Pain and Symptoms

11. It is recommended that pain is assessed at each visit using the Oucher Pain Scale (*Beyer 2005 [4a]*) or NRS (*Williamson 2005 [1b]*, *von Baeyer 2009 [4b]*).

Lower extremity PROM and AROM

12. It is recommended that a fluid filled goniometer be used to measure ROM (*Rao 2001 [4b]*).
Note 1: Hip ROM to assess includes hip flexion, abduction, extension, IR, and ER.
Note 2: Use of a linear goniometer is also acceptable (*Rao 2001 [4b]*, *Clapper 1988 [4b]*, *Local Consensus [5]*).
13. It is recommended that knee and ankle ROM be assessed at the initial evaluation and thereafter, as needed based on limitations (*Local Consensus [5]*).

Lower extremity strength

14. It is recommended that quantitative muscle testing is performed using a hand held dynamometer (*Gajdosik 2005 [4b]*, *Escolar 2001 [4b]*).
Note 1: Muscle groups to assess include hip flexors, hip abductors, hip extensors, hip internal rotators, hip external rotators, knee extensors, knee flexors, and any other muscle group that is significantly limited (*Local Consensus [5]*).
Note 2: The hand held dynamometer has been found to have high intra- and inter-rater reliability with quantitative muscle testing (*Gajdosik 2005 [4b]*, *Escolar 2001 [4b]*).

Gait/Functional Mobility

15. It is recommended that functional mobility and gait be qualitatively assessed following post-operative weight bearing (WB) precautions (*Local Consensus [5]*).
Note 1: Commonly observed gait characteristics seen in children with LCP when WB on the involved LE include, but are not limited to:
- increased hip adduction on stance leg (*Westhoff 2006 [4b]*)
 - trunk lean outside the normal range (*Westhoff 2006 [4b]*)
 - Trendelenburg (*Westhoff 2006 [4b]*) (hip drop on unaffected limb while in swing)
 - compensated Trendelenburg/reverse Trendelenburg/Duchenne (*Westhoff 2006 [4b]*) (trunk lean to the affected side while in stance on the affected limb)

- toe in or toe out (*Yoo 2008 [4b]*)
- decreased hip extension during stance (*Westhoff 2012 [4b]*).

Note 2: Commonly observed gait characteristics seen in children following removal of a hip spica cast include, but are not limited to:

- increased dorsiflexion
- increased hip and knee flexion
- compensated Trendelenburg

(*Wong 2004 [2b]*).

16. It is recommended that the gold standard for gait analysis of 3-D kinematics and kinetics (*Toro 2003 [1b]*) not be used in the clinic due to limited accessibility and feasibility (*Local Consensus [5]*).

Note: There is insufficient evidence and lack of reliability and validity (*Toro 2003 [1b]*) to support use of these observational gait assessment tools with this population (*Local Consensus [5]*).

Balance

17. It is recommended that balance is assessed in patients 7 years old or older using the Pediatric Balance Scale (*Franjoine 2003 [4b]*) as WB status allows (*Local Consensus [5]*).

Note: Balance is assessed using single leg stance on the involved side compared to the uninvolved side if:

- the patient is younger than 7 years old
- the patient is unable to follow commands
- the test is unavailable
- time does not permit its use

(*Local Consensus [5]*).

Outcome measure scores

18. It is recommended that the age appropriate Pediatric Quality of Life Inventory Version 4.0 (PedsQL) (*Varni 2001 [4a]*) Physical Functioning section is administered at the initial evaluation, on a monthly basis, and at discharge for reassessment of patient's reported functional status (*Local Consensus [5]*).

Note 1: The Parent Report for Toddlers is administered for children 2 to 4 years old (*Varni 2007a [4a]*).

Note 2: The Young Child Self Report is administered for children 5 to 7 years old (*Varni 2007a [4a]*).

Note 3: The Child Self Report is administered for children 8 to 12 years old (*Varni 2007a [4a]*).

Note 4: For patients 5 to 12 years old unable to conceptually understand the questionnaire tool, it is acceptable for the parent to complete the parent proxy form for the young child (5 to 7 years old) or child (8 to 12 years old) (*Varni 2007b [4a]*).

