



## **Standard of Care: Lower Extremity Amputation**

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## **Case Type / Diagnosis:**

### ***Practice Pattern:***

4J: Impaired Gait, Locomotion, and Balance and Impaired Motor Function Secondary to Lower Extremity Amputation. Other Practice Patterns may be applicable as well.

### **ICD 9 Codes:**

84.1, 84.3, 84.13, 84.14, 84.15, 84.16, 84.17

This standard of care applies to any patient after a lower extremity (LE) amputation, including transfemoral (above-knee amputation or AKA), transtibial (below-knee amputation or BKA), transmetatarsal amputation (TMA), and toe amputations. This standard of care is intended to serve as a guide for clinical decision-making for physical therapy management of this patient population for Brigham and Women's Hospital (BWH) physical therapy services.

Limb amputation results in significant changes in body structures and functions. There is the physical loss of a body part as well as the closely related effects of the underlying disease, comorbidities, and concurrent injuries<sup>1</sup>. Prosthetic fitting may compensate for the loss of body structures and function of the affected limb(s). Persons with amputations may also experience a wide range of activity limitations and participation restrictions. Typical activity limitations and participation restrictions for lower extremity amputees relate to self-care activities and mobility. These affect the ability of the person to return to and maintain work, maintain social relationships, participate in leisure activities and be active members of the community<sup>1</sup>. Environmental factors such as barriers in the community related to physical/structural environments, as well as personal factors such as age, sex, level of education and ability to adjust, may restrict participation in normal social roles for persons with lower extremity amputation<sup>1</sup>.

An important basis for optimal acute and long-term physical therapy management of amputees is an in-depth understanding of the patient and the functional consequences of the amputation, systemic and detailed consideration of the patient and their environment, and sound measurement of functional outcomes<sup>1</sup>.

Prevalence of amputations internationally has been reported as 17-30 per 100,000 persons<sup>1</sup>. Non-industrialized countries generally have a higher incidence due to a higher rate of war, trauma, and less developed medical systems<sup>1</sup>. Trauma is the most common cause of amputations in non-industrialized countries<sup>1</sup>. The continued high levels of conflict worldwide, including continued use of land mines and increased use of motorized transportation, will result in an increasing prevalence of persons with an amputation globally, equating to an increase in the number of persons with chronic disabling conditions<sup>1</sup>.

In the U.S., limb amputations due to dysvascular causes such as peripheral vascular disease (PVD), Diabetes Mellitus (DM) or Chronic Venous Insufficiency (CVI) account for 82% of all lower extremity (LE) amputations<sup>2</sup>. Other causes of LE amputations are trauma (16.4%), cancer and malignancies (0.9%), and congenital deficiencies (0.8%)<sup>2</sup>. From 1988-1996 the rates of dysvascular amputations in the United States increased 26.9%, while rates of cancer and trauma-related amputations decreased 42.6% and 50.2%, respectively<sup>2</sup>. Risk of amputation increases with

age, regardless of etiology, sex, and race; though the rate of increase is especially high among blacks requiring dysvascular amputations<sup>2</sup>. Males are at a significantly higher risk for trauma-related amputations than females<sup>2</sup>. The leading causes of trauma-related amputations have been reported to be injuries involving machinery (40.1%), powered tools and appliances (27.8%), firearms (8.5%), and motor vehicle crashes (8%)<sup>3</sup>.

The language used in this standard is consistent with the World Health Organization (WHO) International Classification of Function, Disability, and Health (ICF). The International Classification of Functioning, Disability and Health, also known as ICF, is a classification of health and health-related domains. These domains are classified from body, individual and societal perspectives by means of two lists: a list of body functions and structure, and a list of domains of activity and participation. Since an individual's functioning and disability occurs in a context, the ICF also includes a list of environmental and personal factors. For more information on this type of documentation please refer to your mentor or reference material available in the department or on-line at the World Health Organization's web page.

<http://www.who.int/classifications/icf/en/>

### **Indications for Treatment:**

This standard of care applies to any new lower extremity amputation due to vascular disease, diabetes mellitus, trauma, infections, presence of tumor, or other limb deficiencies. It also applies to any new admission for persons who have had a previous lower extremity amputation and are at risk for edema, weakness and/or contractures due to medical issues necessitating admission to BWH.

**Types of Lower Extremity Amputation and Considerations<sup>4</sup>**, organized by anatomical location, distal to proximal:

1. Toe Amputation:
  - Phalangeal or partial toe amputation involves excision of any part of one or more of the toes.
  - Common, account for 24% of DM amputations.
  - Prosthesis is not usually necessary.
  - Patients' may have weight-bearing restrictions, the Physical Therapist needs to clarify with surgical team.
  - In dysvascular cases where neither pain nor infection is a concern, auto-amputation can be awaited<sup>5</sup>.
2. Transphalangeal Amputation (Toe Disarticulation):
  - Amputation done at the metatarsophalangeal joint.
  - May result in biomechanical deficiencies:
    - Amputation of great toe affects push-off during fast gait and running, and may result in a non-propulsive gait pattern.
    - If the base of the proximal phalanx with the insertion of the flexor hallucis brevis is saved, stability is enhanced.
    - Second-digit amputation results in severe hallux valgus.
3. Transmetatarsal Amputation (TMA):

- Foot amputation in which a dorsal incision is made through the mid- to proximal metatarsal shafts, and a long, thick myocutaneous plantar flap including the flexor tendons is used, with closure of this flap onto the dorsum of the foot.
  - There are approximately 10,000 TMA's performed each year in the U.S.
  - Patients' may have weight-bearing restrictions. The Physical Therapist needs to clarify these restrictions with the surgical team.
  - Once incision is healed and the patient is ambulatory, they may require a prosthetic orthosis (rocker-bottom sole and a polypropylene ankle-foot orthosis (AFO)) to offset increased weight-bearing load on remaining tissues.
4. Lisfranc Amputation:
- Performed at the tarsometatarsal joint and involves disarticulation of all five metatarsals and digits.
  - Uncommon
  - Often result in an equinus and varus deformity due to the pull of the plantarflexors and loss of dorsiflexor and peroneal muscles.
5. Chopart Amputation:
- At the talonavicular and calcaneocuboid joints, it involves disarticulation through the midtarsal joint leaving only the calcaneus and talus.
  - Uncommon
  - Often result in an equinus and varus deformity due to the pull of the plantarflexors and loss of dorsiflexor and peroneal muscles.
    - For Lisfranc, Chopart and transphalangeal amputations, orthotic shoe fillers or shoe modifications may be used, such as a spring-steel shank extending to the metatarsal heads, and a rocker sole or padding to the tongue of the shoe to assist in holding the hindfoot firmly in the shoe.
6. Syme Amputation:
- Ankle disarticulation in which the heel pad is kept for good weight-bearing.
  - Thick heel pad can allow direct weight-bearing.
  - Post-operative complications may include an unstable heel flap, development of neuroma of the posterior tibial nerve, and poor cosmesis.
  - Patients are typically kept non-weight-bearing (NWB) immediately post-op.
  - Uncommon
7. Transtibial Amputation (BKA):
- Very short transtibial amputation occurs when less than 20% of tibial length is preserved.
    - May result from trauma, and not usually an elective procedure.
    - Results in small-moment arm, making knee extension difficult.
  - Standard Transtibial Amputation occurs when between 20% and 50% of tibial length is preserved.
    - At least 8cm of tibia is required below the knee joint for optimal fitting of a prosthesis.
  - Long Transtibial Amputation occurs when more than 50% of tibial length is preserved.
    - Usually not advised due to poor blood supply to the distal leg.
  - Long posterior flap is normally used because of good vascularization and it provides an excellent weight-bearing surface.
  - Fibula is usually transected 1-2cm shorter than the tibia to avoid distal fibula pain.

- Transtibial amputations have been reported to account for 27.6% of dysvascular amputations performed in the U.S.<sup>2</sup>.
8. Knee Disarticulation (Through-Knee Amputation or TKA):
    - Old and anatomic procedure which does not require surgically cutting through bone or muscular bellies.
    - Offers good weight distribution and retains a long, powerful femoral lever arm.
    - Yields a non-cosmetic socket due to need for an external joint mechanism and resultant difficult swing-phase control.
    - Often performed on patients who will not become a prosthetic walker, or in growing children to maintain femoral length.
  9. Supracondylar Amputation:
    - Surgical procedure in which the patella is left for better end weight-bearing.
    - Area between the end of the femur and patella may delay healing.
  10. Transfemoral Amputation (AKA):
    - Short transfemoral amputations occur when less than 35% of the femoral length is present.
      - Uncommon
    - Medium transfemoral amputations occur when between 35% and 60% of femoral length is preserved.
      - In general, the residual limb must be at least 4 to 6 inches in length from the groin to fit a prosthesis<sup>6</sup>.
      - Ideally, amputations should be at least 4 inches (10cm) above the lower end of the femur to allow room for the prosthetic knee.
      - Normally, anterior and posterior muscular surfaces are well vascularized, so equal flaps are used.
    - Long transfemoral amputations occur when more than 60% of femoral length is present.
    - Transfemoral amputations have been reported to account for 25.8% of dysvascular amputations performed in the U.S.<sup>2</sup>.
  11. Hip Disarticulation:
    - Involves loss of all the femur
    - Uncommon
    - Usually done in cases of malignant tumors, extensive gangrene, massive trauma, or advanced infection.
  12. Hemipelvectomy:
    - Involves loss of any part of the ilium, ischium, and pubis.
    - Uncommon
    - Can be internal, in which the limb is salvaged, or external, in which the limb is removed. External hemipelvectomy may also be referred to as a transpelvic amputation.
    - Usually done in cases of malignant tumors, extensive gangrene, massive trauma, or advanced infection.

## **Stages of Amputee Rehabilitation<sup>7</sup>:**

Rehabilitation after major lower extremity amputation can be divided up into nine specific periods of evaluation and intervention, each with its' particular set of treatment goals and objectives<sup>7</sup>.

Communication among the interdisciplinary healthcare team, the patient, and with the patient's family is essential. Each stage entails specific treatment objectives listed below, but care should be focused on individual treatment goals based on the patient's health status, level of amputation, and relevant personal and environmental factors.

- I. Preoperative – Involves medical and physical assessment, patient education, functional prognosis, discussion about phantom limb pain, realistic short and long term goals.
  - Optimal rehabilitation care of the amputee begins, if feasible, prior to the amputation<sup>8</sup>.
  - If possible, patient should be placed in a cardiopulmonary conditioning program.<sup>7</sup>
- II. Amputation Surgery/Dressing – Involves surgical residual limb length determination, closure of wound and soft-tissue coverage, nerve management, dressing application, and limb reconstruction.
  - The residual limb must be surgically constructed to optimize the intimacy of fit of future prosthesis, maintain muscle balance, and allow it to assume the stresses necessary to meet its new function<sup>8</sup>.
  - An underlying goal of surgical management of patients' requiring LE amputation is to retain the knee joint given its contribution to more efficient ambulation with a prosthesis, requiring less energy expenditure<sup>9</sup>.
- III. Acute Post-Surgical – This phase begins immediately post-operatively and continues until the patient is discharged from the acute care hospital. Goals at this stage are pain control, optimization of range of motion (ROM) and strength of both lower and upper extremity musculature, promotion of wound healing, phantom limb pain/sensation management, functional mobility training, equipment prescription, and continued patient education and emotional support<sup>7</sup>. See Treatment section below for specific guidelines.
- IV. Pre-prosthetic – Involves residual limb shaping, stump shrinking, skin care, increasing ROM and muscle strength, cardiovascular training, progressive functional mobility training without a prosthesis, restoring locus of control of the patient, and patient education and preparation for prosthetic use<sup>4</sup>. During initial recovery it is important to restore the individuals' locus of control.
  - Generally 6-8 weeks or longer post-operatively with soft dressings, or 3-6 weeks with use of an Immediate Post-Operative Prosthesis (IPOP)<sup>4</sup>.
  - Preparatory or training prosthesis may be used to promote residual limb maturation and for use during gait training.
  - Individuals are vulnerable to losses in strength and range of motion (contractures) during this period.
- V. Prosthetic Prescription/Fabrication – Involves team consensus on prosthetic prescription to satisfy the needs, desires and abilities of the patient.
  - Criteria for fitting of LE prosthesis: Wound must have healed, edema must have resolved, the stump should be conically shaped and stump maturation should be achieved<sup>10</sup>.
    - Obesity can be a limiting factor because most prosthetic devices are designed with a maximum load of 330 lbs<sup>11</sup>.
  - Patients' with advanced vascular pathology may be less likely to be able to use a prosthetic device due to poor skin integrity, delayed healing, and impaired aerobic

capacity/endurance. If they *are* fit for a prosthesis, appropriate wound healing may take an extended period of time.

