THE REHABILITATION OF THE LOWER LIMB AMPUTEE: A COMPREHENSIVE REVIEW

SHAMEL S. ALLEN, MPT, CP

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Presenter Introduction & background
Course Content

Day 1

- Lower Limb Amputation Demographics & Causes
- Early post-op Care
- Psychological Impact of Losing a Limb
- Pre-prosthetic Evaluation & Goal Setting
- Prosthetic Functional Levels
- Prosthetic Evaluation & Goal Setting
- Lower Limb Socket Designs
- Common Suspension Methods
- End of day 1
Course Content
Day 2

- Recap of day 1
- Assessing proper fit
- Potential skin problems
- Prosthetic knee considerations
- Prosthetic foot options
- Analyzing prosthetic gait
  - Recognizing gait deviations
  - Prosthetic vs. amputee cause
- Gait training and progression
CAUSES & LEVELS OF AMPUTATIONS
Amputation Demographics

In the United States:

- Total number of amputees in the U.S. ranges from 300,000-2.5 million various levels
- 47% increased in the number of amputations expected from 1994-2020
- Increase of 8-10% per year
- 156,000 people with limb loss per year
- 13,000 people with limb loss per month
- 2,996 people with limb loss per week
- 428 people lose a limb per day
Causes of Amputations

- PVD- particularly when associated with smoking and diabetes
  - 2-5% of patients with PVD without diabetes, 6-25% with PVD and diabetes come to amputation
  - 60-80% of amputations are due to complications of diabetes
  - The 3 year survival rate after a major amputation for diabetes or vascular disease is about 50%. Studies have shown that about 50% of surviving patients are expected to lose their remaining limb within 2 to 3 years.

- Trauma-usually from MVA or gunshot wounds (GSW)- typically young adults (20-40 y.o) and more commonly men 4:1 ratio
  - increases during war-times

- Tumor-improved imaging techniques, more effective chemotherapy, and better limb salvage procedures have reduced the incidence of amputation due to tumor (osteogenic sarcoma).

- Congenital anomalies or deformites
Levels of Lower Limb Amputation

- Transfemoral or above knee (AK) - amputation across the axis of the femur; short or long

- Transtibial or below knee (BK) – amputation across the axis of the fibula and tibia; labeled according to the larger of the two adjacent bones; short or long
Other Levels of Lower Limb Amputation

- Partial toe- any part of one or more toes
- Toe disarticulation- disarticulation at the MTP joint
- Transmetatarsal- amputation through the midsection of all metatarsals

- Syme’s- ankle disarticulation with attachment of heel pad to the distal end of the tibia; may include removal of the malleoli and distal tibia/fibular flares
  - Allows for end-bearing
Other Levels of Lower Limb Amputation

- Knee disarticulation- amputation through the knee joint; femur left intact
- Hip disarticulation- amputation through the hip joint; pelvis intact
- Hemipelvectomy- resection of the lower half of the pelvis
- Hemicorporectomy- amputation of both lower limbs and pelvis (below L-4, L-5)
- 75% transtibial
- 19% transfemoral
- 3% ankle disarticulation and other
Amputee Rehab - Continuum of Rehab Care

- Acute Post-Operative Therapy
- Inpatient Rehab- pre-prosthetic training
- Home Health Care-pre or post prosthetic training
- Day Institute-prosthetic training
- Outpatient Rehab- fine tune gait, balance, and strength deficits

No matter what setting you choose to work in, you will encounter this unique population of patients. So, let’s be prepared and look forward to helping to improve their overall function, mobility, and independence!
Early Post-op Care
Pre-prosthetic Therapy: Post-op Care

- Starts in the post-op/acute care setting with surgeon, nurse, and physical therapist and continues throughout the rehab process.

- The following is required immediately after surgery. This phase of recovery addresses the following:
  - Wound care
  - Maintenance of skin integrity
  - Joint mobility
  - Prevention of scarring
  - Pain control (differentiate btw phantom pain and phantom sensation)
  - Reduction of edema
Pre-prosthetic Therapy: Post-op Care

Residual Limb Care: Wound Care

- Keep wound and periwound area clean
- Treatment usually includes use of antibiotics, topical antiseptics, and cleansing
- Wound is surgically anastomosed with sutures or staples
- Generally heal in 6-8 weeks if no further problems
Maintenance of skin integrity - the scar should be pliable and nonadherent. This will help to decrease the occurrence of pain due to the soft tissue “sticking” to the bone or surrounding tissue and causing discomfort in the socket.
Pre-prosthetic Therapy: Post-op Care

Joint mobility:
Common Contractures for AKA: hip flexors, abd, and ER
Common Contractures for BKA: primarily knee flexors

- Prevent contractures and maintain ROM
- Discuss proper positioning at rest
  - Encourage prone lying
  - Keep hips and knees close together and flat when lying supine
  - Avoid placing pillows under the limb, hip, or between thighs
- With a transtibial amputee (BKA), use a residual limb board when patient is sitting in wheelchair to prevent hamstring contracture
  - Avoid hanging the limb over the edge of the bed or chair
Pre-prosthetic Therapy: Post-op Care

Prevention of scarring

- Once the wound is healed and closed, scar massage can be used to ensure that the tissue is soft and pliable and that the wound does not adhere to the bone and to surrounding tissue.

- Instruct patient in correct performance of scar massage and encourage them to perform multiple times per day.
Pre-prosthetic Therapy: Post-op Care

2 types of pain

- **Phantom limb sensation**: this feeling is quite common. The sensation of limb that is no longer there. Often described as tingly, pressure, numbness. The distal part of the extremity is most frequently felt, hand or foot. On occasion, the patient may feel the entire extremity. Usually painless and does not interfere with prosthetic rehab.
  - Almost universally a sequela of a major amputation
  - Usually reserved for individuals who have awareness of the missing limb
  - Varies in frequency and intensity

- Desensitization techniques can be used to accommodate the residual limb to touch and pressure (tapping, vibration, massage)
Pain Control

- **Phantom Limb Pain**—often described as stabbing, shooting, squeezing, burning, cramping.
- A study performed by Melzack listed four major characteristics of phantom limb pain:
  1. Pain that endures long after healing of the injured tissues and may last for years.
  2. Trigger zones may spread to healthy areas and stimulation of these zones may produce pain.
  3. Phantom pain is more likely in patients who have suffered pain in the limb for some time.
  4. Phantom pain may be eliminated by changes in somatic input.
Pre-prosthetic Therapy: Post-op Care

- The causal of phantom pain remains controversial. It is thought that peripheral nerve irritation, abnormal sympathetic function, and psychological factors all contribute to the pain in some manner.