Physical Therapy Interventions

19. It is recommended that supervised PT is supplemented with a customized written HEP (*Friedrich 1996 [2b]*) in all phases of rehabilitation (*Local Consensus [5]*).
20. It is recommended that the PT engage in ongoing communication with the patient, family, and referring physician regarding the disease process and plan of care (*Local Consensus [5]*).
21. It is recommended that advancement through the phases of rehabilitation follow both a goal based and time based progression, due to the nature of the surgical procedure and disease process (*Local Consensus [5]*).

Note: Treatment is to focus on containment of the femoral head in the acetabulum throughout the disease process (*Wenger 1991 [5a]*, *Leach 2006 [5b]*) and each phase of rehabilitation (*Local Consensus [5]*).

Phases of Rehabilitation

Initial Phase (0 to 2 weeks post-cast removal)

22. It is recommended that goals of the Initial Phase include:
- minimize pain
 - optimize ROM of hip, knee, and ankle
 - increase strength to 3/5 or greater for hip flexion, abduction, and extension
 - increase strength to 3+/5 or greater for the knee and ankle
 - increase independence with functional mobility using appropriate assistive devices and maintaining WB status
- (*Local Consensus [5]*).
23. It is recommended that supervised PT services are provided weekly (*Bailes 2008 [5a]*) at a frequency of 2 to 3 times per week (*Local Consensus [5]*).
24. It is recommended that treatment interventions of the Initial Phase used to address these specific goals include:
- Minimizing Pain
 - Hot pack for relaxation and pain management with stretching (*Taylor 1995 [2b]*, *Nadler 2004 [5a]*)
 - Cryotherapy (*Nadler 2004 [5a]*)

- Medications for pain as prescribed by the referring physician (*Local Consensus [5]*)
 - Increasing ROM (See Appendix 1 for exercise prescription)
 - Passive static stretch (*Moseley 2005 [2a]*, *Bandy 1998 [2a]*, *Davis 2005 [2b]*) for LE musculature. **Note:** A hot pack may be used with passive static stretching based on patient preference and comfort (*Taylor 1995 [2b]*, *Nadler 2004 [5a]*).
 - Dynamic ROM (*Bandy 1998 [2a]*) and AAROM as appropriate if the patient is muscle guarding due to pain and/or is unable to achieve end ROM with passive static stretch (*Local Consensus [5]*)
 - Perform AROM and AAROM following passive stretching to maintain newly gained ROM (*Depino 2000 [2b]*)
 - Perform stretching in a position that is suitable for the individual including hip IR, hip ER, hip abduction, and hip extension (*Local Consensus [5]*)
 - Increasing strength (See Appendix 2 for exercise prescription)
 - Begin with isometric exercises at the hip and progress to isotonic exercises in a gravity lessened position (*Brech 2006 [3b]*)
 - Begin with isometric exercises at the knee and ankle, progressing to isotonic exercises in a gravity lessened position with further progression to isotonic exercises against gravity (*Brech 2006 [3b]*)
 - Begin with 2 sets of 10 to 15 repetitions of each exercise (*Rhea 2002 [2b]*, *Faigenbaum 1996 [4b]*) with progression to 3 sets of each exercise to be used (*Rhea 2002 [2b]*)
Note: If the patient is unable to perform 2 sets of 10 repetitions of an exercise, decrease the difficulty of the exercise through weight or type of exercise (*Local Consensus [5]*).
 - Focus on strengthening of hip abductors, hip flexors, hip ER, hip IR, hip extensors, or other LE muscle group that displays weakness (*Local Consensus [5]*)
 - Improving Skin Integrity
 - Scar massage and desensitization to minimize adhesions (*Local Consensus [5]*)
 - Warm bath to improve skin integrity following cast removal, if feasible in the home environment (*Local Consensus [5]*)
 - Warm whirlpool may be utilized if the patient is unable to safely utilize a warm bath for skin integrity management (*Local Consensus [5]*)
 - Improving gait and functional mobility
 - Follow the referring physician's guidelines for WB status (*Local Consensus [5]*)
 - Transfer training and bed mobility to maximize independence with ADL's (*Local Consensus [5]*)
 - Gait training with the appropriate assistive device, focusing on safety and independence (*Local Consensus [5]*).
- Intermediate Phase (2 to 6 weeks post-cast removal)**
25. It is recommended that goals of the Intermediate Phase include:
- minimize pain
 - normalize ROM of the knee and ankle
 - optimize ROM of hip in all directions
 - increase strength of the knee and hip, except for hip abductors, to at least 60% of the uninvolved LE
 - increase strength of the hip abductors to at least 50% of the uninvolved LE due to mechanical disadvantage (*Joo 2008 [4b]*, *Salter 1984 [5a]*)
 - maintain independence with functional mobility maintaining WB status and use of appropriate assistive devices
- (*Local Consensus [5]*).
26. It is recommended that supervised PT services are provided weekly (*Bailes 2008 [5a]*) at a frequency of 2 times per week (*Local Consensus [5]*).
27. It is recommended that treatment interventions of the Intermediate Phase used to address these specific goals include:
- Minimizing Pain
 - Hot pack for relaxation and pain management with stretching (*Taylor 1995 [2b]*, *Nadler 2004 [5a]*)
 - Cryotherapy (*Nadler 2004 [5a]*)
 - Medications for pain as prescribed by the referring physician (*Local Consensus [5]*)
 - Increasing ROM (See Appendix 1 for exercise prescription)