- VI. Prosthetic Training – Prosthetic management and training to increase wearing time and functional use.
  - For patients s/p AKA and BKA using a soft dressing after amputation, a cast for a temporary socket is often fabricated 6-8 weeks postoperatively<sup>4</sup>.
  - Ambulation activities with a LE prosthesis often begin during weeks 10-11 after amputation<sup>4</sup>.
  - The more proximal the amputation, the more energy is demanded from the cardiovascular and pulmonary systems for prosthetic gait<sup>12</sup>.
- VII. Community Integration – Involves resumption of family and community roles, addressing emotional needs and developing healthy coping strategies, and resumption of previous and adapted recreational activities.
- VIII. Vocational Rehabilitation – Involves assessment and training for work activities, and assessment of further education needs or job modification
  - On the basis of residual functional capacity, patients may be able to return to their previous line of work. In many cases patients' may choose a different line of work, dependent on the physical demands of the job.
  - For the successful reintegration of the amputee, return to work should take place gradually, with time and workload increasing over several weeks and clinical staff being available for counseling and consultation<sup>7</sup>.
- IX. Follow-Up – Includes lifelong prosthetic, functional, and medical assessment and psychological support.
  - Patients should be seen for follow-up by one of the team members at least every 3 months for the first 18 months, with physical follow-up every 6 months<sup>7</sup>.

### **Rehabilitation Management:**

Post-operatively, physical therapy (PT) plays an integral role in restoring function, preparing patients for a lower-extremity orthotic or prosthetic device, and training them with that device once it has been fabricated. At BWH, physical therapy is consulted post-operatively by the surgical team, and the acute post-surgical stage of amputee rehabilitation is initiated. The focus of physical therapy management begins with initial evaluation on POD#1 if the patient is medically/surgically appropriate, and includes patient education, mobility, functional training, as well as promoting wound healing, and optimizing ROM and motor control of the residual and non-affected limbs. Early mobility has been shown to improve functional outcomes, foster independence, decrease mortality rates, and reduce acute care length of stay for the person s/p LE amputation<sup>13</sup>. Among elderly amputees, an early coordinated post-amputation rehabilitation program may reduce the time to prosthetic ambulation and the risk of further disability<sup>12</sup>. If immobility and associated deconditioning and contracture formation in the residual limb are allowed to occur, prosthetic fitting and functional outcomes are compromised<sup>3</sup>. Knowledge of the basic concepts in LE amputee rehabilitation and the acute care hospital course will help to guide clinical decision making in the outpatient physical therapy setting.

### **Contraindications, Precautions, and Considerations for Treatment:**

Below are common issues specific to patients undergoing any LE amputation that may impact physical therapy intervention and overall prognosis.

#### ***Early Post-operative Complications:***

Recognition of signs and symptoms of early post-operative complications is important and will require consultation with appropriate health care providers. Potential complications that occur during the acute care hospital stay that would increase morbidity/mortality and impact the patient's ability to participate in therapy, and influence overall prognosis and treatment design and goals are:

- Blood loss requiring transfusion
- Deep vein thrombosis (DVT)
- Pulmonary embolism (PE)
- Cardiac complications including arrhythmia, congestive heart failure (CHF), and myocardial infarction (MI)<sup>9</sup>.
- Systemic complications including pneumonia, renal failure, stroke, and sepsis<sup>9</sup>.
- Complications at the surgical site include hemorrhage or hematoma, wound infection, and failure to heal requiring additional operative interventions such as split-thickness skin grafting (STSG), hematoma evacuation, soft tissue debridement, stump revision, and conversion to AKA after BKA<sup>9</sup>.

If a patient presents during the first few days post-operatively with increased pain, excessive swelling, decreased muscle strength or sensation along a motor and/or sensory nerve distribution, sudden shortness of breath and decreased oxygen saturation along with increased resting heart rate, physical therapy interventions must be stopped, and the medical team consulted.

Also see “General Surgery” Standard of Care for general post-operative precautions and contraindications that may affect appropriateness of PT intervention.

#### ***Contractures:***

Joint contractures are serious complications that may interfere with prosthetic fitting and proper gait, and will eventually increase the energy requirements of ambulation<sup>14</sup>. The joints immediately proximal to the amputation site may develop contractures if full range of motion is not initiated in the early post-operative period. Joint contractures can be avoided with proper positioning and exercise. See “Positioning Guidelines for Edema Management and Prevention of Contractures” in the intervention section below.

#### ***Phantom Limb Pain and Sensation:***

Phantom limb sensation is the sensation that the limb is still present, and phantom pain includes the various painful sensations in the body part that is no longer present<sup>15</sup>.

- Immediate post-operative incidence of phantom pain and phantom sensation has been reported to be 72% and 84%, respectively, while the incidence at 6 months post-operatively changes to 67% and 90%, respectively<sup>15</sup>.
- Both phantom pain and sensation are generally localized to the distal part of the missing limb<sup>15</sup>.
- Persons with phantom limb pain have worse or lower health-related Quality of Life (QOL) than persons without phantom pain<sup>16</sup>.



- Pre-amputation pain has been shown to significantly increase the incidence of phantom pain post-amputation<sup>17</sup>.
- Phantom limb pain and prosthetic use may be inversely related, as it has been shown that persons using their prosthetic limbs 9 or more hours per day have less phantom pain than others<sup>15</sup>.
- Treatments for phantom-limb related symptoms include:
  - Pharmacological interventions such as opioids, anticonvulsants, antidepressants, botulinum toxin, and topical agents such as lidocaine<sup>18</sup>.
  - Surgical treatments such as stump revision, intrathecal implants, trigger point injections, dorsal root entry zone lesions, and dorsal column tractotomy have been described. Due to risk of complications and limited benefit, these are generally used in a limited number of patients<sup>15</sup>.
  - Physical Therapy modalities and techniques as described in the Treatments section below.
  - Alternative techniques such as acupuncture and hypnosis may also be beneficial.<sup>18</sup>

### ***Pain Complications:***

Other causes of pain in individuals undergoing LE amputation may include neuromas, reflex sympathetic dystrophy and bursitis or tendonitis at the end of the residual limb<sup>14</sup>.

- *Neuroma* formation is a natural repair phenomenon that may occur when a peripheral nerve is transected. During the repair phase, axons turn back on themselves and combine with fibrous tissue to form an enlargement at the distal nerve end. Pain occurs when the neuroma is situated at the end of the residual limb or at a pressure point in the prosthesis. Nonoperative interventions include injections with local analgesics or corticosteroids. If these interventions are ineffective, surgical excision of the neuroma is the treatment of choice<sup>14</sup>.
- *Reflex sympathetic dystrophy*, also called *complex regional pain syndrome*, includes sensory, autonomic and motor symptoms that may occur in the affected extremity. The hallmark of this condition is severe, unremitting pain that is out of proportion to the injury. Pain is thought to be caused by an abnormal prolongation of the sympathetic reaction to the injury which produces vasospasm, hyperhidrosis and erythema. Early treatment may include interruption of the abnormal sympathetic reflex with the use of TENS or sympathetic blocks, pharmacologic agents, and physical therapy<sup>14</sup>.
- *Bursitis* or *tendonitis* may cause aggravating residual limb pain, characterized by localized tenderness, mild edema, slight occasional erythema of the overlying skin, increased skin temperature, and subcutaneous crepitus. If tendonitis is present, passive stretching of the involved tendon will cause significant pain. Intervention may include cessation of provocative activities, oral non-steroidal anti-inflammatory medications, temporary discontinuation of the prosthesis, rigid immobilization for brief periods, compression dressings, thermal modalities, corticosteroid injections, analgesic medications, and/or modification of the prosthetic socket<sup>14</sup>.

### ***Functional Outcomes:***

While up to 85% of vascular amputees are fitted with a prosthesis after major LE amputation, only 5% of these persons use their prosthesis for more than half of their waking hours<sup>17</sup>. Within 5 years the use of the prosthesis drops from 85% to 31%. Two years after major LE amputation only 26%

are walking outdoors<sup>17</sup>. The proportion of total wheelchair users rises from 13% in the first year after surgery to 39% after 5 years<sup>17</sup>. For persons undergoing Syme amputation (ankle disarticulation), the cumulative ambulatory rate at 1, 2, and 5 years has been reported to be 92%, 80% and 80%, respectively<sup>17</sup>.

### ***Post-operative Mortality:***

The life expectation of vascular amputees is short. Survival rates for individuals with dysvascular pathology undergoing major LE amputations including AKA and BKA have been reported as 69.7% and 34.7% at 1 and 5 years, respectively. Mortality was found to be significantly higher for patients who underwent AKA (50.6% and 22.5% at 1 and 5 years) as compared to BKA (74.5% and 37.8% at 1 and 5 years)<sup>9</sup>.

### ***Inpatient Acute Rehab for Patients with Pre-existing LE Amputations:***

Patients' with pre-existing LE amputations may be admitted to the inpatient acute care setting for a variety of medical reasons related to their amputation or due to unrelated medical issues, including cardiopulmonary and vascular disease. Physical therapy evaluation and intervention for these individuals may begin as soon as the patient is medically stable. Considerations, examination principles and interventions described in this standard of care are applicable in the physical therapy management of these patients. During the patient interview special attention should be focused on assessing the patients' prior level of function, use of assistive devices and prosthetic use. Prosthetic devices should be brought in from home for these patients to assist with mobility retraining. Edema of the residual limb and/or muscular atrophy related to medical issues or immobility is possible, which will affect the patients' ability to don a prosthesis. Therefore, intervention techniques for edema management described below, including limb wrapping, may be beneficial and should be implemented.

## **Evaluation**

*This section is intended to capture the most commonly used assessment tools for this case type/diagnosis. It is not intended to be either inclusive or exclusive of assessment tools.*

### **Medical Record Review/Patient Interview:**

- A. HPI & PMH:
  - Onset and duration of symptoms and reason for admission
  - Anthropometrics: (height, weight, BMI)
  - Tobacco use
  - Presence of co-morbid conditions that may affect outcomes, including peripheral vascular disease, diabetes mellitus, coronary artery disease, previous myocardial infarction, valvular disease, congestive heart failure, severe pulmonary disease (COPD or asthma), vision and/or cognitive impairment, and obesity.
- B. Hospital Course:
  - Previous and ongoing medical and/or surgical treatment, date of any procedures and any post-operative complications.
  - Current laboratory results: WBC, HCT, HGB, PLT, INR, PTT, Blood glucose levels.
- C. Pertinent Current Medications: (e.g. cardiac, pulmonary, pain)
  - Types of medications, side effects and rehabilitation implications.
- D. Social History:

- Prior functional level, use of assistive devices
- Home environment and current/potential barriers to returning home
- Family/caregiver support system available
- Family, professional, social and community roles
- Patient's goals and expectations of returning to previous life roles

**Physical Examination (Systems Review):**

- A. Subjective:
- Documentation can include patients' goals, or comments about their current medical status or psychological well-being.
- B. Observation:
- Lines and tubes.
  - Positioning: Position of residual limb and fit of knee immobilizer (if BKA)
- C. Cognition/Mental Status:
- Level of alertness, ability to follow motor commands, and level of safety awareness.
  - Consider screening with Mini Mental State Examination, or ask for an occupational therapy consult.
  - Personality changes: e.g., emotional lability, euphoria
  - Fear and Anxiety
  - Mental status: Level of alertness, orientation, and ability to follow commands
  - Safety awareness
  - Psychological considerations: Assess patient's coping mechanisms and psychological adjustment to altered body image (i.e. History of depression)
- D. Learning:
- Assess patient's learning style (i.e. written, visual)
- E. Pain:
- Intensity at rest and with treatment is documented at every inpatient visit using the 0-10 Numeric Analog Scale (NAS) or Verbal Report Scale (VRS) if possible.
  - Quality including frequency, alleviating/aggravating factors, and descriptors and measures taken to reduce pain must also be documented in every visit.
  - Presence of Phantom Pain/Sensation
  - Consider self-report measures such as the McGill Pain Questionnaire (MPQ)
- F. Neuromuscular:
- Light touch
  - Proprioception: Assessed at joints of residual limb if possible and on contralateral limb
  - Semmes-Weinstein Monofilaments
- G. Integumentary:
- Surgical incision
  - Presence of Pitting edema (0-4+)
    - 0= non pitting
    - 1+= barely perceptible
    - 2+ = skin rebounds <15 sec
    - 3+ = skin rebounds 15-30 sec
    - 4+ = skin rebounds >15 sec