- Be sure to caution your patients to lessen fall risk.
Pre-prosthetic Therapy: Post-op Care

More on phantom pain…

- Exacerbations of phantom pain may be triggered by the following and elicit more painful attacks:
  - cold, local heat, and other weather changes may worsen the condition
  - Anxiety, depression, sleeplessness, fatigue, stress
  - Yawning, coughing, frequent urination or BM

- Often treated with NSAIDs, narcotics, antidepressants, anticonvulsants, nerve blocks

- Sometimes wearing a shrinker or the prosthesis will ease the phantom pain
Pre-prosthetic Therapy: Post-op Care

3 Types of post-op dressings:
- Rigid
- Semirigid dressing
- Soft dressing
IPOP
Immediate Post-Operative Prosthesis

- Fit in OR within 2-3 hours of amp. sx, remains for 3-7 days
- Eliminates contracture potential
- Reduces time to fitting of preparatory prosthesis
- Must be careful with vascular or diabetic patient due to skin abrasion and inability to monitor the residual limb
- Should be reserved for young, traumatic amputees
Pre-prosthetic Therapy: Post-op Care

Rigid dressings- use varies greatly, IPOP's more prevalent in some areas of the country. Applied in operating room

Advantages are: (IPOP)

- Limits the development of edema
- Reduces post-op pain and enhances wound healing
- With the attachment of a pylon and foot, it allows for early WB and ambulation
- Allows for earlier fitting of the definitive prosthesis
- Improved psychological state
- Protects the limb
Pre-prosthetic Therapy: Post-op Care

Rigid Dressings

Disadvantages are: (IPOP)

- Requires careful application
- The residual limb requires close supervision during the healing stage, not able to monitor closely
- Does not allow for daily wound inspection and dressing changes
Rigid Dressing-protector without pylon and foot-often made of plaster of fiberglass cast
- Allows for the possibility of frequent residual limb observation and offers protection
- Elimination of skin breakdown commonly seen with elastic bandaging
- Simple to don/doff and add socks as limb shrinks
- Ex. Wu dressing- below-knee plaster cast suspended by a stockinette to a supracondylar cuff. Tube socks or prosthetic socks are added to provide continuous controlled compression.
  - allows for gradual weight-bearing, generally used from 1 to 2 weeks after amputation. WB progresses from w/c strap, padded car jack, tilt table for bilateral amputees
Image of Wu Dressing-RRD
Pre-prosthetic Therapy: Post-op Care

- **Semi-rigid dressings** may be applied in operating room or later

**Advantages:**
- Provide better control of edema than the soft dressing, assists with limb protection, contracture management. Allows for visual wound inspection

**Disadvantages:**
- May loosen easily
- May not intimately conform to the shape of the residual limb
- Environment may be hot and humid
- Some have a hose and machine which may limit bed mobility and ambulation
Pre-prosthetic Therapy: Post-op Care

Reduction of edema - Soft dressing

- Typically a soft dressing, such as ace bandages (figure 8 pattern) or shrinker is used to help prevent swelling, assist in the healing process, and help with shaping of the residual limb for good prosthetic fit.
Pre-prosthetic Therapy: Post-op Care

Soft dressing – oldest method:
2 forms – Ace bandage & shrinker

Advantages:

- Inexpensive
- Lightweight and easily available
- Easy to apply (shrinker)
- Easy to care for
- Maintains appropriate consistent gradient compression (shrinker)
Pre-prosthetic Therapy: Post-op Care

Soft dressing Disadvantages:

- Relatively poor control of edema (comparatively)
- Requires skill in proper application (ace wrap)
- Need for frequent rewrapping (ace wrap)
- May slip and form a tourniquet (ace wrap)
- New shrinkers must be purchased as the residual limb gets smaller
Remember the higher the amputation, the more difficult it is to use a prosthesis, because fewer joints and muscles are available for control.

The level of amputation is only one reason for discarding the prosthesis. There are many reasons a patient may choose not to wear a prosthesis, including the individual’s psychological reaction to the amputation.
Important Note

- Regardless of the cause or level of amputation, physical therapists have a MAJOR role in the rehabilitation program, and early onset of appropriate treatment influences how independent and functional this patient will become after limb loss.

- The primary skills of pre-prosthetic training help build the foundation necessary for successful prosthetic ambulation.
Psychological Impact of Losing a Limb

- Loss of self-esteem and sense of efficacy
- Shock and disbelief
- Feeling of helplessness
- Painful emotions, including grief
- Anger, denial, bitterness, depression, hopelessness, feelings of guilt
- Very often, the patient may project these negative feelings onto the therapist. It is important that we encourage open discussion and instill a climate of trust and respect
Psychological Impact of Limb Loss

- For emotional support, it may be helpful to introduce the patient to others with similar amputations and circumstances

- Support Programs
PRE-PROSTHETIC PT EVALUATION
Pre-prosthetic Patient Evaluation

Subjective Data

- Date and type of amputation performed
- PMH and reason for amputation
  - If diabetic, regular check of blood sugar level?
- Cardiac precautions
  - CAD, CHF, HTN, angina, arrhythmias, dyspnea, MI
- Current medications
Pre-prosthetic Patient Evaluation

Cont’d

- Baseline status/prior level of function (PLF)
- Patient’s goals
- Presence of phantom pain/sensation and caution
- Inquire about home layout and accessibility

- **If desire to use a prosthesis**, does patient have a company or Prosthetist in mind?
  - Not everyone will be fit with a prosthesis
  - If not, think about necessary wheelchair modifications
Objective Data
- UE/LE function (strength, ROM, sensation)
- ADLS
- Transfers- sit to stand, pivot, slide board, car
- Bed Mobility
- Wheelchair Mobility
- Balance (sitting and standing), trunk control & safety
- Gait without the prosthesis- crutches, walker
- Visual skills
- Coordination
Pre-prosthetic Patient Evaluation

- Be sure to observe residual limb and note condition of wound and skin condition
- If increase in swelling, may want to take measurements
- Talk with patient about any safety concerns, including assistance available in home environment, fall prevention (throw rugs, phone cords)
- Discuss home set-up and equipment needs (spatial accessibility, bath rails, shower chair, etc)
Pre-prosthetic Treatment Program

ONGOING PATIENT EDUCATION

- It is extremely important to teach your patient to inspect their residual limb AND their sound foot DAILY (mirror)
  - Proper foot care and proper shoe fitting
- Disease process and effects of exercise
- Benefits of exercise
- Methods of edema control
- Discussion of the rehab process and what to expect
After completing evaluation, **possible goals** may include:

- Education in proper limb shaping and desensitization techniques
- Education in HEP and positioning
- Education in safe home environment-free of clutter, pet safety
- Improving transfers: w/c to/from bed and chair, sit to/from stand, car transfers
- Improving strength and/or ROM
- Indep. in donning ace-wrap or shrinker-cone
Pre-Prosthetic Goal Setting cont’d

- Independent wheelchair mobility and management (leg/arm rests, breaks)
  - Patients who will not be fit with a prosthesis need to be independent in wheelchair propulsion: fwd, retro, turning, maneuvering around objects.
  - Special modifications
- Standing tolerance with bilateral progressing to one UE and finally unsupported
- Ambulation in parallel bars progressing to proper device, level and unlevel surfaces
- Think about discharge: What does your patient need to master to be safe at home??
Pre-prosthetic
Special Considerations

Bilateral amputees:

- more common currently secondary to an aging population with an increased incidence of PVD and diabetes mellitus.