- Passive static stretch (*Moseley 2005 [2a], Bandy 1998 [2a], Davis 2005 [2b]*) for LE musculature
Note: A hot pack may be used with passive static stretching based on patient preference and comfort (*Taylor 1995 [2b], Nadler 2004 [5a]*).
 - Dynamic ROM (*Bandy 1998 [2a]*) and AAROM may be appropriate if the patient is muscle guarding due to pain and unable to achieve end ROM with passive static stretch (*Local Consensus [5]*)
 - Perform AROM and AAROM following passive stretching to maintain newly gained ROM (*Depino 2000 [2b]*)
 - Perform stretching in a position that is suitable for the individual and include hip IR, hip ER, hip abduction, hip extension (*Local Consensus [5]*)
 - Perform stretching of the knee and ankle as needed based on remaining limitations (*Local Consensus [5]*)
 - Increasing strength (See Appendix 2 for exercise prescription)
 - Isotonic exercises of the hip in gravity lessened positions and advancing to against gravity positions (*Brech 2006 [3b]*)
 - Isotonic exercises of the knee and ankle in gravity lessened and against gravity positions (*Brech 2006 [3b]*)
 - Begin closed chain double limb (DL) exercises with very light resistance (less than 50% body weight on involved LE) (*Bolgia 2005 [4b]*) if WB status allows
 - Improving Skin Integrity
 - Continue with scar massage and desensitization (*Local Consensus [5]*)
 - Improving gait and functional mobility
 - Follow the referring physician's guidelines for WB status (*Local Consensus [5]*)
 - Continue gait training with the appropriate assistive device focusing on safety and independence (*Local Consensus [5]*)
 - Begin slow walking in chest deep pool water with arms submerged (*Roesler 2006 [4b], Harrison 1992 [4b]*).
28. It is recommended that activities outside of PT are restricted at this time due to WB status. If the referring physician allows, swimming is permitted (*Local Consensus [5]*).
- Advanced Phase (6 to 12 weeks post-cast removal)**
29. It is recommended that the goals of the Advanced Phase include:
- minimize pain
 - optimize ROM and flexibility of the hip, knee, and ankle
 - increase strength of the knee and hip, except for hip abductors, to at least 70% of the uninvolved LE
 - increase strength of the hip abductors to at least 60% of the uninvolved LE due to mechanical disadvantage (*Joo 2008 [4b], Salter 1984 [5a]*)
 - ambulation without use of an assistive device or pain
 - negotiate stairs independently using step to pattern with upper extremity (UE) support
 - improve balance to greater than 69% of the maximum Pediatric Balance Score (39/56) or single limb stance of the uninvolved side (*Local Consensus [5]*).
30. It is recommended that supervised PT services are provided weekly (*Bailes 2008 [5a]*) at a frequency of 1 to 2 times per week (*Local Consensus [5]*).
31. It is recommended that treatment interventions of the Advanced Phase used to address these specific goals include:
- Minimizing pain
 - Hot pack for relaxation and pain management with stretching (*Taylor 1995 [2b], Nadler 2004 [5a]*)
 - Cryotherapy (*Nadler 2004 [5a]*)
 - Medications for pain as prescribed by the referring physician (*Local Consensus [5]*)
 - Increasing ROM (See Appendix 1 for exercise prescription)
 - Static stretch (*Moseley 2005 [2a], Bandy 1998 [2a], Davis 2005 [2b]*) for LE musculature focusing on the hamstrings, quadriceps, hip flexors, gastrocnemius, hip adductors, and hip rotators to maintain containment of the femoral head and allow for normalized gait (*Local Consensus [5]*)
 - Dynamic ROM (*Bandy 1998 [2a]*) and AAROM may be appropriate if the patient is muscle guarding due to pain and unable to achieve end ROM with passive static stretch (*Local Consensus [5]*)