- Length of residual limb
  - Circumferential measurements:
    - Measure at tibial tubercle for transtibial amputation, then every 8-10cm distally
    - Measure at proximal thigh/ischial tuberosity for transfemoral amputation, then every 8-10cm distally
  - Presence of ulcers or neuroma
  - Skin integrity: skin color, signs of infection, potential areas for breakdown, scar tissue at surgical site and contralateral limb.
  - Shape of residual limb (conical, cylindrical, bulbous)
- H. Balance:
- Static/dynamic sitting and standing assessment.
  - Head/Trunk Control
- I. Musculoskeletal:
- Range of Motion (ROM) of residual limb joints and remaining extremities
  - Muscle Performance
  - Manual Muscle Testing (MMT) or gross measurement of the LE and UE muscles is assessed and documented
  - Posture/Positioning including resting position of residual limb (neutral or rotated)
- J. Vital Signs: HR, BP, RR, SpO2, RPE
- At rest, during, and post-activity
- K. Pulmonary:
- Auscultation, breathing pattern, cough quality, management of secretions
- L. Cardiac:
- EKG on Telemetry (if applicable): at rest and in response to activity
  - Auscultation: rate/rhythm
- M. Vascular:
- Pulses of residual and opposite LE (femoral, tibial, dorsalis pedis, and posterior tibial)
    - 0 = absent
    - D = Doppler
    - 1+ = normal
    - 2 = increased
  - Capillary refill (normal time <3 seconds)
  - Doppler Ultrasound
  - Temperature (normal, increased temperature, cool)
- N. Prosthetic device for patients with previous amputation:
- Assess prosthesis, fit of socket, number of ply used prior to admission and currently, ability to don/doff and care for prosthesis independently
- O. Outcome Measurement Tools: Outcome measurement tools are a useful way to objectively measure various aspects of physical and psychological functioning, and to track changes over time. The therapist should pick an outcome tool that is appropriate for the specific stage of amputees' rehabilitation course.
- A lower-extremity amputee specific outcome measure appropriate for use in the inpatient acute care setting is the *Amputee Mobility Predictor (AMP)*<sup>19</sup> (Appendix V and VI). The AMP was developed to enable physicians, prosthetists, and physical therapists

to objectively assess an amputee patient's functional capabilities with or without a prosthesis and to predict his/her ability to ambulate with a prosthesis. It is designed to be administered before prosthetic fitting to predict functional mobility after prosthetic fitting, to be clinically feasible in terms of time, resources, and ease of use, and to assist in classifying a patient in *Medicare's 5-level functional classification system (MFCL)* for prosthetic prescription of Medicare-eligible patients (Appendix IV). The AMP is designed to assess unilateral amputee subjects with and without a prosthesis. However, bilateral amputee subjects with amputation levels higher than transtarsal foot amputations must be tested wearing their prosthetic devices.

- The item selection of the AMP is organized with an increasing level of difficulty to permit progressive assessment of the amputee subject (see Appendix V and VI). Items 1 and 2 test the person's ability to maintain sitting balance, and if the subject does not score well the possibility for even limited prosthetic use is remote and the amputee subject is classified as a MFCL level K0. Items 3 through 7 are specifically designed to examine the amputee subject's ability to maintain balance while transferring from chair to chair and standing unchallenged. The ability to perform these test items safely would suggest that the patient could manage a prosthesis in limited situations in a supervised environment. Items 8 through 13 are more challenging activities related to standing balance. These qualities imply that the amputee subject has the potential to be a safe household ambulatory and could function at MFCL level K2. Variable cadence, stepping over a curb or obstacle, and negotiating stairs (AMP items 14 through 20) are specific activities defined for a Medicare level K3 ambulator<sup>19</sup>.
- The total score range for the AMP is 0 to 42 points. When used with subjects without a prosthesis, the highest possible score is 38 points because item 8 (single-limb standing) is eliminated, as standing on the prosthetic side is impossible. By using an assistive device, the subjects' potential total score possibilities increase by 5 points (to 43 and 47 points), depending on the type of assistive device used during testing<sup>19</sup>.
- Medicare Functional Classification System (MFCL):
  - In 1995 Medicare adopted a 5-level functional classification system (MFCL) which uses code modifiers (K0, K1, K2, K3, K4) to describe the functional abilities of persons who have undergone lower-limb amputation, and to justify the medical necessity of certain prosthetic components and additions<sup>19</sup> (Appendix IV). By using this system, the physician, prosthetist and physical therapist are able to determine the patient's ability to reach a defined functional state within a reasonable period of time.
- Other outcome measurement tools reported in the literature and more appropriate for use in an *outpatient* setting include:
  - Functional Independence Measure<sup>20</sup>
  - Office of Population Censuses and Surveys Scale (OPCS)<sup>20</sup>
  - Amputee Activity Score (AAS)<sup>20</sup>
  - Get up and Go Test<sup>18</sup>
  - 6-minute Walk Test<sup>18</sup>
  - Barthel Index<sup>18</sup>
  - Medical Outcomes Study 36-Item Short Form Health Survey<sup>18</sup>
  - Prosthesis Evaluation Questionnaire (PEQ)<sup>18</sup>
  - Locomotor Capabilities Index (LCI)<sup>18</sup>

- Sickness Impact Profile<sup>18</sup>
- Questionnaire for Persons with Transfemoral Amputation<sup>18</sup>
- Trinity Amputation and Prosthetic Experience Scale<sup>18</sup>
- Amputee Body Image Scale: Developed to specifically address body image with persons with lower extremity amputation, both with and without prosthesis<sup>16</sup>

**Assessment:**

Based on the Guide to Physical Therapist Practice, patients following LE Amputation are classified into the following practice pattern:

**4J: Impaired Gait, Locomotion, and Balance and Impaired Motor Function Secondary to Lower Extremity Amputation.**

According to this practice pattern, the expected number of visits in an episode of care is 15 to 45. Other Practice Patterns may be applicable as well.

Patients in this pattern may demonstrate impairments in body structure including, but not limited to, circulation (arterial, venous or lymphatic), limb amputation and integumentary integrity. Potential body function changes may include, but are not limited to, muscle performance (including strength, power, and endurance), ROM (including muscle length), aerobic capacity and endurance, pain, posture, sensory integrity, gait, locomotion, balance, and knowledge of exercise program/ACE wrapping techniques.

These impairments will result in decreased independence with bed mobility, transfers, ambulation, functional activities, basic/instrumental activities of daily living (B/IADL), and may negatively impact quality of life.

The aim after a LE amputation is to bring the person to an optimum of physical, mental, emotional, social, vocational, and economic efficiency, and requires a multidisciplinary approach<sup>17</sup>. The primary goals of inpatient physical therapy while in the acute care setting are pain control, optimizing range of motion (ROM) and strength of both lower and upper extremity musculature, promotion of wound healing, early mobilization and maximization of functional independence, and to develop the skills necessary to progress towards prior level of activity and social participation as appropriate.

Suggested short-term goals (STG) to be achieved in 3-5 days in patients who were independent prior to acute care hospital admission are:

1. Patients will demonstrate Independence with bed mobility
2. Patients will demonstrate Independence with transfers to wheelchair with least restrictive assistive device
3. Patients will demonstrate Independence with ambulation  $\geq$  100 feet with least restrictive assistive device
4. Patients will demonstrate Independence or assisted with stairs as necessary
5. Patients will demonstrate ROM WFL and strength  $> 3/5$  throughout affected and non-affected limb, as appropriate
6. Patients will demonstrate good balance in sitting and/or standing with device
7. Patients will perform an initial independent exercise program

8. Patient/family will demonstrate good understanding of residual limb management, edema control, and frequent skin inspection/skin care
9. Patient/family will demonstrate Independence with wrapping techniques (or with family assist)
10. Patients will demonstrate good safety awareness with all functional mobility

These STG will vary depending on the patient's prior functional level, as well as the patient's own personal goals. If the above goals do not appear they will be met during the inpatient acute care hospital stay then inpatient rehab should be considered.

### **Long-Term Goals:**

The predicted optimal level of improvement for this patient population is to return to their previous life roles and lifestyle using a prosthetic and/or assistive devices and adaptive equipment, as appropriate, in 4-6 months. This prognosis may need to be modified due to any of the following factors: presence of co-morbidities, post-op complications or secondary impairments, decreased cognitive status, barriers to returning to previous living environment and any other factors that may influence the patient's ability to use a prosthetic device and decrease their independence.

### **Prognosis:**

When setting attainable short and long-term goals, the therapist should be aware of, and document, factors that may negatively or positively affect that person's prognosis. Prognosis for person's s/p LE amputation may be negatively affected by any of the following factors:

- Presence of co-morbidities, such as End Stage Renal Disease (ESRD) and Coronary Artery Disease (CAD), which may increase mortality and affect recovery<sup>21</sup>.
- Pre-operative ambulatory status, as non-ambulatory and homebound status is associated with inability to use a prosthesis post-operatively<sup>21</sup>.
- Age > 60 years at time of surgery is associated with decreased post-operative prosthetic use, increased mortality, and decreased ability to ambulate and maintain an independent living status<sup>21</sup>.
- Level of amputation, as persons undergoing bilateral or AKA are less likely to ambulate, use a prosthesis, and achieve independent living status post-operatively<sup>21</sup>.
- Presence of post-op complications or secondary impairments, including phantom pain and sensation, which may negatively influence rehabilitation process.
- Decreased cognitive status, including dementia, may prevent persons from achieving an independent living status post-operatively<sup>21</sup>.
- Barriers to returning to previous living environment and any other factors that may influence the patient's ability to use a prosthetic device and decrease their independence.

### **Treatment Planning / Interventions**

Established Pathway \_\_\_ Yes  No

Established Protocol \_\_\_ Yes  No

### **1. Interventions:**

*This section is intended to capture the most commonly used interventions for this case type/diagnosis. It is not intended to be either inclusive or exclusive of appropriate interventions.*

#### A. Therapeutic exercise program for acute and subacute LE amputations:

- Exercise programs for the LE amputee should focus on four main components: flexibility, muscle strength, cardiovascular training, and balance<sup>7</sup>.
- Flexibility or stretching exercises to help prevent muscle shortening and joint contractures should be performed in a slow, controlled manner and held for at least 20 seconds. See positioning guidelines below.
- Strengthening exercises may include isometric, isotonic, PNF and isokinetic activities.
  - For the unilateral lower-limb amputee, the non-affected limb becomes the sole support limb. Stance-phase stability requires adequate strength of the hip extensors and abductors, knee extensors and plantarflexors. Swing-phase limb advancement and clearance require adequate hip flexor and ankle strength. Frequently, the non-affected limb can develop symptoms consistent with overuse<sup>7</sup>.
  - Sitting balance, bed mobility and transfers are facilitated by strong, flexible back and abdominal flexors, rotators, and extensors and hip extensors<sup>7</sup>.
  - Shoulder stabilizers, adductors and depressors, elbow extensors, wrist stabilizers and grip strength are important for supporting the body during transfers and during the use of assistive devices<sup>7</sup>.
  - For persons undergoing AKA, strength of operative (residual) limb hip extensors and abductors should be emphasized for eventual prosthetic use.
  - For persons undergoing BKA, strength of the operative (residual) limb hip extensors and abductors and knee flexors and extensors should be emphasized for eventual prosthetic use.
  - For persons undergoing external hemipelvectomy or hip disarticulation, strength of the upper extremities, abdominals and contralateral lower limb must be maximized. Persons with a hip disarticulation must be able to perform a posterior pelvic tilt to initiate swing phase with a prosthesis, so good abdominal control is necessary<sup>4</sup>.
- Cardiovascular training may be initiated as appropriate to patient tolerance in order to improve endurance and functional mobility tolerance. Duration, frequency, intensity and mode may be changed according to the needs and abilities of the patient.
  - Wheelchair mobility or upper-extremity ergometry can be used in the pre-prosthetic phase. Swimming may be initiated as appropriate once incision has healed, and is an excellent exercise for patients' who have sensitive residual limbs or may need to minimize weight-bearing impact<sup>4</sup>.
- Balance training should include sitting and standing, static and dynamic activities as appropriate. Patients can be further challenged by reaching for objects, using soft/unstable surfaces, and accepting external forces.
- Post-op Day #1: Initiate AA/AROM or theraband exercises for UE's and non-affected limb. Initiate isometrics, AAROM, AROM for residual limb. Exercises may include Quad sets, glut sets, hip IR/ER, hip adduction isometrics, bridging, seated push-ups (dips), and supine hip/knee flexion. (See Appendix I for suggested initial therapeutic exercise program).

