Multidisciplinary Care of Lower Limb Amputations

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OUTCOMES

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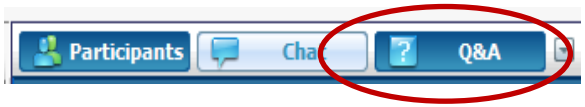
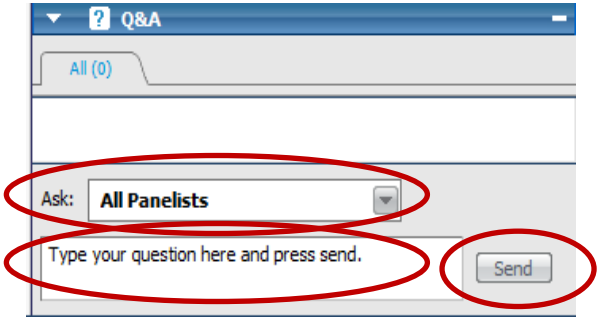
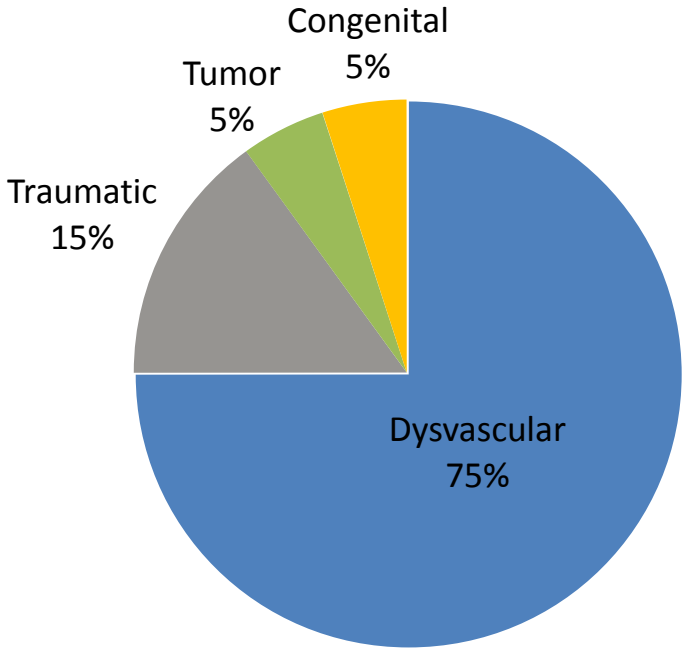




Lower Limb Amputee Rehabilitation

What are the facts?

- **Incidence of Lower Limb Amputation**
  - 140,000 new lower limb amputations/year in US
- **Etiology of Lower Limb Amputation**
- **Prevalence of Lower Limb Amputation**
  - 2,000,000 in US
  - 2/3 traumatic (normal life expectancy)
- **Gender Inequity**
  - Dysvascular: 69% Male vs. 31% Female
  - Traumatic: 88% Male vs. 12% Female
  - Tumor: 56% Male vs. 44% Female
- **Advances in Limb Salvage Techniques**
  - Prolonging acute medical/surgical management
- **Technical Advances in Prosthetics**
  - **Dynamic, evolving field**



Source: Amputee Coalition, 2012 data

Today's Webinar Objectives

Our conversation centers on four primary goals.

1. Identify the ***epidemiology*** of lower limb amputations, including classification of levels of amputation and corresponding functional potential with and without prosthetic fitting and training
2. Cite ***medical concerns and complications*** after amputation, including pain issues and summarize appropriate interventions
3. Outline the ***phases of amputee care and rehabilitation***, extending from initial surgical intervention to pre-prosthetic training, prosthetic prescription and fitting, and rehabilitation with functional prosthetic training
4. Assess need for and appropriate timing of ***psychological and vocational counseling*** for IW amputees

Our Presenter

Dr. Gary Clark

Paradigm Medical Director

Director of Amputee Rehabilitation at the MetroHealth Rehabilitation Institute

- Residency program director, professor and vice chair in the Department of Physical Medicine & Rehabilitation at Case Western Reserve University
- Associate chief medical officer for education for the MetroHealth System in Cleveland, Ohio
- MD with specialty in amputee, stroke and geriatric rehabilitation, as well as multiple trauma and brain injury

Multidisciplinary Care of Lower Limb Amputations

Dr. Gary Clark

Limb Trauma Surgery

What is feasible versus advisable?