- Perform AROM and AAROM following passive stretching to maintain newly gained ROM (*Depino 2000 [2b]*)
 - Increasing strength (See Appendix 2 for exercise prescription)
 - Isotonic exercises of the hip, knee, and ankle in gravity lessened and against gravity positions, including concentric and eccentric contractions (*Brech 2006 [3b]*)
 - WB and non-weight bearing (NWB) activities can be used in combination based on the patient's ability (*Jacobs 2008 [4b]*) and goals of the treatment session (*Local Consensus [5]*)
 - Begin UE supported functional dynamic single limb activities (e.g. step ups, side steps) (*Local Consensus [5]*)
 - Continue with double limb closed chain exercises with resistance, progressing to single limb closed chain exercises with light resistance if WB status allows (*Local Consensus [5]*)
 - Use of a stationary bike in an upright or recumbent position keeping the hip in less than 90 degrees of flexion (*Local Consensus [5]*)
 - Improving balance
 - Begin with activities that include DL stance on stable surfaces with a narrowed base of support, progressing to perturbations (*Local Consensus [5]*)
 - Progress to DL stance on unstable surfaces with a wide base of support, progressing to perturbations (*Local Consensus [5]*)
 - Improving gait and functional mobility
 - Gait training WB as tolerated (WBAT) with an appropriate assistive device when the referring physician allows, focusing on minimizing deficits (*Local Consensus [5]*)
Note 1: WB forces and muscle actions on bone are important stimulators of bone formation and maintenance of bone mineral density. Altered WB patterns and reflex inhibition of the hip abductors on the involved LE can lead to deficits in bone mineral density at the trochanter (*Bailey 1997 [4b]*).
Note 2: Gait compensations can alter loading of the hip joint. A Trendelenburg gait pattern with prolonged hip adduction during stance increases load on the hip joint. An elevation of the pelvis combined with trunk lean towards the stance limb, hip abduction, and hip ER unloads the hip joint (*Svehlik 2012 [4b]*).
 - Progress gait training without an assistive device as appropriate, focusing on minimizing deficits and improving efficiency of walking (*Local Consensus [5]*)
 - Progress to walking on uneven surfaces with an emphasis on safety (*Local Consensus [5]*)
 - Stair negotiation with a step to pattern and UE support (*Local Consensus [5]*)
 - Use of a heel lift may be utilized, if needed, due to leg length discrepancy to improve quality of gait (*Local Consensus [5]*).
32. It is recommended that activities outside of PT are limited to swimming if the referring physician allows (*Local Consensus [5]*).
Note: Running and jumping activities are restricted at this time (*Local Consensus [5]*).
- Pre-Functional Phase (12 weeks to 1+ year post-cast removal)**
33. It is recommended that the goals of the Pre-Functional Phase include:
- minimize pain
 - optimize ROM and flexibility of the hip, knee, and ankle
 - increase strength of the knee and hip, except for hip abductors, to at least 80% of the uninvolved LE
 - increase strength of the hip abductors to at least 75% of the uninvolved LE due to mechanical disadvantage (*Joo 2008 [4b]*, *Salter 1984 [5a]*)
 - non-painful gait pattern with minimal deficits and normal efficiency
 - negotiate stairs independently with reciprocal pattern and UE support
 - improve balance to 80% or greater of the maximum Pediatric Balance Score (at least 45/56) or single limb stance of the uninvolved side (*Local Consensus [5]*).
34. It is recommended that supervised PT services are provided weekly (*Bailes 2008 [5a]*) at a frequency of 1 time per week (*Local Consensus [5]*) initially and progressed on a periodic or bimonthly basis (*Bailes 2008 [5a]*) later at a frequency of 1 to 2 times per

month as the family is able to demonstrate independence and self-report compliance with HEP and the patient maintains strength and ROM while waiting to progress to the Functional Phase (*Local Consensus [5]*).

Note: Sufficient bone healing needs to be determined by the physician before progressing to the Functional Phase (*Local Consensus [5]*).