- Increasing number of bilateral lower-limb amputees:
  - Trauma-war, natural disasters
  - Severe burns
  - Motorcycle accidents
  - Pedestrian involvement in car or train accidents
Wheelchair modifications

- Anti-tippers-used to prevent accidental backward tipping
- For bilateral AK, position drive wheels behind vertical back support in order to increase the length of the BOS. Move the BOS approx. 2 inches more posterior with respect to the patient seated in the wheelchair.
Bilateral amputees-AKA

- Stubbies—nonarticulated transfemoral sockets with rocker-bottom. Not as cosmetic, but studies have indicated that patients who walk with stubbies and a walker were able to walk at a faster speed with a greater rate of oxygen consumption than with conventional prosthesis and crutches.

- Stubbies—lowers center of gravity in order to help improve balance

- May progress to articulated limbs, slowly increasing overall height.
Stubby prostheses
Prosthetic Functional Levels
Prosthetic Functional Levels

- Also called K-levels

- Extremely important to note that these are levels of potential and should be tied to patients PLOF and level of motivation
Medicare Prosthetic Guidelines

- Provide established clinical basis for provision of prosthetic care
- Decisions not made in arbitrary manner
- Thorough evaluation and associated documentation completed describing patients PLOF
- Consistency in prescription criteria
- Emphasis on word “potential”
Functional Level & Component Selection

- Identify the specific potential abilities of the patient to determine their access to prosthetic designs and components.
- Functional levels not required for upper extremity or bilateral patients, although significant detail required with “Letter of Medical Necessity” and “Letter of Prosthetic Necessity”.
Functional Levels

- **0** No ability or potential to use a prosthesis to ambulate or assist with transfers (with or without assistance).
- **1** Ability or potential to transfer or ambulate on level surfaces; household ambulator, limited distances.
- **2** Ability or potential for ambulation at a FIXED cadence with ability to traverse low level barriers such as curbs, stairs, or uneven surfaces.
- **3** Ability or potential for ambulation with VARIABLE cadence, unlimited community ambulation.
- **4** Ability or potential for ambulation that exceeds basic ambulation skills.
Patient Considerations
Functional Level
Patient is not a candidate for prosthetic fitting under Medicare guidelines.
Prosthesis will assist with transfers, household ambulator, very limited distances

Limited restrictions on feet, knees and ankles

No restrictions on socket configuration, materials or suspension
Functional Level 1 Components
Functional Level 2

- Unlimited household, Limited community ambulation, able to traverse low level barriers, single speed ambulation
- Expanded access to knees, ankles and feet
- No restrictions on socket configuration, materials or suspension
Functional Level 3

- Unlimited Community ambulator who can traverse most environmental barriers without difficulty, variable cadence
- No limits to feet, knees, ankles, materials or socket design
Functional Level 4

- Exhibiting high impact, stress or energy levels (e.g. child, active adult or athlete)
- Same as FL 3-No limits to feet, knees, ankles, materials or socket design
Patient Priorities

- Stability
- Confidence
- Function
- Freedom
Let’s Review

- 1. Wheelchair modifications
- 2. K-level
Let’s take a look back….

- It seems that each major war has been the stimulus for the development of improved prosthetics.
- Toward the end of WWII, amputees in military hospitals in the US began to voice their disappointment with the performance of their artificial limb.
History of Prosthetics

- To ensure that they received the best prosthetic possible, a conference was organized by the NAS in 1945.
- A group of leading surgeons, prosthetists, and scientists met & discovered that very little modern scientific effort had gone into the dev. of prosthetics.
- A crash research program was launched to support amputees after discharge from the armed services.
- Program supported by VA, focus was on new dev. and innovations in casting techniques, fabrication materials, socket designs, suspension, & components.
History of Prosthetics

- Exoskeletal Prostheses
  - Characterized by a hard, plastic outer shell and a hollow inside
  - All structural stability comes from the outer lamination—typically made of wood
History of Prosthetics

- Exoskeletal Prostheses

- Indications
  - Heavy duty user
  - Funding limitations
  - Previous user

- Contraindications
  - When cosmetics is a priority
  - When alignment changes are expected
  - When the need for a light weight prosthesis is important
History of Prosthetics

- Exoskeletal Prostheses
- Advantages
  - Durable
  - Less expensive
- Disadvantages
  - Jeopardize cosmesis
  - Difficult to adjust alignment
  - Increased weight
Endoskeletal Prostheses - characterized by a pylon system which may or may not be covered by a soft outer over.

Indications

- Cosmesis is a priority
- Need for permanent alignment adjustments
- Need for lighter weight prosthesis, especially at higher amputation levels
History of Prosthetics

- Endoskeletal Prostheses
- Contraindications
  - When the cover is exposed to destructive activities
  - Funding limitations
  - Obese patients requiring higher weighted componentry
Endoskeletal Prostheses

Advantages
- Improved cosmesis with foam cover
- Decreased overall weight of prosthesis
- Ability to interchange components
- Align. adjustments
History of Prosthetics

- Endoskeletal Prostheses
- Disadvantages
  - Durability of foam cover
  - Weight limit of componentry
  - Increased cost compared to exoskeletal
Prosthetic Evaluation and Fabrication Overview
Prosthetic Eval & Fabrication Process-Overview

- Evaluation-determine PLOF, level of motivation, other comorbidities, proper suspension method and K-level for componetry
  - Discuss prosthetic history
- Impression taking-cast, scan, by measurements
- Diagnostic check socket
- Proceed to definitive
Prosthetic Eval & Fabrication Process-Overview cont’d

- Instruct in donning/doffing
- Fine-tune dynamic alignment
- Initiate gait training in parallel bars
- Transition to therapy
- Discuss follow-up
PT EVALUATION AFTER RECEIPT OF PROSTHESIS
PT Evaluation After Receipt of Prosthesis

- In addition to the subjective and objective information that you obtain during the pre-prosthetic eval, you will also need to assess:
  - Type of prosthesis:
    - Ability to don/doff prosthesis
    - Including liner, socks, etc
    - Ongoing education regarding sock management
  - Sit-to/from stand- technique, quality
  - Standing balance and tolerance- WB on prosthesis
  - Ambulation- device, distance, wt. shift, stance time, if AKA-ability to lock/unlock knee
  - Functional testing-TUG, AMP-Pro, etc.
  - Gait deviations- energy expenditure, activity tolerance
PT Evaluation After Receipt of Prosthesis

- If working with an AKA, it is necessary for the therapist to understand how the prosthetic knee works. Consult with the Prosthetist.