- **Limb Salvage and Reconstruction: Unknown Outcome & Timeframe**
  - Debridement, skin/muscle flaps, skin/bone grafts
  - Neurovascular repair
  - Multiple surgeries, frequent early/late complications, often significant deformity, pain
  - Major functional, psychological, marital, vocational impact
  - Unknown outcomes/timeframes for healing/function

- **'Therapeutic' Amputation: Predictable Outcome & Timeframe**
  - Removal of painful/unstable/infected/non-functional body part
  - Predictable time frame and functional outcome post-amputation
  - Typically able to ambulate independently, often without assistive device
  - Evidence-Based Medicine:
    - Complex open tibia fracture: TTA better functional outcome than external fixation/flap
    - Complex foot & ankle injuries: TTA better functional outcome than ankle fusion/flap

Perspective: Always preferable to perform an elective amputation in the face of non-healing after multiple salvage attempts, to avoid urgent/emergent amputation due to progressive infection (osteomyelitis/cellulitis/sepsis) with risk of need to revise to a higher level (or even death).

Amputation Surgery

What are the goals?

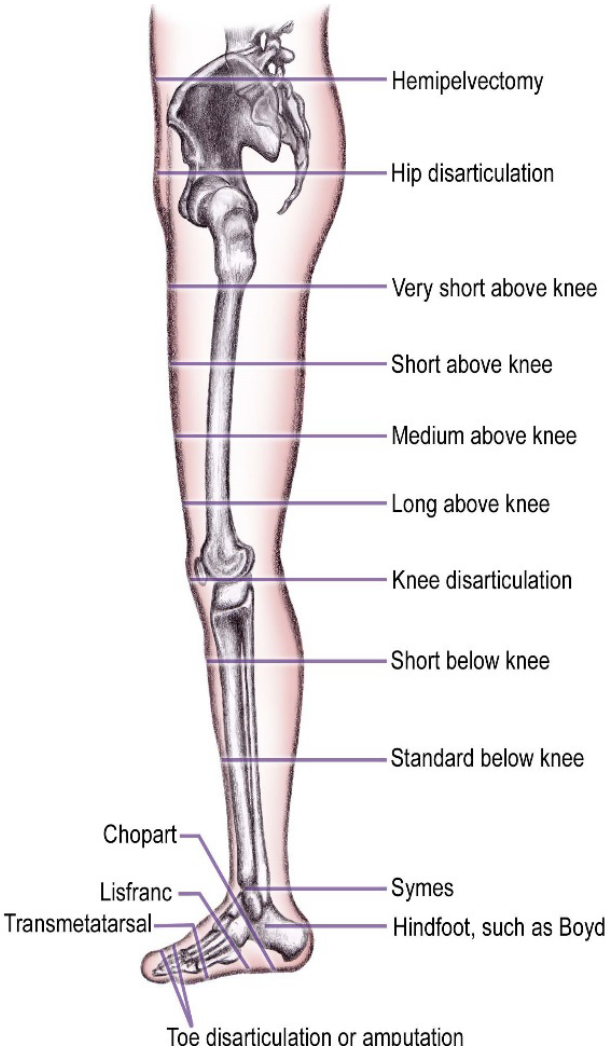
- Preservation of **functional** length (middle third of tibia or femur)
- **Durable** skin/soft tissue coverage
- Ensure viable circulation/soft tissue for **healing**
- **Preservation** of useful sensation
- **Prevention** of symptomatic neuromas
- **Stabilization** of adjacent weight-bearing structures
- **Controlled** short-term morbidity
- **Facilitate** early prosthetic fitting/function
- **Early** patient return to work and play

Lower Limb Amputee Rehabilitation

What are the levels of amputation?