35. It is recommended that treatment interventions of the Pre-Functional Phase used to address these specific goals include:
- Minimizing pain
 - Hot pack for relaxation and pain management with stretching (*Taylor 1995 [2b]*, *Nadler 2004 [5a]*)
 - Cryotherapy (*Nadler 2004 [5a]*)
 - Medications for pain as prescribed by the referring physician (*Local Consensus [5]*)
 - Increasing ROM (See Appendix 1 for exercise prescription)
 - Static stretch (*Moseley 2005 [2a]*, *Bandy 1998 [2a]*, *Davis 2005 [2b]*) for LE musculature focusing on the hamstrings, quadriceps, hip flexors, gastrocnemius, hip adductors, and hip rotators based on remaining limitations (*Local Consensus [5]*)
 - Increasing strength (see Appendix 2 for exercise prescription)
 - Progress isotonic exercises of the hip, knee, and ankle including concentric and eccentric contractions (*Brech 2006 [3b]*)
 - Use WB and NWB activities in combination based on the patient's ability (*Jacobs 2008 [4b]*) and goals of the treatment session (*Local Consensus [5]*)
 - Progress functional dynamic single limb activities (e.g. step ups, side steps) with UE support only as needed for patient safety (*Local Consensus [5]*)
 - Progress single limb closed chain exercises with resistance (*Bolgia 2005 [4b]*)
 - Use of a stationary bike in an upright or recumbent position keeping the hip in less than 90 degrees of flexion (*Local Consensus [5]*)
 - Improving balance
 - DL stance with narrowed base of support on unstable surfaces with perturbations (*Local Consensus [5]*)

- Static single limb (SL) stance activities on stable surfaces, progressing to perturbations and unstable surfaces (*Local Consensus [5]*)
- Improving gait and functional mobility
 - Progress gait training focusing on minimizing deficits and normalizing efficiency without use of an assistive device (*Local Consensus [5]*)
 - Stair negotiation with a reciprocal pattern with UE support (*Local Consensus [5]*).

36. It is recommended that activities outside of PT include swimming and bike riding as guided by the referring physician (*Local Consensus [5]*).
- Note:** Continue to restrict running and jumping activities (*Local Consensus [5]*).

Functional Phase

37. It is recommended that progression to the Functional Phase occur when the physician has determined there is sufficient reossification of the femoral head based on radiographs (*Local Consensus [5]*).
- Note 1:** Jumping and other impact activities are still limited and only progressed per instruction from the physician based on healing and progression of the disease process (*Local Consensus [5]*).
- Note 2:** It is appropriate for the patient to transition to Return to Activity Following Lower Extremity Injury Clinical Practice Guideline (*Schmitt 2010 [5a]*) if the patient meets the following criteria:
- has been released by the referring physician
 - meets the inclusion criteria
 - plans on returning to sports activity
- (*Local Consensus [5]*).
38. It is recommended that the goals of the Functional Phase include:
- Reduce pain to 1/10 or less
 - Increase ROM to 90% or greater of the uninvolved side for the hip, knee, and ankle, except for hip abduction
 - Increase hip abduction ROM to 80% or greater due to potential bony block (*Grzegorzewski 2006 [4b]*)
 - Increase strength of the knee and hip, except for hip abductors, to 90% or greater of the uninvolved LE
 - Increase strength of the hip abductors to at least 85% of the uninvolved LE due to mechanical disadvantage (*Joo 2008 [4b]*, *Salter 1984 [5a]*)

- Ambulation with a non-painful limp and normal efficiency
- Negotiation of stairs independently using a reciprocal pattern without UE support
- Improve balance to 90% or greater of the maximum score on the Pediatric Balance Scale (at least 51/56) or single limb stance of the uninvolved side

(Local Consensus [5]).

39. It is recommended that supervised PT services are provided on a periodic or bimonthly basis (Bailes 2008 [5a]) at a frequency of 1 to 2 times per month (Local Consensus [5]).