- Talk with patient about weight management. A small change in weight can effect the fit of the prosthesis.
Lower Limb
Socket Designs
Lower Extremity Socket Designs

- Transfemoral (AK) - 2 types
  1. Quadrilateral
  2. Ischial containment

  - Comfort Flex/narrow M-L - unique to specific company

- Transtibial (BK) – 4 types
  1. Patella Tendon Bearing (PTB)
  2. Total Surface Bearing
  3. Hydrostatic
  4. Hybrid/Combination
Characteristics of Transfemoral Sockets

Quadrilateral Socket

- Total contact but not end weight bearing; limb essentially floats within the socket
- Four walls, each provides a specific function to assist with proper fit and alignment
- Ischial tuberosity is outside of socket
- Especially good for longer and stronger residual limbs

- Specifically designed with WWII veterans in mind
- Long, strong residual limbs with good remaining musculature
Characteristics of Transfemoral Sockets

**Ischial Containment**

- Total contact design
- Narrow medial lateral dimension for added stability and to decrease rotation of socket
- Contoured to the patient’s shape
- The ischial tuberosity is contained **within** the socket. Attempt is made to grab onto the pelvis and provide greater stability
- Especially good for short, fleshy limbs
Characteristics of Transfemoral Sockets

Similarities

Both are:

- Total surface devices
- Both hard and flexible
  - The flexible sockets are thought to be more comfortable, cooler, and provide better suspension and better proprioception
- Set in initial flexion and adduction to increase the tension, creating abilities of the hip extensors and abductors, and to encourage easier sitting on ischial seat
Types of AKA Socket Designs

Quadrilateral Socket
- Ischial tuberosity sits on the posterior wall
- Adductor tendon in adductor channel
- High lateral wall centered on lateral aspect of hip

Ischial Containment
- Ischial tuberosity sits inside prosthesis on ischial seat
- Adductor tendon in adductor channel
- High lateral wall centered on lateral aspect of hip
- More proximal trimlines to provide a boney lock to prevent rotation

Remember 3 Key Areas For Proper Fit:
Ischial tuberosity
Adductor tendon
Greater trochanter
Characteristics of Transtibial Sockets

PTB
- Loading specific design
- More triangular in shape
- Best for limb with considerable bony prominences
- Supra condylar supra patellar design (SCSP)
  - High medial, lateral, and anterior walls with femoral condyles contained
  - Gives max knee stability

Total Surface Bearing
- Non-loading specific
- Equal loading on all aspects of the limb with no specific relief areas
- More circular in shape
- Best candidate has a fleshy limb with distal padding
- Not ideal for frail patients with superficial bony prominences
Characteristics of Transtibial Sockets

Hydrostatic Design
- Emphasis is on tissue density and tissue elongation

Hybrid: modified TSB or modified PTB
- Oftentimes, Prosthetists may use a combination of socket designs depending on the patient’s residual limb presentation

- Talk with patient about weight management. A small change in weight can effect the fit of the prosthesis.
Transtibial PTB Design

PTB socket

**Pressure Tolerant Areas**
- Patellar tendon
- Medial tibial flare
- Shaft of fibula
- Anterior compartment
- Gastroc region
- Popliteal fossa
- Slight on distal end

Total Surface Bearing
- Non-loading specific

PTB Socket

**Non Pressure Tolerant Areas**
- Fibular head
- Peroneal nerve
- Crest of tibia
- Distal end of fibula
- Lateral tibial condyle
- Anterior distal tibia
- Hamstring tendons
Soft Inner Liner vs. Hard Interface

- Inner Liner-different varieties of material can be used; provides cushion and self-reliefs
  - Examples are: pelite, foams, plastics with and without silicone, etc.
  - **Advantages**- good for patients who have boney residual limbs, volume fluctuations, scar tissue
  - **Disadvantages**- durability of material used, absorb perspiration, adds bulk
Soft Inner Liner vs. Hard Interface

- **Hard Interface** - no insert present, residual limb inside of a hard socket
  - patient may wear additional prosthetic socks inside of a laminated socket
  - Used for residual limbs that are well-healed, well-padded, with good musculature
  - **Advantages**: more hygenic, easily cleaned, more cosmetic with not as much bulk
  - **Disadvantages**: no cushion or extra padding for increased comfort, does not allow for as much adjustability
Modes of Suspension
Modes of Suspension

- **Transfemoral**
  - Suction
    - skin fit-interface is smaller than limb-use of a pull sock, stockinette, or lotion to don
    - Seal-in liner
    - Vacuum
    - Contraindication for skin fit-volume fluct, severe scarring or invaginations, UE involvement, poor balance
  - Locking liner (pin, lanyard)
Modes of Suspension

- Transfemoral
- Silesion Belt
- Hip joint and pelvic band
- Suspenders
Used for auxillary suspension when the need for a secondary form of suspension is indicated.
Modes of Suspension

- **Transtibial**
  - Joint and corset
  - Belt or cuff-supracondylar cuff
  - Sleeve/outer sleeve
  - Anatomical (SC, SCSP) or Symes
  - Pin-lock
  - Suction/expulsion valve
  - Vacuum
Suspends off the proximal part of the patella. Incorporates up to 60-70% thigh WBing allowing user to unweight residual limb. Offers increased M-L stability. Knee extension is controlled due to joint stops. Heavy, uncosmetic, relatively poor mode of suspension.
Suspension comes off the proximal border of the patella. Remains snug from 0-60 degrees of flexion. Loosens to allow for sitting at 60-90 degrees of knee flexion. Good for patient’s who have long residual limb, can have shorter trim lines. Can be restrictive, does not provide M-L stability, uncosmetic.
Higher trimlines. Ideal candidate has a very short residual limb and a need for increased M-L support. Fits and grabs in over the medial femoral condyle. Can be restrictive. No sleeve, belt, straps, or gel liner required.
Assessing proper fit..

How do I know if the prosthesis is fitting properly?
Let’s Review

- 1. AK socket question
- 2. BK socket question
- 3. BK PTB socket pressure question
- 4. Patient scenario
Proper Prosthetic Fit

- Proper fit and alignment are **extremely** important for the patient to be successful with using their prosthesis.
- A prosthesis should fit snugly to minimize the risk of chafing, friction, and to maximize control.

Having proper fit and alignment:
- Helps improve compliance
- Enable the patient to increase wear time
- Improve confidence and body image
- Allows the patient to have better control of the prosthesis and become a successful, functional prosthetic wearer
Proper Prosthetic Fit

- Be sure that all interface layers are donned in correct order
- Is the patient using anti-persp. spray? Thin sheath? Soft insert?
- Be sure to “roll” on liner to get rid of trapped air distally
- Check for proper sock ply - get rid of all wrinkles
- Check for proper rotation of socket
- In standing, assess socket fit, posture, rotation of hips, proper height (make sure the patient is all the way down in the socket)
- Is the pylon vertical in midstance??
Assessing Proper Fit of Socket

☐ AK Sockets- Remember 3 Key Areas:
- ischial tuberosity
- adductor tendon
- greater trochanter

☐ BK Sockets- Remember 3 Key Areas:
- location of patella and patella tendon
- pressure-sensitive distal aspect
- foot rotation
Proper Fit
Tips for Success

- **Suction**
  Skin fit: patient should be all the way down in the socket. Assess their placement in socket by unscrewing the valve and looking in or placing your finger inside.
  Seal-in liner: it is possible to add socks when using a one seal, seal-in liner, however only at the proximal aspect of socket.