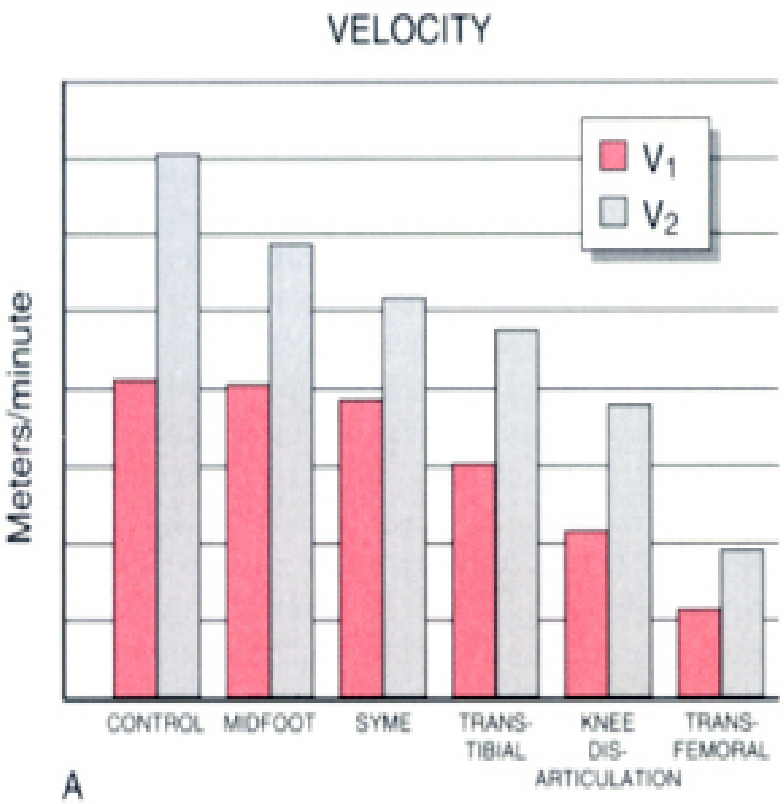
- **Levels of Amputation**
  - **Partial foot**
    - *NOT Chopart/Lisfranc/Boyd => equinus/fit issues*
    - Toe, ray resection– most common overall
    - Transmetatarsal
  - **Ankle disarticulation**
    - Symes (Bimalleolar)
      - Weight bearing surface vs cosmesis (bulbous)
  - **Transtibial:** TTA or BKA - 46%
  - **Knee disarticulation**
    - Less blood loss vs less function
  - **Transfemoral:** TFA or AKA - 23%
  - **Hip disarticulation / Hemipelvectomy**

- **Functional Implications of the Knee**
  - Independent ambulation: TTA 67% vs TFA 32%
  - Stand up from sitting, stairs
  - Energy costs, speed of ambulation



Walking with an Amputation

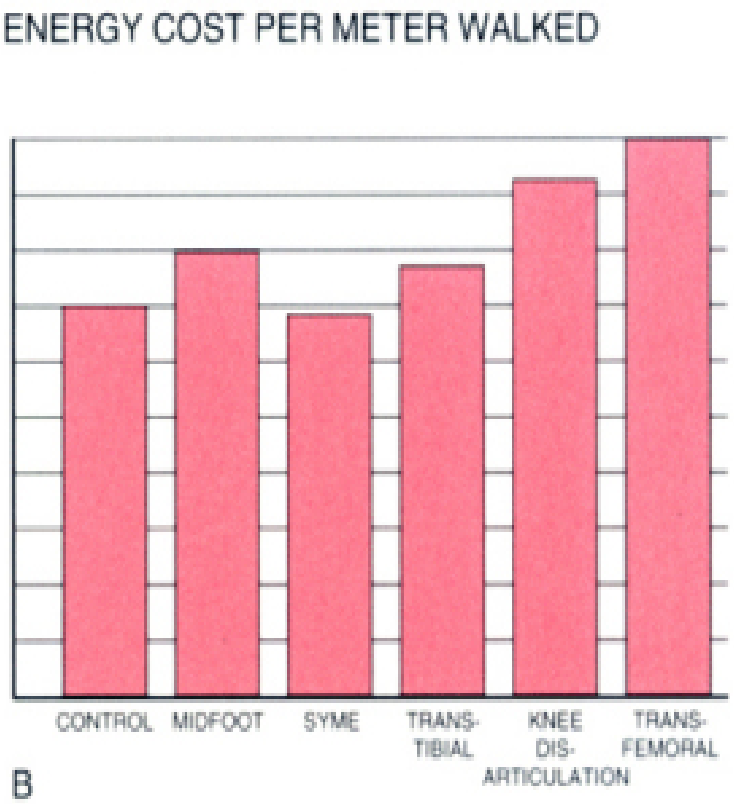
What is the metabolic cost?



Walking speed compared with surgical amputation level.

V1 is the subject's **self-selected walking speed**.

V2 is the subject's **maximal walking speed**.



Oxygen consumption per meter walked compared with resting oxygen consumption.

Adapted from Pinzur, M.S.; Gold, J.; Schwartz, D.; Gross, N. Orthopedics 15:1033–1037, 1992.
Browner: Skeletal Trauma: Basic Science, Management, and Reconstruction, 3rd ed.

Special Amputation Surgical Procedures

What are the options?