40. It is recommended that treatment interventions for the Return to Activity Phase for these goals include:

- Minimizing pain
 - Hot pack for relaxation and pain management with stretching (Taylor 1995 [2b], Nadler 2004 [5a])
 - Cryotherapy (Nadler 2004 [5a])
 - Medications for pain as prescribed by the referring physician as needed (Local Consensus [5])
- Normalizing ROM (See Appendix 1 for exercise prescription)
 - Static stretch (Moseley 2005 [2a], Bandy 1998 [2a], Davis 2005 [2b]) for LE musculature focusing on the hamstrings, quadriceps, hip flexors, gastrocnemius, hip adductors, and hip rotators as needed based on remaining deficits (Local Consensus [5])
- Normalizing strength (see Appendix 2 for exercise prescription)
 - Progress isotonic exercises of the hip, knee, and ankle and include concentric and eccentric contractions (Brech 2006 [3b])
 - WB and NWB activities used in combination based on the patient's ability (Jacobs 2008 [4b]) and goals of the treatment session (Local Consensus [5])
 - Functional dynamic single limb activities (e.g. step ups, side steps) with UE support as needed for patient safety (Local Consensus [5])
 - Progress SL closed chain exercises with resistance (Bolgia 2005 [4b])
 - Use of a stationary bike in an upright or recumbent position keeping the hip in less

than 90 degrees of flexion (Local Consensus [5])

- Normalizing balance
 - Static SL stance activities on unstable surfaces with perturbations (Local Consensus [5])
 - Progress SL stance with dynamic movements and in multiple planes (Local Consensus [5])
- Normalizing gait
 - Progress gait training focusing on minimizing deficits and improving efficiency (Local Consensus [5])
 - Progress functional mobility working on age appropriate activities, including running, skipping, and galloping. Focus on safety and minimizing deficits following physician precautions (Local Consensus [5])
 - Stair negotiation with a reciprocal pattern without UE support (Local Consensus [5]).

41. It is recommended that progression of running, jumping, and contact activities be resumed during this phase as guided by the referred physician and determined safe by the physical therapist (Local Consensus [5]).

Note: Swimming and biking may be continued during this phase (Local Consensus [5]).

Discharge Criteria

42. It is recommended that children be discharged from PT when four of five of the following criteria have been met:

- Pain rating 0 to 1/10 (Local Consensus [5])
- ROM 90 to 100% of the uninvolved side except for hip abduction at 80% of the uninvolved side (Local Consensus [5]) due to potential bony block (Grzegorzewski 2006 [4b])
- Strength 90 to 100% of the uninvolved side (Local Consensus [5]) except for hip abduction at 85% of the uninvolved side due to mechanical disadvantage (Joo 2008 [4b], Salter 1984 [5a])
- Balance 90 to 100% of total score for the Pediatric Balance Scale (score of 51/56) (Franjoine 2010) or maintaining balance with SL stance 90 to 100% of the uninvolved side (Local Consensus [5])
- Gait presents with a non-painful limp when walking and running and uses a reciprocal pattern without UE support on stairs (Local Consensus [5]).

43. It is recommended that following discharge from supervised PT, the patient continue a HEP to maintain improvements in strength, balance, locomotor function, and pain control until it has been determined by the physician that the disease process is complete (*Local Consensus [5]*).
44. It is recommended that PT services are provided as needed on a consultative basis (*Bailes 2008 [5a]*) to manage flare up of symptoms or other concerns until the disease process has resolved (*Local Consensus [5]*).

Future Research Agenda

1. In patients, status-post surgical intervention for Legg-Calve-Perthes, what are the long term outcomes related to pain and functional level?
2. In patients, status-post surgical intervention for Legg-Calve-Perthes, what is the effect of limiting WB on joint integrity and long term functional level?

Appendix 1

ROM Exercise Prescription				
Intervention	Parameters	Intensity	Notes	Muscle Groups
Passive Static Stretch	<ul style="list-style-type: none"> • 2 minutes of stretching per day, per muscle group (<i>Santonja Medina 2007 [2b], Cipriani 2003 [4b]</i>) • 30 second hold time, doing 4 repetitions per muscle group (<i>Reid 2004 [2b], Depino 2000 [2b], Bandy 1994 [2b]</i>) • If not tolerated, may do 10 to 30 second hold time with repetitions adjusted to meet 2 minute requirement (e.g. if holding 15 seconds, would do 8 stretches) (<i>Cipriani 2003 [4b], Roberts 1999 [4b]</i>) 	<ul style="list-style-type: none"> • Gentle static hold • Within patient pain tolerance and without muscle guarding so as to prevent tissue damage and inflammatory response (<i>Santonja Medina 2007 [2b], Davis 2005 [2b], Bandy 1994 [2b]</i>) 	<ul style="list-style-type: none"> • This is the preferred method of stretching to gain flexibility and/or ROM (<i>Moseley 2005 [2a], Davis 2005 [2b], Bandy 1994 [2b]</i>). • Stretching to be done after warm up, but prior to active exercises to maintain newly gained ROM (<i>Depino 2000 [2b]</i>) 	<p>Address any limited motions or tight muscles in the lower extremities with particular emphasis on the following:</p> <ul style="list-style-type: none"> • hip adductors • hip internal rotators • hip external rotators • hip flexors <p>(<i>Local Consensus [5]</i>)</p>
Dynamic ROM	<ul style="list-style-type: none"> • 5 second hold, done with 24 repetitions per muscle group per day to meet 2 minute stretching time required (<i>Bandy 1998 [2a], Santonja Medina 2007 [2b], Cipriani 2003 [4b]</i>) 	<ul style="list-style-type: none"> • Self-selected intensity by patient as long as not causing pain (<i>Local Consensus [5]</i>) 	<ul style="list-style-type: none"> • Done with patient activation of antagonistic muscle group (<i>Bandy 1998 [2a]</i>) • Done with slow movement to end range for full benefit (<i>Bandy 1998 [2a]</i>) • This is done if patient does not tolerate passive static stretch 	