- **Vacuum**
  Adjustments in sock ply throughout the day should be minimal. This system should keep patient’s volume relatively stable. Be caution, if over-socked, can create a void distally and cause a blister to develop.
  - When donning outer sleeve, it needs to come in contact with both the socket and the gel liner.
Proper Fit
Tips for Success

- Pin-lock

- be sure that when donning gel liner, the pin is placed in the center of the distal aspect of the limb in order to line up properly with the lock. Line the socket up properly with the patella and slide into socket. While sitting, place pressure on the heel to lock in. Should hear an audible click.
Proper Fit-Sock Ply
Tips for Success

- May need to **add** sock when….
  - If AKA feels pressure/pain on the ramus or distal end
  - If socket seems loose or is rotating- be careful here, first assess for proper donning, especially if AK
  - If BKA reports feeling as if he/she is standing on the bottom
  - If BKA with a PTB style socket, appears as if his/her patella is inside the socket
Proper Fit-Sock Ply
Tips for Success

- May need to **remove** socks when....
  - For AK wearing a IC socket, ischial tuberosity is outside of socket
  - For AK, socket is rotating during ambulation (be careful here-assess boney landmarks)
  - For BK wearing PTB style, patient complains of pressure on tibial tubercle
  - For BK, patella tendon is outside of socket and if wearing pin-lock, cannot get any clicks

**Call Prosthetist** if you have questions or proper fit cannot be obtained
Potential Skin Conditions of the Amputee
Potential Skin Problems of the Amputee

- The skin of an amputee who wears a prosthesis is subject to numerous abuses.
- In addition to the effects of pressure and friction, the amputee’s skin is vulnerable to the possible irritant or allergic reaction to the materials used in the manufacturing of the prosthesis or topical agents applied to the skin.
- It is also possible for the amputee to sustain negative skin conditions as a result of the absence of contact on the residual limb, particularly at the distal end.
- Many of these skin problems can be prevented with a properly fitting prosthesis and optimal alignment.
Potential Skin Problems of the Amputee

- **Stump Edema Syndrome**
  - When an amputee first starts to wear a prosthesis, his or her skin must adapt to the new environment, getting used to the heat, rubbing, and perspiration generated within the socket.
  - The amputee can expect mild edema and a reactive redness when first becoming accustomed to the prosthesis.
  - Gentle compression of the stump tissues prior to using a prosthesis can minimize this.
  - Can also be caused by if wearing a malfitting prosthesis where the distal part of the residual limb is pinched and strangulated within the socket, causing ulcerations or gangrene as a result of impaired blood circulation.
  - Excessive negative pressure in a socket can also cause circulatory congestion and edema. Treatment should be directed toward better support on the distal end of the residual limb.
Potential Skin Problems of the Amputee

- Verrucous hyperplasia
  - A warty condition of the skin of the distal portion of the residual limb
  - Most often caused by the absence of support on the distal aspect of the residual limb and the distal part of the limb dangling and edematous
  - Can be present for months or years, associated with ulceration and edema
  - The greater the compression or support on the distal aspect, the more immediate and lasting was the improvement.
  - In most case, this condition is reversible
Verrucose hyperplasia - 2 years in duration
Potential Skin Problems of the Amputee

- Bacterial and Fungal Infections or boils
  - Often encountered in amputees with hairy, oily skin. The condition is aggravated by sweat and rubbing on the socket wall.
  - Usually worse in late spring and summer
  - Increased warmth and moisture from perspiration promote maceration of the skin within the socket.
  - This maceration favors invasion of the hair follicle by bacteria.
  - May be the result of poor hygiene of the residual limb and socket walls
  - Topical anti-fungal agents may be prescribed by MD
  - Common in amputees where the metabolic process is uncontrolled
    - May be reflective of high blood sugar content
Abscess from bacterial infection
Potential Skin Problems of the Amputee

- Pretibial blister
  - Caused by the prosthetic socket rubbing against the skin
  - May require several weeks for healing to occur
  - Proper prosthetic fit and alignment would resolve and prevent recurrent blisters.

- Contact Dermatitis
  - Amputee may have an acute or chronic skin inflammatory reaction caused by contact with an irritant or allergenic substance.
  - Skin sensitivity to gel liner, fabrication materials, lotion or skin lubricant, cleaning soap
  - Red, rash, intense burning or itching
PLATE 18.
Diabetic male 50 years of age with a pretibial blister from prosthetic rub.
Contact dermatitis
Healthy Habits—poor hygiene may be an important factor in producing some pathologic conditions of the residual limb. A routine cleansing program of the limb, prosthetic supplies, and wall of socket must be employed to avoid potential problems.

- Use a bland or hypoallergenic soap
- Cleansing routine should be followed nightly or more often if increased perspiration. Pat residual limb dry or allow to air dry
- Witch hazel or rubbing alcohol can be used to clean the inside wall of socket (or spray gel liners)
- Change prosthetic socks daily and wash as soon as taken off before perspiration is allowed to dry.
Potential Skin Problems

Take-away Message

- Check skin regularly. The importance of early recognition and treatment of the common skin disorders of residual limbs is vital and cannot be overemphasized.
- Early recognition can avert much psychological anguish and loss of social or economic activity.
- Communicate frequently with the Prosthetist discussing any fitting problems to avoid potential skin issues.
Let’s Review

- 1. Suspension question
- 2. Importance of having total contact within socket
- 3. Patient scenario-fit problem
Prosthetic Knee Options
Prosthetic Knee Options

Prosthetic knees provide three main functions:

1. Support during stance phase of gait
2. Smooth and controlled swing phase
3. Unrestricted flexion for sitting, kneeling, stooping, and related activities.
Prosthetic Knees: 5 Categories

In order from most stable to least amount of stability. As the stability of the knee lessens, the patient must have more voluntary control.

- Manual locking
- Polycentric- “many centers”
- Weight activated friction
- Conventional single axis constant friction
- Outside hinges

If working with an AKA, it is necessary for the therapist to understand how the prosthetic knee works. Consult with the Prosthetist.
Prosthetic Knees - Manual Locking

- Manual locking-knee is locked during gait and the patient releases the locking mechanism in order to sit down.