#### B. Positioning Guidelines for Edema Management and Prevention of Contractures:

- Positioning Guidelines for Patients with Transtibial and Transfemoral Amputations:
  - Contractures may develop due to improper positioning in bed or prolonged sitting in a wheelchair. Contractures of the hip flexors, abductors, and external rotators are



common in the transfemoral amputee (AKA). The transtibial amputee (BKA) is at risk for developing hip and knee flexion contractures<sup>7</sup>.

- For transfemoral amputees (AKA), if a person has a hip flexion contracture greater than 15 degrees, prosthetic fitting must wait until contracture is no greater than 10 degrees<sup>11</sup>.
  - Encourage periods of lying supine or prone (to tolerance) to provide a prolonged low-load stretch on the hip flexors and prevent hip flexion contracture.
  - Some physicians prefer the post-operative limb to be elevated for edema management. While this may be beneficial, the patient should be educated about the need to lie fully supine or prone to prevent contractures.
  - For transtibial amputees (BKA), a knee immobilizer is often used for residual limb positioning and to prevent contracture. Considerations for wearing schedule should include motor control of residual limb, mental status, and integumentary integrity. Encourage careful/thorough skin inspection as knee immobilizer may cause pressure from the posterior stay or if it is strapped improperly over the patella. The knee immobilizer can be trimmed for best fit and to minimize skin issues. As an alternative, a posterior orthoplast splint can be made.
  - Elastic stockinette or ACE bandage may be wrapped over the post-operative dressing to prevent edema accumulation in the residual limb.
  - Transtibial amputees (BKA) should be instructed on proper limb positioning in chair with knee at 0 degrees extension.
- Positioning Guidelines for Patients with TMA or toe amputations:
    - Elevate surgical limb while sitting in chair and lying in bed.
- C. Dressings: Post-operative dressings can contain post-operative drainage, edema and facilitate prosthetic fitting. Dressings after amputation include<sup>4</sup>:
- Soft Dressing: Gauze, cotton padding and an elastic bandage. Most common.
  - Semi-rigid Dressing: Uses a Unna Paste bandage. Uncommon at BWH.
  - Rigid Dressing: Stump is wrapped by a rigid plaster cast socket that fixes the knee in extension immediately post-op or within days of surgery. Use of a rigid dressing, either immediate or delayed, has been shown to result in shorter time period from amputation to delivery of first prosthesis and decrease risk for knee flexion contracture in transtibial amputees<sup>10</sup>. Advantages reportedly include improved wound healing, prevention of edema, prevention of knee flexion contracture, and ability to load the extremity/begin gait training in approximately one week thus preventing secondary complications due to immobility. Disadvantages may include increased risk for pressure ulcers and delay in detecting wound problems<sup>10</sup>. Uncommon at BWH.
  - Removable Rigid Dressing: Functions as rigid dressing above but can be removed daily to inspect the limb for healing. Uncommon at BWH.
  - Immediate Postoperative Prosthesis (IPOP): A hard cast is applied to the residual limb, and a pylon and foot are attached to allow for immediate gait training. Patients with transtibial and knee disarticulation may be permitted to weight-bear up to 40 lbs on the residual limb<sup>22</sup>. Used until sutures are removed<sup>22</sup>. Most often used following trauma for young patients who have good balance and skin integrity<sup>4</sup>. Uncommon at BWH.
- D. Limb Shaping: Indications for use of compression devices include edema management, shaping the residual limb, prevention of contractures, reducing an “adductor roll” in transfemoral amputees, and desensitization<sup>4</sup>. Commonly used compression devices include:

- Elastic Wraps: Use of elastic bandages, usually 3, 4, or 6 inches in width. Elastic bandaging is initiated by the Physical Therapist, changed daily to ensure good pressure gradient from distal to proximal. In the preprosthetic phase bandages should be worn 24 hours per day, except for bathing<sup>4</sup>. Elastic stockinet is an acceptable substitution to ACE wrap. (See Appendix II for residual limb wrapping techniques)
  - Shrinkers: Once the incision is healed and sutures removed (typically 10-21 days after surgery), use of a compression device is appropriate<sup>4</sup>, clarify with MD. Often more practical due to ease of application, especially for transfemoral amputees<sup>4</sup>. Outside vendor is contacted if there is a need while at BWH.
- E. Integument: Perform skin inspection as appropriate during treatment sessions, and educate pt on need for frequent skin inspection.
- F. Mobility and Gait Training:
- Time to fitting of prosthesis is usually 6-8 weeks or longer<sup>4</sup>, once stump has matured. In the meantime, gait training is initiated without a prosthesis<sup>10</sup>.
  - Functional mobility training for individuals undergoing LE amputation may be initiated post-op day #1, as appropriate given the patient's medical status, and progressed based on patient tolerance and ability levels using the treating physical therapist's discretion.
  - Early post-operative mobilization will reduce the risk of patient's developing orthostatic hypotension.
  - For patients s/p AKA or BKA, the following activity guidelines have been reported<sup>13</sup>:
    - Post-op Day #1: Bed mobility, therapeutic exercises.
    - Post-op Day #2: Sitting edge of bed and transfer training. Out of bed no more than 2 hours BID.
    - Post-op Day #3: Ambulate as tolerated with assistive device.
    - Post-op Day #4 to discharge: Continue ambulation BID and OOB to chair BID. Progress distance of ambulation to patient's tolerance. Encourage exercises when in bed or sitting in chair.
  - For patient's s/p transmetatarsal, forefoot and toe amputations, the following activity guidelines have been reported<sup>13</sup>:
    - Post-op Day #1: OOB to chair no more than 2 hours BID. Clarify LE weight bearing status with medical team, as patients' may require heel weight bearing post-op shoe for operative extremity.
    - Post-op Day #2: Ambulate as tolerated TID
    - Post-op Day #3 until discharge: Continue ambulation TID, progress distance ambulated to patient's tolerance. OOB to chair to tolerance.
  - Gait training should begin on flat surfaces with emphasis initially on technique and style and then on velocity, and should then be progressed to uneven surfaces and elevations including stairs as tolerated<sup>7</sup>.
  - Clarify orders for patients who have medical or wound healing complications. Refer to intensive care unit (ICU) standards of care if appropriate.
  - For patients with limited mobility, a slide board may be used to transfer from bed to wheelchair or to a car.
  - Wheelchair mobility training should be initiated, if appropriate, in order to improve endurance and develop skills needed to negotiate a wheelchair both indoors and outdoors.
- G. Skin-desensitization program: Desensitization activities decrease hypersensitivity of the residual limb, are important for pain management and may be necessary before the patient is

able to tolerate the pressure of an orthosis/prosthesis<sup>4</sup>. Activities include gentle rubbing/tapping, massage, soft-tissue and scar mobilization<sup>7</sup>. Performed initially by the therapist, and then taught to the patient/family to be performed independently.

H. Pain Management strategies:

- Biofeedback
- Relaxation and Breathing Techniques
- Cryotherapy

I. Phantom Limb Pain and Sensation: Physical Therapy modalities and techniques used in the treatment of phantom limb pain and sensation include:

- Electrical stimulations such as auricular electrical stimulation, Transcutaneous Electrical Nerve Stimulation or TENS, spinal cord stimulation, and motor cortex stimulation have been used with variable results<sup>15</sup>.
  - TENS has been demonstrated to have about a 50% success rate in the treatment of phantom pain<sup>15</sup>.
- Mechanical stimulations such as stump massage, percussions, and vibratory stimulations<sup>15</sup>.
- Ultrasound, superficial heat and cryotherapy have been reported to have some success in short-term pain relief<sup>15</sup>.
- Eye movement desensitization and reprocessing, in which a series of rapid and rhythmic eye movements are induced by the therapist<sup>15</sup>.
- Mirror Box Therapy: A treatment for phantom limb pain in which amputees use a mirror/mirror box to view a reflection of their anatomical limb in the visual space occupied by the phantom limb. Pain relief is hypothesized to be due to cortical restructuring achieved by activation of the mirror neurons in the hemisphere of the brain contralateral to the amputated side, and may help the person recreate a coherent body image and update internal models of motor control<sup>15,23,24</sup>.
  - Treatment may include performance of a therapeutic exercise program with bilateral lower limbs, the amputated limb visualized as the contralateral limb in the mirror, in order to gain a greater sense of “control” of the phantom limb and reduce pain<sup>25</sup>.
  - Continued practice is generally required for sustained results<sup>24</sup>.
- Immersive Virtual Reality (IVR) in which movements of the persons opposite anatomical limb are transposed into the movements of a virtual limb using a virtual reality head-mounted display has been shown to offer some short-term benefit<sup>23</sup>.

J. Coordination, Communication and Documentation: Communication and collaboration among the interdisciplinary team, the patient, and family members is essential for successful rehabilitation of the person undergoing a LE amputation. Interdisciplinary teamwork is facilitated by appropriate documentation in the medical record. Discuss the patient’s need for additional services with the primary team. The patient may benefit from the following services/referrals:

- Occupational Therapy: Recommend an Occupational Therapy consult for patients who present with impairments that affect their ability to perform activities of daily living independently and who may have adaptive equipment needs. This applies for most patients’ after a lower extremity amputation being discharged directly home.
- Speech and Swallowing: If a patient presents with impairments that affect his or her ability to swallow without difficulty and/or presents with a new communication impairment.

- Nutrition/Dietary: Wound-healing potential can be evaluated with a nutritional assessment, especially for diabetics.
- Psychiatry: May be considered for the psychological and social adjustments and coping required after the loss of a body part.
- Care Coordination: If a patient has a complicated discharge situation and the care coordinator is not already involved.
- Social Work: If a patient has a complicated social history and/or he or she requires additional support or counseling.
- Chaplaincy: If a patient requires spiritual support or counseling.

## **2. Patient/Family Education:**

- Discuss realistic expectations regarding function, appropriate level of assist that patient requires from family, rehab progression, changes in body image, and potential for phantom sensation/pain.
- Discuss safety awareness and fall prevention strategies including asking for appropriate assistance during mobility and use of assistive devices, as it has been reported that one in five persons with lower limb amputation will experience a fall during inpatient rehabilitation, with 18% sustaining an injury<sup>26</sup>. Risk factors for falls in persons after major LE amputation include age greater than 71 years, extended inpatient rehabilitation hospital stay (>3 weeks), four or more significant comorbidities, cognitive impairment, and use of benzodiazepines or opiates<sup>26</sup>.
- Instruct the patient and family members in the following techniques and assess their understanding via return demonstration:
  - Proper residual limb positioning and use of knee immobilizer, prone positioning as appropriate
  - Therapeutic exercise program
  - Safe mobility techniques encouraging maximal independence
  - ACE wrapping or shrinker sock use, as appropriate

## **3. Emotional Support:**

- Limb loss is a life-altering event that requires the patient to grieve. Amputees are often concerned acutely about helplessness and dependency, especially in elderly populations. Efforts should be made to restore the patient's locus of control.
- Provide emotional support to the patient and family.

## **4. Available handouts (post in room and/or distribute to patient upon discharge):**

- Amputee exercise program (see Appendix I)
- Residual limb wrapping (see Appendix II)
- Amputee support groups and resources (see Appendix III)

## **5. Frequency of Treatment:**

Initially these patients are seen 5-7 times weekly to implement positioning, exercise, mobility programs, depending on medical status and appropriateness to participate with therapy program. Treatment can be decreased to 3 times weekly when patient is independent with exercises and positioning. Treatment continues at 5-7 times weekly if the discharge plan is to home or patient's function is severely decreased.

**Re-evaluation / assessment:**

Patients are re-evaluated on a daily basis with respect to their range of motion, muscle performance, skin integrity, quality of movement, pain intensity, and functional mobility status/level of independence. If the patient's hospital course is prolonged past the timeline set in the short term goals, or if a significant change in medical status occurs, a formal re-evaluation will be performed to re-assess progression towards the previously outlined goals and outcomes every 7-10 days. In the outpatient setting, the patient is to be formally re-evaluated every 30 days.

**Discharge Planning:**

Overall acute care length of stay is decreasing in the U.S.<sup>3,27</sup>. Acute care length of stay and discharge destination for persons undergoing LE amputation are dependent on multiple factors including the individual's payer source, amputation level, comorbidities, age, social supports, and injury characteristics<sup>3,27</sup>. While the majority of persons with trauma-related amputations are able to discharge from acute care directly to home, more proximal amputation levels, bilateral LE amputations, presence of severe injuries to other body systems, and acute care at a designated trauma center increase the likelihood of discharge to inpatient rehabilitation among trauma-related amputees<sup>3</sup>. For persons with dysvascular amputations, there has been an increase in discharge to nursing home and inpatient rehabilitation centers in recent years, which is likely related to a reduction in acute care length of stay<sup>27</sup>. Likelihood of discharge to a nursing facility has been found to increase with age, higher amputation levels, and those with Medicare insurance among dysvascular amputees, while men and married patients are less likely to be discharged to a skilled nursing facility (SNF)<sup>27</sup>.