Appendix 2

Strengthening Exercise Prescription				
Intervention	Parameters	Intensity	Notes	Muscle Groups
Isometric Strengthening	<ul style="list-style-type: none"> • 10 second hold with 10 repetitions per muscle group, for a total of 100 seconds (<i>Local Consensus [5]</i>) • Can adjust hold time to 5 seconds, would then adjust to 20 repetitions to meet 100 second requirement <i>Local Consensus [5]</i>) 	<ul style="list-style-type: none"> • Performed at approximately 75% maximal contraction (<i>Local Consensus [5]</i>) 	<ul style="list-style-type: none"> • Performed with hip in neutral position, <ul style="list-style-type: none"> ○ 0 degrees hip flexion/extension, ○ 0 degrees hip abduction/adduction and ○ 0 degrees hip external/internal rotation <p>(<i>Local Consensus [5]</i>)</p>	<p>Address any lower extremity muscle that demonstrates weakness with special attention given to the following:</p> <ul style="list-style-type: none"> • hip abductors (especially gluteus medius) • hip internal rotators • hip external rotators • hip flexors • hip extensors (<i>Plasschaert 2006 [4b], Westhoff 2006 [4b], Bolgla 2005 [4b]</i>).
Isotonic Strengthening	<ul style="list-style-type: none"> • High repetitions (10 to 15 reps) and 2 to 3 sets (<i>Campos 2002 [2b], Faigenbaum 1999 [2b]</i>) • Perform both concentric and eccentric contractions (<i>Brech 2006 [3b]</i>) 	<ul style="list-style-type: none"> • Low resistance (<i>Campos 2002 [2b], Faigenbaum 1999 [2b]</i>) • Rest 1 to 3 minutes between sets (<i>Campos 2002 [2b], Jacobs 2008 [4b], Bolgla 2005 [4b]</i>) (depending on strength and endurance) • Rest can include exercise of a different muscle group or cessation of activity (<i>Local Consensus [5]</i>) 	<ul style="list-style-type: none"> • If patient is unable to perform 2 sets of 10 repetitions with proper form, decrease exercise intensity either through weight or type of exercise (<i>Local Consensus [5]</i>). 	

Members of Legg-Calve-Perthes Disease Team 2012

Division of Occupational Therapy and Physical Therapy Guideline Development Team

Julie A. Lee, PT, DPT, Team Leader, Division of Occupational Therapy and Physical Therapy
Michael D. Allen, PT, OCS, Division of Occupational Therapy and Physical Therapy
Kathleen Hugentobler, PT, DPT, Division of Occupational Therapy and Physical Therapy
Christopher Kovacs, PT, DPT, CSCS, Division of Occupational Therapy and Physical Therapy
Jessica King Monfreda, PT, DPT, Division of Occupational Therapy and Physical Therapy
Barbara Nolte, PT, Division of Occupational Therapy and Physical Therapy
Elizabeth Woeste, MPT, Division of Occupational Therapy and Physical Therapy

Senior Clinical Director

Rebecca D. Reder OTD, OTR/L, Division of Occupational Therapy and Physical Therapy

All Team Members listed above have signed a conflict of interest declaration and none were found.