- Most stable prosthetic knee

- Good for patients with very short residual limbs, poor balance, poor strength, and/or decreased vision who are unable to control the knee.
Prosthetic Knees-Manual Locking

- **Advantages**
  - Inherently stable
  - Helps to build patient trust/confidence
  - Great for patients who are weak and unstable
  - May also be used for patients in unstable environments, such as uneven terrain for hiking, hunting, etc.
  - Locking mechanism can be disengaged as patient progresses

- **Disadvantages**
  - Increased energy expenditure and gait deviations due to the lack of knee flexion during swing phase
  - Does not mimick normal knee or normal human locomotion
Characteristics: also referred to as 4-bar has "many centers" or axes of rotation. The knee has a variable center of rotation allowing for stability at all phases of gait. The linkage allows the knee to collapse better during swing phase, essentially shortening the shin allowing the foot to clear the ground easier.

Swing phase control can be either mechanical friction or hydraulic resistance.

Stability due to the linkages, changing instantaneous center of rotation

Femoral length equality

4,5,7, and 7 bar linkages
Prosthetic Knees-Polycentric

- **Advantages**
  - Inherent stability-varying mechanical stability throughout the gait cycle
  - Imitates normal knee
  - Easier initiation of knee flexion
  - For longer limbs, eliminates femoral length discrepancy; the shank can be rotated under the knee during sitting, enhancing cosmesis in sitting

- **Disadvantages**
  - Increased maintenance
  - Increased weight and bulk
Prosthetic Knees-Polycentric

- Ideal candidate
  - Long residual limb-example knee disarticulation
  - Very short residual limb- transfemoral or HD
  - Weak hip extensors
Prosthetic knees-Single Axis

- Characteristics: consists of a simple hinge mechanism. Basic knees that bend freely. Stance stability is dependent on alignment stability and amputee muscle contraction.

- May incorporate a constant friction control and a manual lock to increase stability.
Prosthetic Knees - Single Axis

Advantages
- Low maintenance, very durable
- Light-weight
- Inexpensive in comparison

Disadvantages
- Lack of mechanical stability
- Amputee must rely on his or her own muscle control for stability.
Prosthetic Knees - Single Axis

- **Contraindications**
  - Weak hip extensors
  - Poor balance

- **Ideal Candidate**
  - Long residual limb
  - Strong residual limb musculature
  - Cost containment
Characteristics: when weight is applied, a braking mechanism prevents the knee from flexing or buckling.

The amount of weight required to effectively engage the “brake” and prevent flexion can be adjusted depending on the amputee’s weight, activity level, and stance-control needs.
Prosthetic Knees-Weight Activated Stance Control

- **Advantages**
  - Inherently stable when loaded

- **Disadvantages**
  - Must unweight the knee/limb for knee flexion to occur—example sitting
  - Does not imitate or encourage normal swing phase gait mechanics
  - Increased maintenance
Prosthetic Knees-Weight Activated Stance Control

- Ideal Candidate
  - Weak, debilitated patient

- Contraindicated for bilateral amputees because the prosthesis must be fully unweighted for sitting.
Prosthetic Knees-Outside Hinges

- Characteristics
  - Must be used with an exoskeletal design
  - Single axis joint with outside hinge
  - Free swinging knee
  - Often used for knee disarticulation amputees to avoid knee length discrepancy in sitting
Prosthetic Knees-Outside Hinges

- **Advantages**
  - Equalize femoral and step length
  - Durable
  - Allows knee centers to match

- **Disadvantages**
  - NO INHERENT STABILITY
  - NO INHERENT FRICTION
  - Poor cosmetics
Prosthetic Knees-Outside Hinges

- Ideal Candidate
  - Amputees with long residual limbs
  - Good muscle control
Prosthetic Knees-Special Considerations-Microprocessor

- **Characteristics**
  - Provides the highest degree of function and stability
  - On-board computer that analyzes gait up to 50 per second
  - Takes the analyzed data and tells the knee to accommodate for a particular gait pattern, style, or surface

- **Characteristics cont’d**
  - Performs continuous adjustments to ensure stability, security, and efficiency in swing and stance phase
  - Automatically senses what is going on in the knee and makes necessary changes
Prosthetic Knees-Special Considerations-Microprocessor

- Advantages
  - Highest degree of stability on level and unlevel terrain

- Disadvantages
  - Heavy
  - Costly
  - Requires batteries
  - Must plug in to charge
  - Most MPKs are only water or splash resistant
  - Amputee must be somewhat open to new technology
Prosthetic Foot Categories
Prosthetic Feet

- Who is the perfect patient candidate for each type of foot selection?
- Things to consider
  - Activity level
  - Length of residual limb
  - Uneven terrain
  - Desired footwear
  - Hobbies - ex. Golf - Tortional/Rotational unit
6 Prosthetic Foot Categories

- SACH (solid ankle cushioned heel)- the ankle is solid, no movement, no joint articulation. The cushioned heel helps to absorb shock and allows for simulated ankle PF.
  - Lightweight, durable, low cost
  - Indicated for K1, K2

- Single Axis- axis or point of rotation at the heel. Have PF and DF bumpers and allows for true PF within the ankle mechanism.
  - Indicated for patients with weak quads needing more knee stability, provides increased shock absorption, achieves foot flat sooner.
6 Prosthetic Foot Categories

- Multi-Axis- indicated for patients who walk on uneven terrain, split toe allows for inv/ev and rotation, allows for motion in all 3 planes, good shock absorption. Must be K2 or higher functional level

- Dynamic Response- ”energy storing,” flex. keel
  - Indicated for patients who walk at varied speeds, allows for a smoother & more normal gait. No inv/ev, but typically gives energy at heel off & toe off as you move forward.

- Carbon-fiber feet-K 3 level or higher
6 Prosthetic Foot Categories

- Multi-Axial Dynamic Response - benefit of inv/ev AND energy return, indicated for active patients who ambulate on varied terrain and at variable cadences.

- New Technologies - Computerized vs Non Computerized, hydraulic ankles
Let’s Review

- 1. Knee question
- 2. Knee question
- 3. Foot question
Recognizing Gait Deviations

Common Definitions
Gait Deviation Definitions

- Toe lever arm
- Heel lever arm
- Socket flexion
Gait Deviation Definitions

- Socket rotation
- External foot rotation
Gait Deviation Definitions

TKA (Trochanter/Knee/Ankle)

- Stationary alignment line to identify the relative alignment between the center of socket weight line, the rotation point of the knee and the functional rotation point of the ankle/foot
AK Gait Deviations
A Step In The Right Direction-videos
Medial Whip

- Occurs in swing phase. After the foot comes off the ground, at toe off, the heel moves medially.
Medial Whip

Prosthetic Cause
- Excessively ER knee.
- Tight socket
- Mis-aligned toe break

Amputee Cause
- Gait habit
- Socket not put on properly
- External rotation of hip at toe off
- Weak muscles that rotate freely around the femur
Lateral Whip

- Occurs in swing phase. After the foot comes off the ground, at toe off, the heel moves laterally.
Lateral Whip