Post-operatively, many patients are discharged to inpatient rehabilitation (acute or sub-acute) or skilled nursing facilities, and will continue to progress toward their physical therapy goals, initiate prosthetic fitting and home planning as appropriate. A person may be able to discharge directly to home with services if they meet short term goals physical therapy goals. If the patient is discharged home, an environment which is wheelchair and disability friendly will allow for better functional outcomes<sup>1</sup>. Consider the following resources for continued therapy:

- VNA PT
- Prosthetic evaluation when appropriate
- Outpatient PT for patients with high level of function and for prosthetic gait training as appropriate.

**Prosthetic Prescription and Use:**

Timing of prosthetic fitting and training varies widely, dependent on multiple factors including age of patient and type of amputation (traumatic vs. dysvascular). Prosthetic training may begin while the patient is in an inpatient rehab setting or during outpatient follow-up. Fitting of the first prosthesis should be implemented as soon as possible after wound healing. Choice of prosthetic device should be individualized based on the functional capacity and goals of the person, with the intent to allow the highest possible level of function. A team approach to prosthetic prescription writing should be used whenever possible, and should include a physiatrist, physical therapist and prosthetist working closely together to optimize outcomes for the amputee<sup>28</sup>.

Ideally the prosthesis should restore function with a minimal amount of energy expenditure<sup>29</sup>. Oxygen consumption increases approximately 33% for the transtibial amputee, and nearly doubles for the transfemoral amputee<sup>28</sup>. Due to the increasing cardiopulmonary demands with more proximal or bilateral amputations, the level of amputation has a direct effect on successful prosthetic rehabilitation in the older patient<sup>29</sup>.

Prosthetic limb choices have increased dramatically over the past several years<sup>8</sup>, but the basic components remain the same for all LE prosthetic devices: a foot, pylon, socket, suspension system and, if appropriate, a knee mechanism.

- **Prosthetic Feet:** The foot (or terminal device) serves as a shock absorber and provides a stable weight-bearing surface<sup>28</sup>. A variety of prosthetic feet are currently available, ranging from the simple SACH foot to the sophisticated energy storing and multiaxis function of some feet<sup>8</sup>.
- **Suspension System:** The prosthetic socket may be suspended in a number of ways including various cuffs and sleeves, which hold to socket onto the residual limb. Suction is often a feature, which contributes to reliable suspension of the socket. Another type of popular suspension system involves a pin on the bottom of a liner, which inserts and locks into a pinhole at the bottom of the socket<sup>28</sup>.
- **Sockets and Liners:** Sockets are custom made by obtaining a negative impression of the residual limb in plaster and made of plastic materials such as polyester resin<sup>8</sup>. Sockets for individuals with a transtibial amputation may be patellar tendon bearing (PTB), which offers areas of weight-bearing pressure and relief, or total surface bearing (TSB), which distributes pressure more equally throughout the residual limb<sup>4</sup>. Sockets for individuals with a transfemoral amputation generally include the quadrilateral socket, named for its' square appearance in the transverse plane, and ischial-containment socket, which has a wider anteroposterior (AP) dimension and narrower mediolateral (ML) dimension<sup>4</sup>. Liners allow for total contact between the residual limb and prosthetic socket, and may be added or taken off dependent on daily edema changes in the residual limb.
- **Prosthetic Knees:** Can have a single axis or be poly-centric<sup>8</sup>. Most basic prosthetic knee has a locking mechanism that is manually applied to provide stability in the stance phase, with more advanced options including a weight activated brake or a fluid controlled cylinder<sup>8</sup>. To control limb displacement during swing phase options are available and include friction, springs, and fluid resistance<sup>8</sup>. Electric controllers for the timing and amount of fluid resistance (the C-Leg) results in a less effortful and safer gait pattern<sup>8</sup>.

For persons undergoing hip disarticulation or external hemipelvectomy, the skeletal structure and soft tissue available for prosthetic weight bearing are significantly compromised and result in an increased incidence of skin breakdown<sup>30</sup>. Lower extremity prosthetics for these patients' will include a hip socket and prosthetic hip joint. Prosthetic sockets for external hemipelvectomy encase the abdominal cavity and provide hard walls that protect and compress the abdominal viscera so that these areas may accept weight-bearing, and may extend superiorly to the tenth rib to allow additional vertical loading<sup>4</sup>. The hip disarticulation socket encloses the ischial tuberosity and gluteal muscles for weight bearing, extends over the ilium to provide suspension, and also encases the opposite pelvis to assist in mediolateral trunk stability<sup>4</sup>. The prosthetic hip joint in the hip disarticulation prosthesis is attached to the socket anteriorly, which causes the weight line to fall posterior to the hip and anterior to the knee, to assist hip and knee extension, and also to allow the

patient to sit<sup>4</sup>. Rejection rates for lower-limb prostheses are generally highest at these most proximal levels of amputation<sup>4</sup>.

Once appropriate, the patient with a LE amputation should ideally be able to use a prosthesis during most of the day. Upon initiation of ambulation activities with a prosthesis, skin problems may develop, and should be anticipated in patients with PVD and/or DM. Any abrasion, maceration or blister mandates immediate discontinuation of prosthesis use, and the physician and prosthetist should be notified<sup>11</sup>. Initially, the patient should wear the prosthesis for up to 15 minutes, followed by skin inspection and a 15 minute rest period with a shrinker or elastic wrap in place to avoid residual-limb edema<sup>4</sup>. This schedule of 15 minutes wear/15 minutes rest should be followed during the first few days of prosthesis training, and advanced as tolerated<sup>4</sup>.

**Author:**

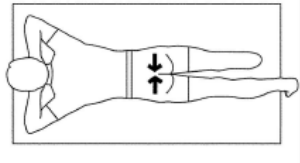
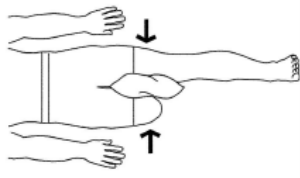
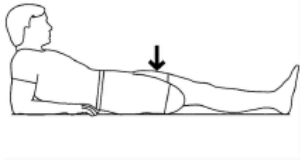
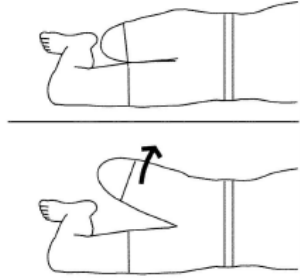
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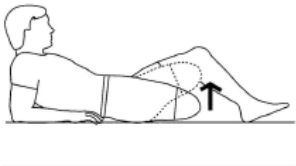
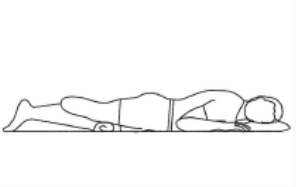
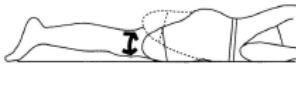
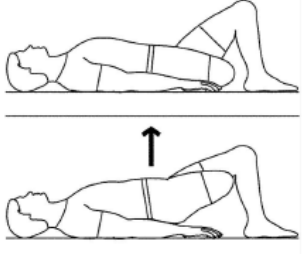
## Appendix I: LE amputee Exercise Program

### A: AKA Initial Therapeutic Exercise Program

<p><b>Glut sets</b></p>  <ul style="list-style-type: none"> <li>• Lie on back or stomach.</li> <li>• Squeeze buttocks together.</li> </ul> <p><b>Special Instructions:</b> Do Not Hold Breath. Perform 1 set of 10 Repetitions, once a day. Hold exercise for 10 Seconds.</p>	<p><b>AK hip squeeze</b></p>  <ul style="list-style-type: none"> <li>• Lie on back.</li> <li>• Place a pillow or ball between your thighs.</li> <li>• Try to squeeze your thighs together.</li> </ul> <p><b>Special Instructions:</b> Do Not Hold Breath. Perform 1 set of 10 Repetitions, once a day. Hold exercise for 10 Seconds.</p>
<p><b>AK hip extend</b></p>  <ul style="list-style-type: none"> <li>• Lie on back.</li> <li>• Push residual limb down into bed.</li> </ul> <p><b>Special Instructions:</b> Do Not Hold Breath. Perform 1 set of 10 Repetitions, once a day. Hold exercise for 10 Seconds.</p>	<p><b>AK sidelying hip lift up</b></p>  <ul style="list-style-type: none"> <li>• Lie on your uninjured leg</li> <li>• Bend knee slightly, for support.</li> <li>• Lift your residual limb upward, towards ceiling.</li> <li>• Keep hip straight.</li> </ul> <p>Perform 3 sets of 20 Repetitions, once a day. Rest 1 Minute between sets. Perform 1 repetition every 4 Seconds.</p>

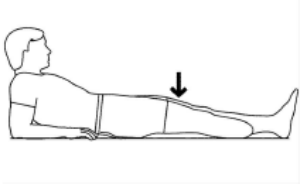
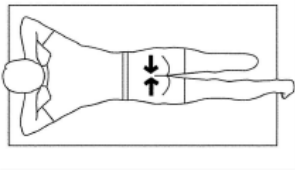
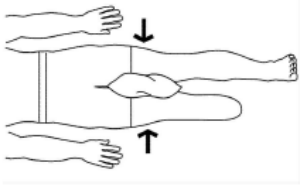
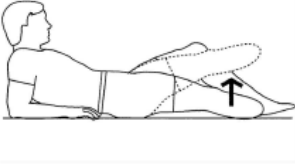
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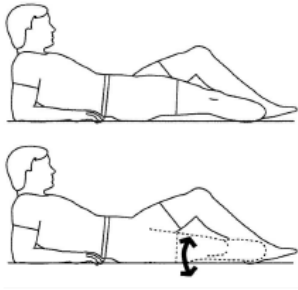
<p><b>AK hip lift up</b></p>  <ul style="list-style-type: none"> <li>• Lie on back.</li> <li>• Lift your residual limb as high as possible.</li> </ul> <p>Perform 3 sets of 20 Repetitions, once a day.</p> <p>Rest 1 Minute between sets. Perform 1 repetition every 4 Seconds.</p>	<p><b>AK hip extend stretch</b></p>  <ul style="list-style-type: none"> <li>• Lie face down.</li> <li>• Keep residual limb straight in line with trunk.</li> <li>• To achieve more stretch, place a towel roll or pillow under end of residual limb.</li> </ul> <p>Perform 1 set of 4 Repetitions, twice a day.</p> <p>Use Towel. Hold exercise for 20 Seconds.</p>
<p><b>AK prone hip extend</b></p>  <ul style="list-style-type: none"> <li>• Lie on stomach.</li> <li>• Lift your residual limb off bed as high as possible.</li> <li>• Return to start position.</li> </ul> <p><b>Special Instructions:</b> Do not arch low back.</p> <p>Perform 3 sets of 20 Repetitions, once a day.</p> <p>Rest 1 Minute between sets. Perform 1 repetition every 4 Seconds.</p>	<p><b>AK bridge</b></p>  <ul style="list-style-type: none"> <li>• Lie on back.</li> <li>• Bend knee of uninvolved leg.</li> <li>• Lift buttocks up, off floor, keeping hips level.</li> <li>• Return to start position.</li> </ul> <p>Perform 3 sets of 20 Repetitions, once a day.</p> <p>Rest 1 Minute between sets. Perform 1 repetition every 4 Seconds.</p>

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## B: BKA Initial Therapeutic Exercise Program

<p><b>BK leg push down</b></p>  <ul style="list-style-type: none"> <li>• Lie on back.</li> <li>• Push residual limb down into the bed.</li> </ul> <p><b>Special Instructions:</b> Do Not Hold Breath. Keep your knee straight Perform 1 set of 10 Repetitions, twice a day.</p> <p>Hold exercise for 10 Seconds.</p>	<p><b>AK/BK glut sets</b></p>  <ul style="list-style-type: none"> <li>• Lie on back or stomach.</li> <li>• Squeeze buttocks together.</li> </ul> <p><b>Special Instructions:</b> Do Not Hold Breath. Perform 1 set of 10 Repetitions, twice a day.</p> <p>Hold exercise for 10 Seconds.</p>
<p><b>BK hip press in</b></p>  <ul style="list-style-type: none"> <li>• Lie on back.</li> <li>• Place a pillow or ball between your thighs.</li> <li>• Try to push your thighs together.</li> </ul> <p><b>Special Instructions:</b> Do Not Hold Breath. Keep knee straight on residual limb. Perform 1 set of 10 Repetitions, twice a day.</p> <p>Hold exercise for 10 Seconds.</p>	<p><b>BK leg raise</b></p>  <ul style="list-style-type: none"> <li>• Lie on back.</li> <li>• Lift your residual limb as high as possible.</li> </ul> <p><b>Special Instructions:</b> Keep your knee straight. Perform 1 set of 10 Repetitions, twice a day.</p> <p>Perform 1 repetition every 4 Seconds.</p>

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**BK hip rotations**

- Lie on back.
- Rotate your residual limb inward and outward as shown.