Ad hoc Advisors

Michelle Kiger, OTR/L, Division of Occupational Therapy and Physical Therapy
Mary Gilene, MBA, Division of Occupational Therapy and Physical Therapy
G. Stephen Morris, PT, PhD, FACSM, Pediatric Rehabilitation Services, St. Jude Children's Research Hospital, Memphis, TN
Barbara Kelly, PT, Paediatric Clinical Specialist, BScPT, MSc, School of Physiotherapy Dalhousie University, Halifax, Nova Scotia
Margo N. Orlin PT, PhD, Physical Therapy and Rehabilitation Sciences, Drexel University, Philadelphia, PA

James M. Anderson Center for Health Systems Excellence Support

Karen Vonderhaar, MS, RN, Methodologist, Anderson Center

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 search and critical appraisal of the literature, using the Table of Evidence Levels described following the references, and examined current local clinical practices.

To select evidence for critical appraisal by the group for this guideline, the Medline, EmBase and the Cochrane databases were searched for dates of January 1970 to October 2012 to generate an unrefined, "combined evidence" database using a search strategy focused on answering clinical questions relevant to post-operative management of Legg-Calve-Perthes Disease and employing a

combination of Boolean, searching on human-indexed thesaurus terms (MeSH headings using an OVID Medline interface) and "natural language" searching on Legg-Calve-Perthes, range of motion, strength, balance, gait, physical therapy, post-operative treatment, and surgical procedures 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 team members 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.

Tools to assist in the effective dissemination and implementation of the guideline may be available online at <http://www.cincinnatichildrens.org/svc/alpha/h/health-policy/ev-based/default.htm>.

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.

The guideline was externally appraised by three reviewers using the AGREE instrument and the results by domain are:

- Scope and Purpose 81%
- Stakeholder Involvement 81%
- Rigor of Development 82%
- Clarity and Presentation 81%
- Applicability 40%
- Editorial Independence 92%

Recommendations have been formulated by a consensus process directed by best evidence, patient and family preference and clinical expertise. During formulation of these recommendations, 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 guideline has been reviewed and approved by clinical experts not involved in the development process, distributed to senior management, and other parties as appropriate to their intended purposes.

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

Copies of this Evidence-based Care Guideline (EBCG) and any available implementation tools 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 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 adopted or adapted for use within the organization, provided that CCHMC receives appropriate attribution on all written or electronic documents; and

- copies provided to patients and the clinicians who manage their care.

Notification of CCHMC at EBDMInfo@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 guideline 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 recommendations to meet the specific and unique requirements of individual patients. Adherence to this guideline is voluntary. The clinician 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 this guideline, its supporting evidences and the guideline development process, contact EBDMInfo@cchmc.org.

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Note: When using the electronic version of this document,  indicates a hyperlink to the PubMed abstract.

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Note: Full tables of evidence grading system available in separate document:

- [Table of Evidence Levels of Individual Studies by Domain, Study Design, & Quality](#) (abbreviated table below)
- [Grading a Body of Evidence to Answer a Clinical Question](#)
- [Judging the Strength of a Recommendation](#) (abbreviated table below)

Table of Evidence Levels (see note above)

<i>Quality level</i>	<i>Definition</i>
1a† or 1b†	Systematic review, meta-analysis, or meta-synthesis of multiple studies
2a or 2b	Best study design for domain
3a or 3b	Fair study design for domain
4a or 4b	Weak study design for domain
5,	Local Consensus
5a or 5b	Other: General review, , case report, consensus report, or guideline

†a = good quality study; b = lesser quality study

Table of Recommendation Strength (see note above)

<i>Strength</i>	<i>Definition</i>
“Strongly recommended”	There is consensus that benefits clearly outweigh risks and burdens (or visa-versa for negative recommendations).
“Recommended”	There is consensus that benefits are closely balanced with risks and burdens.
No recommendation made	There is lack of consensus to direct development of a recommendation.

Dimensions: In determining the strength of a recommendation, the development group makes a considered judgment in a consensus process that incorporates critically appraised evidence, clinical experience, and other dimensions as listed below.

1. Grade of the Body of Evidence (see note above)
2. Safety / Harm
3. Health benefit to patient (*direct benefit*)
4. Burden to patient of adherence to recommendation (*cost, hassle, discomfort, pain, motivation, ability to adhere, time*)
5. Cost-effectiveness to healthcare system (*balance of cost / savings of resources, staff time, and supplies based on published studies or onsite analysis*)
6. Directness (*the extent to which the body of evidence directly answers the clinical question [population/problem, intervention, comparison, outcome]*)
7. Impact on morbidity/mortality or quality of life