**Prosthetic Cause**
- Excessive internal rotation of the knee
- Loose socket
- Mis-aligned toe break

**Amputee Cause**
- Gait habit
- Socket not put on properly
- Internal rotation of hip at toe off/hip flexion
Abducted Gait

- Ambulation with an excessively wide BOS with the prosthesis held away from the midline at all times.
Abducted Gait

Prosthetic Cause
- Prosthesis too long
- Medial wall too high
- Shank aligned in valgus position with respect to the thigh section
- Socket set in abduction

Amputee Cause
- Abduction contracture
- Poor gait habit, patient insecure and desires wide base in belief it will increase stability
Circumducted Gait

- Characterized by a wide arc made by prosthetic limb in swing phase. Follows a lateral curved line as it swings. Circumduction occurs in the transverse plane.
Circumducted Gait

Prosthetic Cause
- Long prosthesis
- Excessive knee friction
- Excessive knee stability/tight extension aid
- Manual knee lock
- Inadequate suspension-pistoning
- Foot too PF
- Socket too tight

Amputee Cause
- Lack of confidence/understanding in flexing knee
- Abduction contracture
- Weak hip flexors
- Habit
A technique used to clear the prosthetic limb in swing phase; rising up on the toes of the sound limb or PF the sound ankle to elevate the COM in order to clear the prosthetic limb.

Observe during the swing phase of the prosthetic side.
Vaulting

Prosthetic Cause
- Long prosthesis
- Poor suspension-pistoning
- Excessive plantar flexion of foot
- Excessive knee resistance or friction
- Manual locking knee
- Socket too small

Amputee Cause
- Gait habit, fear of catching toe
- Weak hip flexors
- Improper initiation of hip flexors on residual limb
- Insecurity or fear of using prosthetic knee joint
Excessive heel rise

- Characterized by the heel moving abnormally high in initial swing phase. Problematic because it delays swing phase and reduces walking velocity.
Heel Rise

Prosthetic Cause
- Inadequate extension aid
- Insufficient knee friction
- Improper knee selection

Amputee Cause
- Excessive use of hip flexors to initiate swing phase, overpowering knee unit to ensure that the prosthetic knee will be fully extended at heel strike.
Knee Instability

- The knee flexes uncontrollably at LR.
Knee Instability

Prosthetic Cause
- Knee aligned in unstable position…TKA
- Insufficient socket flexion
- Mal-alignment of foot
- PF resistance too great causing knee to buckle

Amputee Cause
- Weak hip extensors
- Hip flexion contracture
Uneven Timing

Short Prosthetic Step (decreased stance on prosthetic side)

Prosthetic Cause
- Socket Pain
- Weak extension aid - causes excessive heel rise and prolonged swing
- Unstable knee
- Excessive dorsi-flexion

Amputee Cause
- Patient insecurity
- Weak hip muscles
- Poor balance
Uneven Timing

Long Prosthetic Step (increased stance time on prosthetic side)

**Prosthetic Cause**
- Excessive plantar-flexion of foot
- Insufficient initial socket flexion
- Long toe lever arm

**Amputee Cause**
- Flexion contracture
- Pain on sound side
Lateral Shift-

pylon leans out to side

Prosthetic Cause
- Prosthetic foot too far inset
- Excessive socket abduction

Amputee Cause
- Tight hip abductors
- Habit, narrow gait base
Lateral Trunk Bend

- Trunk flexion away from midline, typically toward the prosthetic side, occurs at midstance.
Lateral Trunk Bend

**Prosthetic Cause**
- Foot too far outset
- Ineffective lateral socket containment
- High medial wall
- Aligned in abduction
- Short prosthesis

**Amputee Cause**
- Weak hip abductors
- Short residual limb
- Habit
Toe Drag

Prosthetic Cause

- Long prosthesis
- Excessive plantar-flexion
- Excessive knee friction-too stiff

Amputee Cause

- Weak hip flexors
- Weak hip abductors on sound side
- Poor posture
- Poor gait habits
Long Prosthesis

Observations

- Patient reports lower back pain
- Patient reports they feel like they are walking up a hill
- Noticeable rise and drop of shoulder on the effected side
- Reduced arm swing on the effected side, while arm swing may be exaggerated on the sound side
## Short Prosthesis

### Observations

- Patient reports lower back pain
- Patient reports they feel like they are stepping into a hole
- Noticeable rise and drop of shoulder on the sound side
- Uneven arm motion to accommodate uneven stride length
- Appears like the patient may be vaulting
BK Gait Deviations
A Step In The Right Direction
Premature loss of anterior support. Occurs at the end of stance phase and is characterized by a downward movement of the trunk as the body moves forward over the prosthesis.
Drop Off

Prosthetic Cause
- Excessive socket flexion
- Excessive dorsiflexion
- Incorrect shoe-heel ht too tall for prosthetic foot and pushes fwd.
- Socket too anterior to foot
- Keel too short of soft

Amputee Cause
- Unusual Gait habit
Vaulting

- A technique used to clear the prosthetic limb in swing phase; rising up on the toes of the sound limb or PF the sound ankle to elevate the COM in order to clear the prosthetic limb.
Vaulting appears same as AKA, more common in AKA

**Prosthetic Cause**
- Long prosthesis
- Poor suspension-pistoning
- Excessive plantar flexion of foot

**Amputee Cause**
- Gait habit, fear of catching toe
- Weak hip flexors
- Improper initiation of hip flex
Wide Gait

Prosthetic Cause
- Prosthetic foot too far outset
- Excessive socket abduct.
- Prosthesis too long

Amputee Cause
- Insecurity, wants to widen base in attempt to increase stability
- Weak ML knee control
Lateral Shift

Prosthetic Cause
- Foot too far inset
- Socket abducted
- Short prosthesis

Amputee Cause
- Inadequate balance
- Weak knee muscles and supporting structures
- Habit, narrow gait base
Long Prosthesis

Observations

- Patient reports lower back pain
- Patient reports they feel like they are walking up a hill
- Noticeable rise and drop of shoulder on the affected side
- Hesitation in gait timing from prosthetic mid-stance to sound side heel strike
Short Prosthesis

Observations
- Patient reports lower back pain
- Patient reports they feel like they are stepping into a hole
- Noticeable rise and drop of shoulder on the sound side
- Uneven arm motion to accommodate uneven stride length
- Appears like the patient may be vaulting
External Foot Rotation

Possible Causes

- Patient wants foot to match sound side
- Heel too stiff/firm

Observations

- Induces “medial whip”
- Drop off at end of stance phase
- Skin irritation due to rotational stress in socket
Gait Deviations
A Step In The Right Direction

Four Factors of Gait

- Patient
- Prosthetic alignment
- Socket fit
- Rehab teamwork
Let’s Review

1. Gait deviation question-AK
2. Gait deviation question-AK
3. Gait deviation question-BK
GAIT TRAINING AND PROGRESSION
Prosthetic Gait Training