**Special Instructions:**

Keep knee straight as possible

Perform 1 set of 10 Repetitions, twice a day.

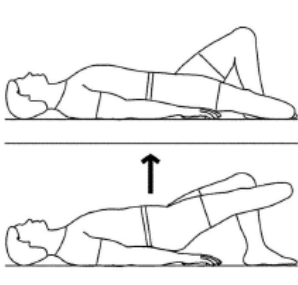
Perform 1 repetition every 4 Seconds.

**BK seated LAQ**

- Sit in chair with knee of residual bent.
- Straighten knee as much as possible.
- Return to start position.

Perform 1 set of 10 Repetitions, twice a day.

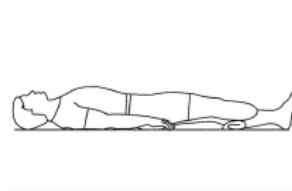
Perform 1 repetition every 4 Seconds.

**BK bridge**

- Lie on back as shown.
- Bend knee of uninvolved leg.
- Lift buttocks up, off floor, keeping hips level.
- Return to start position.

Perform 1 set of 10 Repetitions, twice a day.

Perform 1 repetition every 4 Seconds.

**BK knee extend stretch**

- Lie on back.
- Place towel roll or pillow under end of residual.
- Allow gravity to straighten knee.

**Special Instructions:**

Keep leg in neutral position, that is do not allow leg to roll inward or outward.

Perform 1 set of 5 Repetitions, twice a day.

Use Towel.

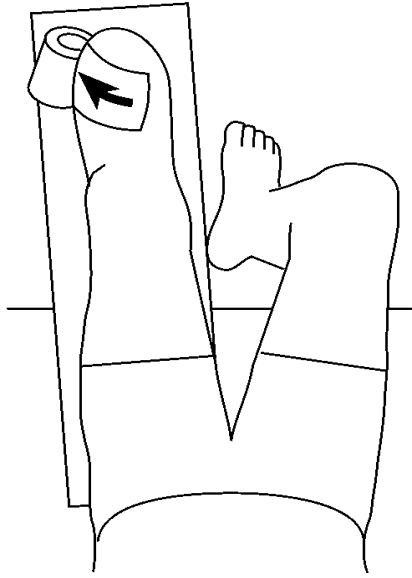
Hold exercise for 30 Seconds.

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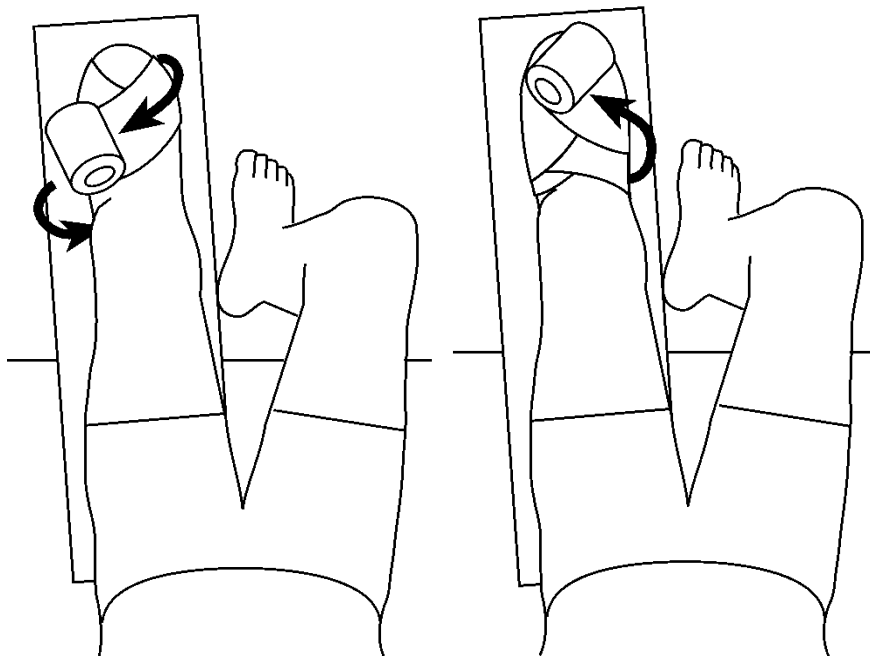
## Appendix II: Limb Wrapping Techniques

### Below Knee Amputation Limb Wrapping: (With patient instructions)

1. Hold bandage facing up and toward you as shown. Begin at outside as shown.

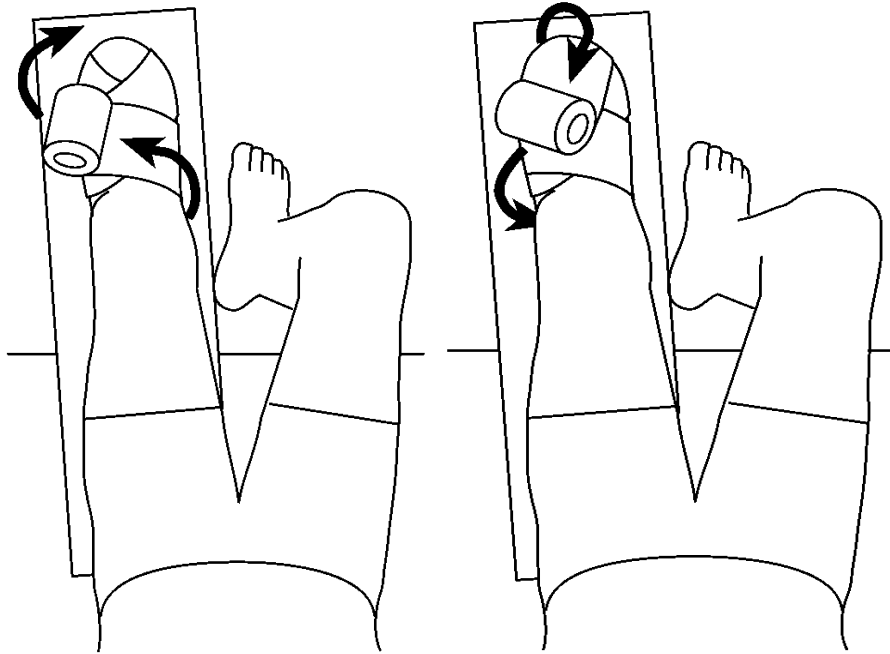


2. Unroll bandage diagonally down, behind and around limb.

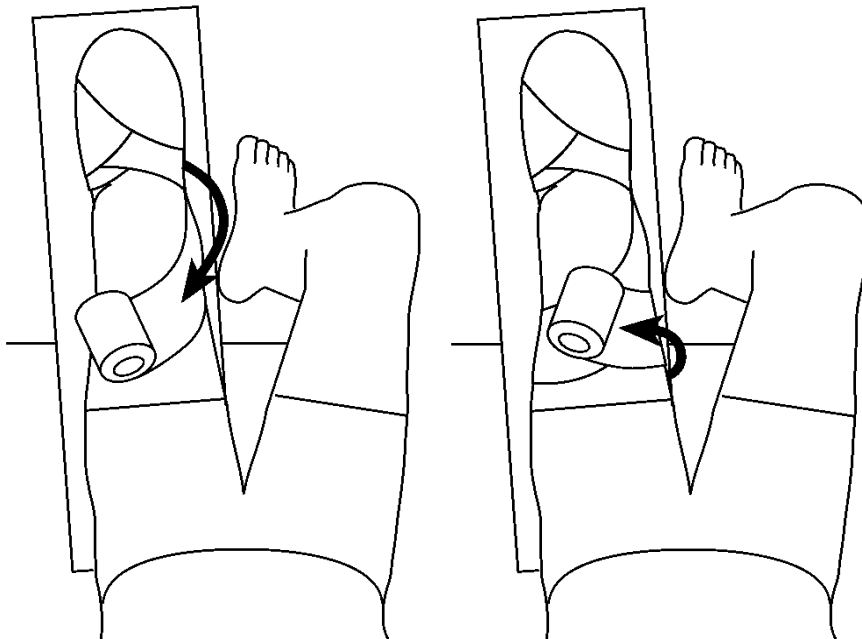


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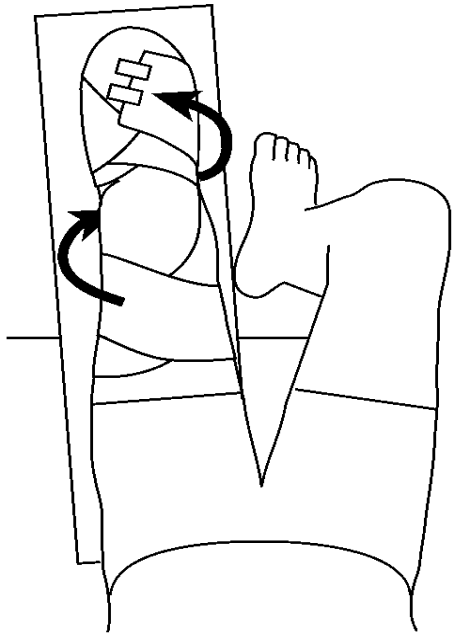
3. Use figure of eight wraps until all the skin is covered.



4. To prevent bandage from slipping, bring it up above the knee and back down, then secure to another layer with paper tape. Do not use safety pins or clips.



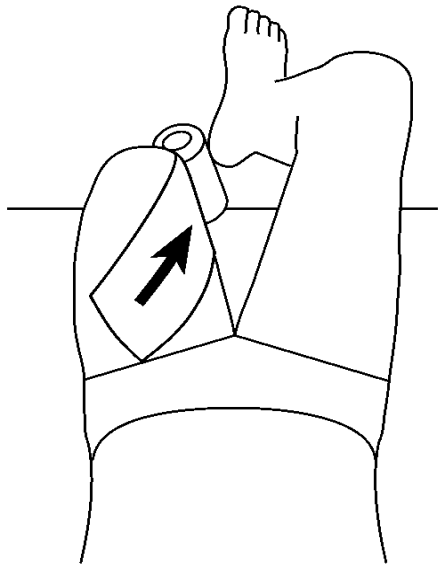
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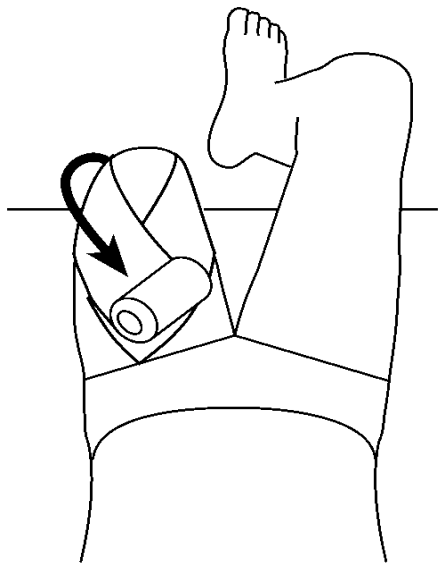
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**Above Knee Amputation Limb Wrapping:** (with patient instructions)

1. Begin with bandage with the roll facing up and toward you.

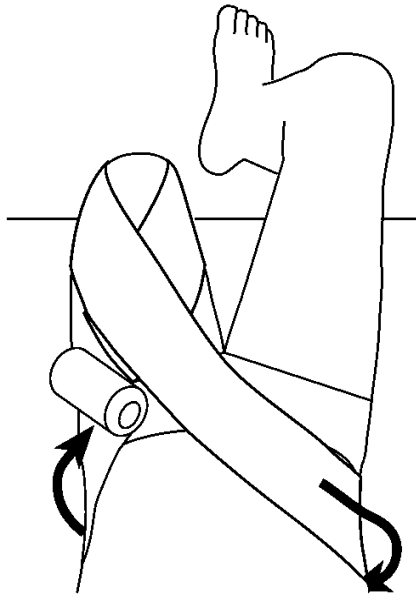


2. Unroll the bandage diagonally down the inside of thigh, around the back to the outside, bringing it around to the outside. Cross over the end to hold in place.

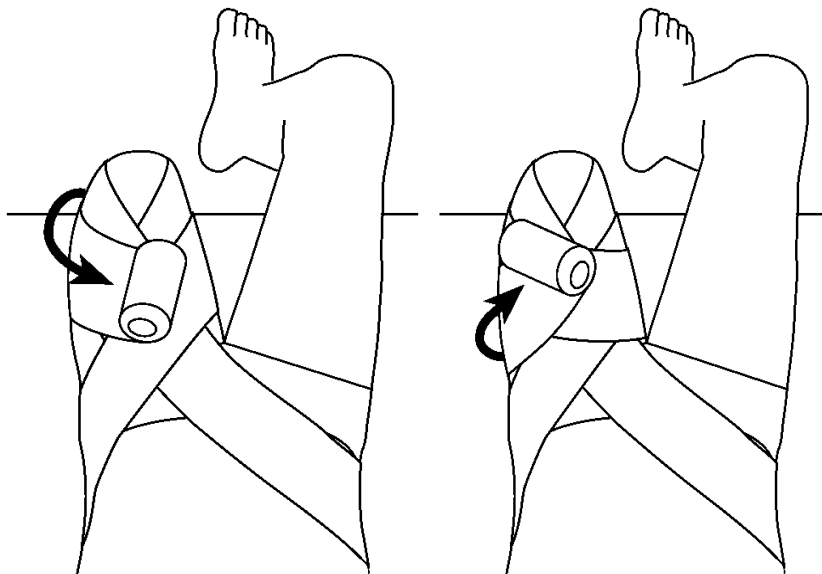


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3. Continue up and around over hip and behind waist.



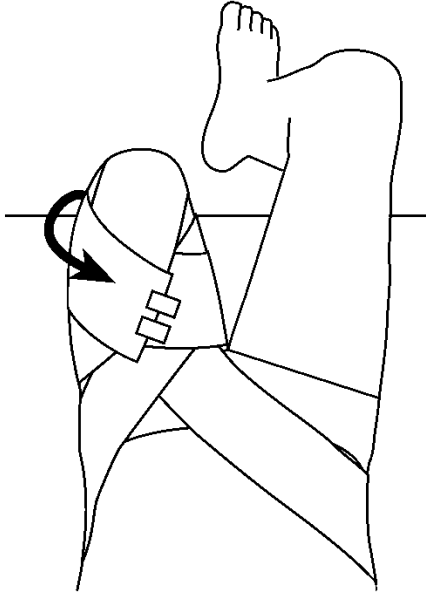
4. Proceed back to limb with figure-of-eight turns, overlapping the first wrap.



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5. Continue in this pattern, ensuring all the skin is covered. Use a second bandage if needed. Secure the final end with paper tape. Do not use safety pins or clips.



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### **Appendix III: Online amputee support groups and resources**

**Amputee Coalition of America:** Comprehensive website from an organization intended to “reach out to and empower people affected by limb loss to achieve their full potential through education, support and advocacy, and to promote limb loss prevention”. Site includes information for new amputees, children with amputations, financial help/funding, advocacy, peer support and prosthetics.

<http://www.amputee-coalition.org/>

**Amputee Online:** Amputee support group which operates both within the US and on an international level. Web site is designed primarily to help out amputees on a peer to peer basis. Site includes general information, prosthetic components, phantom pain and sensation information, as well as sport and recreation resources/links.

[www.amputee-online.com](http://www.amputee-online.com)

**American Amputee:** The American Amputee Foundation is a non-profit organization which includes a national resource directory for amputees and people with disabilities. This site provides information both on the national and local level and is designed to empower readers with information and education to help them find the best services possible tailored to meet their specific needs.

[www.americanamputee.org/](http://www.americanamputee.org/)

Site includes a state-by-state comprehensive list of support and resource groups throughout the U.S. and contact information

<http://www.americanamputee.org/sopport-groups.html>

**Appendix IV: Amputee Mobility Predictor scoring: Definitions for the MFCL Classification<sup>19</sup>**

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K-Level 0	Does not have the ability or potential to ambulate or transfer safely with or without assistance, and a prosthesis does not enhance quality of life or mobility.
K-Level 1	Has the ability or potential to use a prosthesis for transfers or ambulation in level surfaces at a fixed cadence. Typical of the limited and unlimited household ambulator.
K-Level 2	Has the ability or potential for ambulation with the ability to transverse low-level environmental barriers such as curbs, stairs, or uneven surfaces. Typical of the limited community ambulatory.
K-Level 3	Has the ability or potential for ambulation with variable cadence. Typical of the community ambulatory who has the ability to transverse most environmental barriers and may have vocational, therapeutic, or exercise activity that demands prosthetic use beyond simple locomotion.
K-Level 4	Has the ability or potential for prosthetic ambulation that exceeds basic ambulation skills, exhibiting high impact, stress, or energy levels. Typical of the prosthetic demands of the child, active adult, or athlete.

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NOTE: K is the arbitrary letter assigned by HCFA to this classification system.

## Appendix V: Amputee Mobility Predictor (AMP) scoring form<sup>19</sup>

### Amputee Mobility Predictor Questionnaire

Initial instructions: Testee is seated in a hard chair with arms. The following maneuvers are tested with or without the use of the prosthesis. Advise the person of each task or group of tasks prior to performance. Please avoid unnecessary chatter throughout the test. Safety first, no task should be performed if either the tester or testee is uncertain of a safe outcome.

The Right Limb is: ☺ PF ☺ TT ☺ KD ☺ TF ☺ HD ☺ intact. The Left Limb is: ☺ PF ☺ TT ☺ KD ☺ TF ☺ HD ☺ intact.

1. Sitting balance: sit forward in a chair with arms folded across chest for 60s.	Cannot sit upright independently for 60s Can sit upright independently for 60s	=0 =1	_____
2. Sitting reach: reach forward and grasp the ruler. (Tester holds ruler 12in beyond extended arms midline to the sternum.)	Does not attempt Cannot grasp or requires arm support Reaches forward and successfully grasps item	=0 =1 =2	_____
3. Chair to chair transfer: 2 chairs at 900. Pt may choose direction and use their upper extremities.	Cannot do or requires physical assistance Performs independently, but appears unsteady Performs independently, appears to be steady and safe	=0 =1 =2	_____
4. Arises from a chair: ask pt to fold arms across chest and stand. If unable, use arms or assistive device.	Unable without help (physical assistance) Able, uses arms/assist device to help Able, without using arms	=0 =1 =2	_____
5. Attempts to arise from a chair (stopwatch ready): if attempt in no. 4 was without arms then ignore and allow another attempt without penalty.	Unable without help (physical assistance) Able requires >1 attempt Able to rise 1 attempt	=0 =1 =2	_____
6. Immediate standing balance (first 5s): begin timing immediately.	Unsteady (staggers, moves foot, sways) Steady using walking aid or other support Steady without walker or other support	=0 =1 =2	_____
7. Standing balance (30s) (stopwatch ready): For items nos. 7 & 8, first attempt is without assistive device. If support is required, allow after first attempt.	Unsteady Steady but uses walking aid or other support Standing without support	=0 =1 =2	_____
8. Single-limb standing balance (stopwatch ready): time the duration of single limb standing on both the sound and prosthetic limb up to 30s. Grade the quality, not the time.	Nonprosthetic side Unsteady Steady but uses walking aid or other support for 30s Single-limb standing without support for 30s	=0 =1 =2	_____
Sound side ___seconds	Prosthetic Side Unsteady	=0	
Prosthetic side ___seconds	Steady but uses walking aid or other support for 30s Single-limb standing without support for 30s	=1 =2	_____
9. Standing reach: reach forward and grasp the ruler. (Tester holds ruler 12in beyond extended arm(s) midline to the sternum.)	Does not attempt Cannot grasp or requires arm support on assistive device Reaches forward and successfully grasps item no support	=0 =1 =2	_____
10. Nudge test (subject at maximum position #7): with feet as close together as possible, examiner pushes firmly on subject's sternum with palm of hand 3 times (toes should rise).	Begins to fall Staggers, grabs, catches self, or uses assistive device Steady	=0 =1 =2	_____

Content has been excerpted from Gailey RS, Roach KE, Applegate EB, et al. The amputee mobility predictor: an instrument to assess determinants of the lower-limb amputee's ability to ambulate. *Arch Phys Med Rehabil.* 2002;83(5):613-627.

11. Eyes closed (at maximum position #7): if support is required grade as unsteady.	Unsteady or grips assistive device	=0	
	Steady without any use of assistive device	=1	_____
12. Picking up objects off the floor (pick up a pencil off the floor placed midline 12in in front of foot).	Unable to pick up object and return to standing	=0	
	Performs with some help (table, chair, walking aid, etc)	=1	
	Performs independently (without help from object or person)	=2	_____
13. Sitting down: ask pt to fold arms across chest and sit. If unable, use arm or assistive device.	Unsafe (misjudged distance, falls into chair)	=0	
	Uses arms, assistive device, or not a smooth motion	=1	
	Safe, smooth motion	=2	_____
14. Initiation of gait (immediately after told to "go").	Any hesitancy or multiple attempts to start	=0	
	No hesitancy	=1	_____
15. Step length and height: walk a measured distance of 12ft twice (up and back). Four scores are required or 2 scores (a & b) for each leg. "Marked deviation" is defined as extreme substitute movements to permit clearing the floor.	a. Swing foot		
	Does not advance a minimum of 12in	= 0	
	Advances a minimum of 12in	= 1	_____
b. Foot clearance			Prosthesis Sound
	Foot does not completely clear floor without deviation	= 0	
	Foot completely clears floor without marked deviation	= 1	_____
			Prosthesis Sound
16. Step continuity.	Stopping or discontinuity between steps (stop & go gait)	= 0	
	Steps appear continuous	= 1	_____
17. Turning: 180° turn when returning to chair.	Unable to turn, requires intervention to prevent falling	= 0	
	Greater than 3 steps but completes task without intervention	= 1	
	No more than 3 continuous steps with or without assistive aid	= 2	_____
18. Variable cadence: walk a distance of 12ft fast as safely as possible 4 times. (Speeds may vary from slow to fast and fast to slow, varying cadence.)	Unable to vary cadence in a controlled manner	= 0	
	Asymmetrical increase in cadence controlled manner	= 1	
	Symmetrical increase in speed in a controlled manner	= 2	_____
19. Stepping over obstacle: place a movable box of 4in. in height in the walking path.	Cannot step over the box	= 0	
	Catches foot, interrupts stride	= 1	
	Steps over without interrupting stride	= 2	_____
20. Stairs (must have at least 2 steps): try to go up and down these stairs without holding on to the railing. Don't hesitate to permit pt to hold on to rail. Safety first, if examiner feels that any risk in involved omit and score as 0.	Ascending		
	Unsteady, cannot do	= 0	
	One step at a time, or must hold on to railing or device	= 1	
	Steps over step, does not hold onto the railing or device	= 2	_____
	Descending		
	Unsteady, cannot do	= 0	
	One step at a time, or must hold on to railing or device	= 1	
	Steps over step, does not hold onto the railing or device	= 2	_____
21. Assistive device selection: add points for the use of an assistive device if used for 2 or more items. If testing without prosthesis use of appropriate assistive device is mandatory.	Bed bound	= 0	
	Wheelchair	= 1	
	Walker	= 2	
	Crutches (axillary or forearm)	= 3	
	Cane (straight or quad)	= 4	
	None	= 5	_____

Total  
Score \_\_\_\_\_/47

Trial © no prosthesis © with prosthesis Observer \_\_\_\_\_

Date \_\_\_\_\_ Abbreviation: PF, partial foot; TT, transtibial; KD, knee disarticulation;

TF, transfemoral; HD, hip disarticulation; Pt, patient.

Content has been excerpted from Gailey RS, Roach KE, Applegate EB, et al. The amputee mobility predictor: an instrument to assess determinants of the lower-limb amputee's ability to ambulate. *Arch Phys Med Rehabil.* 2002;83(5):613-627.

## Appendix VI: Amputee Mobility Predictor (AMP) Testing Protocol<sup>19</sup>

The AMP testing protocol can be administered by a clinician, without an assistant. The average time required to administer the AMP or AMPnoPRO is less than 15 minutes and often less than 10 minutes for an experienced examiner. The necessary equipment for testing consists of the following: a stopwatch, 2 chairs, a 12-in ruler, a pencil, a 4-in high obstacle (preferably 18-24in long), and a set of stairs with 3 steps. A safety or gait belt is also suggested, along with the assistive device of the amputee's choosing. The AMPnoPRO eliminates question 8 because the task of standing on the prosthetic side is not possible. The use of an assistive device during testing is accounted for in the scoring system. The prosthesis wearer may use whatever assistive device he/she is most comfortable with whenever he/she requests it.