- Energy demands are so much greater for an amputee.
- The higher the level of amputation, the less efficient and greater the energy demand for ambulation.
- Goal is to enhance efficiency by eliminating gait deviations and encouraging normal gait mechanics.
Prosthetic Gait Training

- Start in parallel bars with basic activities
  - Weight shifting left /right, fwd/back
    - Helps patient get used to putting weight through prosthesis and gain trust
    - May be necessary to get the residual limb further into socket
    - Start with small amplitudes of movement and then increase
  - Diagonal weight shifts
  - Stepping fwd and back with prosthesis to work on pre-swing and swing phase-
    learning mechanics of prosthetic knee, if AKA
Prosthetic Gait Training

- Emphasize weight bearing through prosthesis
  - Stepping fwd/back with sound limb
  - Toe tapping to small curb step with sound limb
  - Bolster or ball rolling with sound limb
  - Soccer ball kicking with sound limb

- Progress patient to walking full length of parallel bars
  - Focus on posture and mechanics, equal step length, consistent knee bending and straightening, if AK

- Advance patient to turning in parallel bars to cont. walking
Prosthetic Gait Training

Parallel bar activities:

- Use mirror for visual feedback
- Encourage BOS 2-4 inches apart
- Be aware of pressure changes of residual limb within socket
- Be certain to doff the prosthesis very often early on in the rehab process and check the residual limb
  - Look for redness to subside in 15 min
  - Continue to reassess fit
Prosthetic Gait Training

Once patient is walking safely in parallel bars and has learned to trust prosthesis, ambulation outside bars will begin.

- To start, use walker or axillary crutches
- Start with short distances and level surfaces, may need wheelchair follow
- Give minimal cueing for posture/mechanics early on. May have carry-over from training in parallel bars
Prosthetic Gait Training

- Slowly try to increase patient’s distance while decreasing level of assistance needed
- Goal is for patient’s gait to appear as normal as possible mimicking the sound limb mechanics/NHL
- Continue to emphasize posture, increasing stance time on the prosthesis, and normal pre-swing and swing mechanics
Prosthetic Gait Training

- Once patient is able to safely ambulate on level terrain with little assistance (preferably no more than CGA) demonstrating good mechanics, slowly add in obstacles:
  - Stepping over objects on floor (canes of various heights)
    - Step over object with prosthetic limb first for visual confirmation of limb clearance
  - Walking over mats
  - Ambulating up and down small curbs (up with good, down with bad)
Prosthetic Gait Training

- Ambulating up and down ramps
  - larger steps when ascending (with more hip and/or knee flexion if possible), keep wt. anterior
  - Small steps (step to step pattern) going down keeping a wide BOS for balance
  - Can zig-zag or side-step if steep decline
Prosthetic Gait Training

- Ambulating up and down stairs
  - Always use rail, if available
  - Up with good, down with bad
  - Start with step to step pattern and progress to step over step pattern with BKA, if safe

- Remember how the knee works. Call the Prosthetist with any questions or concerns

- Good idea to return to the parallel bars to practice new activities in a safe environment for the first time!
Prosthetic Gait Training

Once patient has mastered level and unlevel terrain with larger, more cumbersome assistive device (AD), progress to smaller device

- Walker to hemi-walker
- LBQC to SBQC
- straight cane to no AD, if safe
  - return to parallel bars first to practice ambulation using unilateral UE support
  - Emphasize upright posture and arm swing
    - May place cane or dumbbell in opposite hand to emphasize importance of arm swing
Prosthetic Gait Training

- Bilateral ax. crutches to single ax. crutch to QC to str. cane to no AD, if safe
- Requires more balance and WB on prosthetic limb
- Much like with the first device outside the bars, start with level surfaces and progress to uneven terrain (curbs, ramps, hills, stairs) when the patient demo safety
Prosthetic Gait Training

Higher level gait and balance activities:

- Side-stepping
- Retro-ambulation- if AKA, important to remember how the knee works to prevent buckling
- Trunk rotation and placement of object- using wand, cones, ball pass with rotation
- Bending down to pick up objects off floor
  - Keep prosthetic limb in back of sound limb
- Multidirectional turns-changing directions, maneuvering in confined areas-simulate elevators, crowded restaurants
Higher level gait and balance activities
- Soccer ball kicking - progressing to trap and kick
- Balloon batting, ball throwing
- Cone tapping
- Half and full braiding
- Tandem walking
- Single-Limb Squatting
- Falling-floor to stand transfer
- Running Skills
Prosthetic Gait & Falls

Tips for safe falling

- It is unavoidable, at some point your prosthetic patient will have a fall. This is an important skill to learn not only for safety reasons, but for floor-level activities.
- Teach patient how to fall so that they do not injure themselves:
  - Discard any AD to avoid injury
  - Try to fall fwd, landing on their hands with elbows slightly flexed
  - Roll to one side, preferably the sound side
  - Land on soft, cushioned surface, if possible
How to get up from a Fall

- Roll to stomach
- Assume all-fours position
- Crawl to nearest, safest supportive surface
  - If on wheels, push against wall
- Face object and put hands on supportive surface
- Bring sound limb up first - be sure to place foot flat on floor in front and slightly out to side to increase BOS
How to get up from a Fall

- Use hands and sound foot to push up and straighten sound knee
- Once sound knee is straight, bring prosthetic limb forward and foot flat
- Turn and sit on supportive surface to recover
- If no supportive surface, arise from tall-kneeling, bring sound limb up, place hands on thigh of sound limb and push down to straighten sound knee and bring prosthesis forward.
- If have an AD, place hands on AD, then bring sound limb up first. Be sure to have someone stabilizing AD, if needed.
Alternate Technique for Floor transfers-
- From long-sitting, cross sound leg over, put weight through sound limb and hands, turn and pivot around to hands and feet.
Amputee Rehab - Tips for Success
Amputee Rehab
Tips to Improve Patient Compliance

- Do not overwhelm the patient with too much information at once
- Tailor the program to the individual’s life style
- Involve the patient and family when establishing goals and setting priorities
- Explain why you are asking the patient to do certain activities where the goal is less obvious
- Ask for the patient’s input and perception of how their rehab is progressing
Amputee Rehab
Tips to Improve Patient Compliance

- Encourage the patient to have open communication with you, free to ask questions along the way
- Treat the whole person, not just their amputated limb
- Remember what THEIR personal goals are and work toward them
- Keep in close communication with the Prosthetist, discussing fit and patient’s progress. Invite them in to observe patient in therapy.
The integrated Care Model is hugely important and delivers the best possible outcomes for this unique population of patients!

- The Physical Therapist & the Prosthetist must work together in order to provide comprehensive care for the amputee.
- The degree of success the amputee experiences in therapy with ambulation may directly influence how much the prosthesis will be utilized and how active a life-style is chosen.
- Optimum outcomes are achieved when the Therapist and the Prosthetist work as a team.
THANK YOU!

QUESTIONS/COMMENTS?

ssallen@novacare.com