The following is an item-by-item description of the AMP testing and scoring procedure.

### *Item 1: Sitting balance*

**Task:** The amputee subject sits upright in a chair; the patient's buttocks are slightly forward so that there is no support from the back of the chair and his/her arms are folded comfortably in the lap.

**Score 0:** The amputee subject cannot sit independently for 60 seconds or requires the observer's support or guarding.

**Score 1:** The amputee subject sits independently for 60 seconds and does not require support or guarding from the observer.

### *Item 2: Sitting reach*

**Task:** Seated as in item 1, the amputee reaches forward and grasps a ruler held by the observer midline to the patient's sternum and 12 in beyond the patient's dominant hand or sound limb side (the patient's choice).

**Score 0:** Does not attempt the task or verbally refuses it because of fear or lack of confidence that he/she may complete the task

**Score 1:** Cannot grasp the ruler or requires arm support of either the chair or assistive device.

**Score 2:** Reaches forward and successfully grasps the ruler.

### *Item 3: Chair to chair transfer*

**Task:** The amputee subject sits upright in an armless chair and is asked to transfer from 1 chair to another set at a 90° angle to the first. The amputee subject may choose direction to his/her amputated side or nonamputated side. Use of hands is permitted.

**Score 0:** Cannot transfer independently or requires physical assistance to complete the task.

**Score 1:** Performs independently, but appears unsteady or requires contact guarding.

**Score 2:** Performs independently, appears to be steady and safe.

### *Item 4: Arises from a chair*

**Task:** The amputee subject sits upright and forward in a chair, arms folded comfortably across the chest. The observer asks the amputee subject to stand without

using the arms for assistance unless it is necessary and then he/she may use the chair or assistive device.

**Score 0:** Unable to rise without physical assistance, this includes contact guarding.

**Score 1:** Able to rise but must use his/her arms, the chair, or an assistive device.

**Score 2:** Able to rise without using arms; in other words, they stand hands free.

***Item 5: Attempts to arise from a chair***

**Task:** If the amputee subject attempted in item 4 to rise without using his/her arms but failed in that attempt to arise from the chair, then ignore item 4 and allow another attempt (item 5) without penalty. However, if the amputee subject has difficulty and requires additional attempts or physical assistance or guarding, he/she must be graded accordingly in item 5, with the following scores:

**Score 0:** Unable to arise without the help of physical assistance or contact guarding.

**Score 1:** Able to stand independently but requires more than 1 attempt to reach the standing position.

**Score 2:** Able to rise to standing in a single attempt.

***Item 6: Immediate standing balance***

**Task:** Have stopwatch ready and begin timing the first 5 seconds that transpire immediately after the amputee achieves upright standing posture in front of the chair, with or without support of an assistive device. Be sure to check that the amputee is not leaning against the chair with his/her legs.

**Score 0:** Unsteady posture causes amputee to stagger, move foot quickly in an attempt to maintain balance, or sway excessively. A steady posture with normal foot movement to adjust for comfortable standing is permitted without penalty.

**Score 1:** Able to attain a steady standing posture using a walking aid or other support such as a chair back that has been provided to assist with the testing task.

**Score 2:** Able to attain a steady standing posture without walker or other support.

***Item 7: Standing balance***

**Task:** standing balance is timed for 30 seconds by stopwatch. The first attempt is made without an assistive device. If during the task, the observer believes that an assistive device will help the amputee to stand safely, then repeat items 6 and 7 with an assistive device.

**Score 0:** The amputee subject is unsteady or unable to hold for 30 seconds a satisfactory upright posture that does not require contact guarding or support.

**Score 1:** Stands steady for 30 seconds but uses a walking aid or other support.

**Score 2:** Stands for 30 seconds without assistive device or physical support.

***Item 8: Single-limb standing balance***

**Task:** By using the stopwatch, the observer asks the amputee subject to stand first on the sound limb and then on the prosthesis for 30 seconds each. The observer grades the amputee's performance on both sides unless the amputee subject is being tested without a prosthesis, in which case scoring of the prosthetic side is ignored.

**Score 0:** If the amputee subject cannot show single-limb standing for 30 seconds even with an assistive device, the stance is considered unsteady.

**Score 1:** If the amputee subject grasps, even for a moment, a walking aid or requires other support, he/she is considered steady but requiring support.

**Score 2:** The amputee subject can maintain single-limb standing without support for 30 seconds.

***Item 9: Standing reach***

**Task:** The amputee subject stands with his/her feet 2 to 4in apart and reaches forward to grasp a ruler that is held by the observer midline to the amputee subject's sternum and 12in beyond his/her dominant hand or sound limb side (the amputee subject's choice). The amputee subject may not take a step forward, but may place the prosthetic limb in a position of comfort if the socket brim interferes with performance.

**Score 0:** Does not attempt the task or verbally refuses it because of fear or lack of confidence that he/she may complete the task.

**Score 1:** Cannot grasp the ruler or requires arm support from an assistive device.

**Score 2:** Reaches forward and successfully grasps the ruler.

***Item 10: Nudge test***

**Task:** The amputee subject stands as comfortably possible with feet together; the examiner pushes firmly on subject's sternum with palm of hand 3 times, quickly, with a consistent pressure that would cause a body weight to move toward the heels but not typically cause a person to lose balance in a normal situation.

**Score 0:** The amputee subject begins to fall and requires the observer's assistance.

**Score 1:** The amputee subject cannot or will not stand without the use of the assistive device or he/she stands independently and when nudged staggers, grabs at support, or catches self.

**Score 2:** The amputee subject remains steady with independent standing free of assistive device.

***Item 11: Eyes closed***

**Task:** The amputee subject stands with his/her feet 2 to 4in apart. Stopwatch ready, the observer asks the amputee to close his/her eyes and maintain standing posture for 30 seconds.

**Score 0:** The amputee subject is unable to stand in a steady position for 30 seconds without using an assistive device.

**Score 1:** The amputee subject remains steady accomplishing independent standing without the use of an assistive device.

***Item 12: Picking up objects off the floor***

**Task:** The amputee subject stands with his/her feet 2 to 4in apart. The observer places a pencil (or similar object of same height) on the floor midline from the amputee subject and 12in from the toe of the amputee subject's shoe. The observer asks the amputee to pick up the object off the floor without moving his/her feet, knee straight, and (if safely possible) without using any support.

**Score 0:** The amputee subject cannot pick up the object and return to standing safely.

**Score 1:** The amputee subject performs the task with some support from an assistive device, chair, or person.

**Score 2:** The amputee subject performs the task without any help from object or person.

***Item 13: Sitting down***



**Task:** The examiner asks the subject to fold his/her arms across the chest and sit down in a controlled manner. If the amputee is unable to perform the task, or is unsure, the examiner suggests the amputee subject use his/her arms or an assistive device.

**Score 0:** The amputee subject misjudges distance to the chair, falls into the chair, or requires contact guarding and is scored as unsafe.

**Score 1:** The amputee subject chooses for security or necessity to use his/her arms or cannot sit in a smooth and controlled motion.

**Score 2:** The amputee subject sits in a safe, smooth, and controlled motion.

To ensure safe ambulation in items 14-20, walking aids are permitted and encouraged whether or not the amputee wears a prosthesis. Item 21 compensates for the decision to use an assistive device on the ambulation tasks.

***Item 14: Initiation of gait***

**Task:** From a standing posture with or without an assistive device, as the amputee prefers and the clinician determines to be safe, the amputee is asked to begin walking.

**Score 0:** The amputee subject shows hesitancy, makes multiple attempts to start, or appears to be consciously organizing in their minds the process of initiating walking beyond the cognition required for normal ambulation.

**Score 1:** The amputee starts walking with no hesitancy, with a smooth transition from standing to walking.

***Item 15: Step length and height***

**Task:** The amputee subject walks a measured distance of 12ft (3.66m) twice (up and back) for a total of 24ft (7.32m). Four scores are required, ie, 2 scores (a,b) for the left leg and 2 for the right. “Marked deviation” is defined as extreme substitute movements made to permit the foot to clear the floor.

a. Swing foot

**Score 0:** The leg does not advance a minimum of 12in. If ambulating without the prosthesis and with an assistive device, the same applies: the swing limb must advance a minimum of 12in.

**Score 1:** The swing advances a minimum of 12in, whether the prosthetic limb or the sound limb is being tested.

b. Floor clearance

**Score 0:** The foot does not completely clear floor with step or deviation. This description includes foot shuffling, sliding, and marked deviations such as circumduction that require significant substitution for clearing the floor.

**Score 1:** The foot completely clears floor without marked deviation

***Item 16: Step continuity***

**Task:** As the amputee subject performs the task described in item 15, the examiner observes the quality of gait. Step continuity is defined as continuous steps that are that are devoid of hesitation (i.e., marked differences in step length that require adjustment for loss of balance between steps), and without difficulty maneuvering the assistive device sufficient to interrupt step continuity.

**Score 0:** The amputee exhibits stopping or discontinuity between steps that interrupts a smooth continuous gait.

**Score 1:** The amputee subject’s steps appear to be continuous.

***Item 17: Turning***

**Task:** As the amputee subject completes the first 12ft of ambulation and turns to return to the chair, the examiner notes the quality of the movement.

**Score 0:** The amputee subject is unable to turn and therefore requires intervention such as contact guarding and verbal instructions in order not to fall.

**Score 1:** The amputee subject requires more than 3 steps to complete the task but requires no contact or verbal intervention.

**Score 2:** The amputee subject completes the task in 3 or fewer continuous steps, with or without an assistive aid.

***Item 18: Variable cadence***

**Task:** The examiner instructs the patient to walk a distance of 12ft fast as safely possible 4 times for a total of 48ft (14.63m). Speeds may vary from slow to fast and fast to slow, varying cadence. This task may also be completed with an assistive device although care must be taken that the patient is not extended beyond his/her capabilities.

**Score 0:** The patient is unable to vary cadence in a controlled manner.

**Score 1:** The patient asymmetrically increases his/her cadence in a controlled manner so that step length markedly differs between legs, and/or balance must be re-established with each step.

**Score 2:** The patient symmetrically increases his/her cadence in a controlled manner so that step lengths are equal and balance is maintained.

***Item 19: Stepping over obstacle***

**Task:** Place a movable, 4in high box or hurdle (length, 18-24in) in the walking path. The object must be of a design that will not cause the amputee to stumble or fall should he/she be unable to complete the task. The amputee is asked to step over the obstacle without interrupting step continuity. This task may be performed en route to or from the stair climbing task. The amputee subject is penalized if he/she attempts to circumduct the obstacle by swinging the prosthetic limb to side of the obstacle.

**Score 0:** The amputee subject cannot step over the box.

**Score 1:** The amputee subject catches his/her foot on the obstacle, circumducts it, or interrupts stride by stopping in front of the obstacle to prepare physically or mentally to clear it.

**Score 2:** The amputee steps over the obstacle without interrupting stride.

***Item 20: Stairs***

**Task:** The examiner instructs the amputee to try to go up and down stairs without holding on to the railing. However, to ensure safety, do not hesitate to permit the amputee to grasp the rail. The stairs must have a minimum of 2 steps; 3 to 4 steps are preferred.

a. Ascending

**Score 0:** Unsteady, cannot ascend stairs or expresses fear of or inability to attempt the task.

**Score 1:** Ascends stairs 1 step at a time, or must hold on to railing or assistive device.

**Score 2:** Ascends stairs step-over-step and does not hold onto the railing or assistive device.

b. Descending

**Score 0:** Unsteady, cannot descend stairs or expresses fear of or inability to attempt the task.

**Score 1:** Descends stairs 1 step at a time, or must hold on to railing or assistive device.

**Score 2:** Descends stairs step-over-step and does not hold onto the railing or assistive device.

***Item 21: Assistive device selection***

**Task:** Points are awarded based on the use of an assistive device for items 14 to 20. If the amputee subject required an assistive device because the stairs lacked a railing, but he/she did not use an assistive device for ambulation, then award points based on the performance on items 14 to 19.

**Score 0:** Bed bound

**Score 1:** Wheelchair

**Score 2:** Walker

**Score 3:** Crutches (axillary or forearm)

**Score 4:** Cane (straight or quad)

**Score 5:** none

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