- **Myoplasty vs Myodesis**
- **Tenodesis, Tendon Transfer**
- **Skin Graft (STSG)**
  - Need soft tissue base with granulation tissue
  - Friable, especially with shear pressure
  - Decreased/absent sensation
- **Rotational/Regional Flap**
  - Skin + soft tissue mobilized, rotated for coverage/healing
- **Free Flap**
  - Intact skin/fascia/muscle/nerve/vascular supply dissected free and reattached over wound for coverage & healing
- **Special Procedures**
  - **Gritti-Stokes** – patella fused to distal femur
    - Broad/smooth weight bearing surface
  - **Ertl** – bone bridge between tibia and fibula
    - Broad/smooth weight bearing surface
  - **Sole Flap, Filet of Foot**
    - Provides sensate skin very tolerant of weight bearing, shear forces

Amputation Rehabilitation

What are the clinical steps?

Amputee Clinic Team Approach	Initial Evaluation	Frequent Follow-up (q4-6 weeks x 6-9 months)	Periodic Long Term Follow-up (q3-6 months)
• Surgeon (Trauma, Ortho, Vascular, Plastics) • Physiatrist • Physical Therapist • Prosthetist • Rehab Psychologist • Patient/family	• Patient/family **education** • Clarify **patient goals** • **Engage therapy** for pre-prosthetic program • **Identify prosthetic Rx**, timing	• Evaluate **fit and function** of prosthesis • Track **functional progress** – update therapy program • **Assess** need for socket modification, alignment change, etc. • **Monitor** for complications	• Socket modifications and replacement • Prosthetic maintenance, repair, replacement • Vocational needs, driving, etc.

Amputation Rehabilitation

Pre- and post-operative considerations

- **Medical Stability and Comorbidity**
  - Associated injuries/conditions (other trauma, burns, etc.)
  - Infection/antibiotics, lines
  - Co-morbid conditions
    - Cardiopulmonary, neurological, arthritis ***=> Endurance, Activity Tolerance***
- **Cognitive Status**
  - Comprehension, cooperation, motivation ***=> Ability to Learn***
- **Psychological/Emotional Status**
  - Anxiety/depression/PTSD ***=> Education, Counseling, Medications***
  - Patient goals
- **Pain Management**
  - PCA progressing to ATC long acting + prn opioids for breakthrough pain; anxiolytics?
  - Time IR opioids for one hour prior to therapy to facilitate active participation
  - Gabapentin (Neurontin) vs. Pregabalin (Lyrica) for phantom limb pain
  - Work to stabilize/taper analgesic regimen (opiates)

Amputation Rehabilitation

Pre- and post-operative considerations (continued)

- **Musculoskeletal/Neurological Status**
  - Lower 'intact' limb function => ROM/strength/sensation/pulses/balance
  - Lower amputated limb => proximal ROM/strength/sensation
- **Functional Status**
  - Mobility
  - Self care skills (ADL)– eating, bathing, toileting, dressing, grooming
- **Rehabilitation Considerations**
  - Living setting
  - Premorbid functional status (work, home & leisure)
  - Family support
  - Realistic patient/family expectations (functional goals, timeframes)
  - Proximity to experienced prosthetist/therapist

Amputation Rehabilitation

Pre-prosthetic training

- **Patient & Family Education**
  - Attitude: therapeutic, function-enhancing
  - Stages of amputation rehabilitation/timeframes
  - Phantom sensation awareness
- **Residual Limb Examination**
  - Length, shape (cylindrical)
  - Skin
    - Incision healing – staples/sutures (vs secondary intention)
    - Skin grafts, scars, vascular grafts, erythema, blisters, open wounds
    - Distal soft tissue padding
    - Distal skin mobility
    - Edema
  - Proximal joint stability, ROM
  - Proximal muscle strength
  - Areas of focal tenderness, bony prominences

Amputation Rehabilitation

Pre-prosthetic training (continued)

- **Desensitization**
  - Massage, tapping, heat/cold, ace wrap/shrinker sock => sensory input
- **Edema Control**
  - Ace wrapping to decrease edema, shape residual limb, desensitize
  - 4” ace wraps sewn together, ‘Figure of 8’ technique, snug/rewrap as needed (use tape not pins)
  - TTA: extend above knee vs TFA: extend around waist – to limit distal slippage
  - Progress to Shrinker Sock when incision healing well
- **Skin Care/Soft Tissue Mobility**
  - Massage to mobilize soft tissues, avoid adherent scarring
- **ROM/Stretching, Positioning**
  - TTA: knee/hip extension vs TFA: hip extension, IR, adduction/abduction
- **Strengthening**
  - Proximal residual limb + intact limb
- **Functional Training**
  - Independence at wheelchair level (transfers, W/C mobility); **“Amputee W/C”**
  - Independence in short distance ambulation with crutches/walker (‘hopping’)
  - ADL/self care; IADL (Instrumental ADL), community survival skills

A Successful Prosthesis

What characteristics make for the best prosthesis?

Characteristics
Comfortable to wear (if socket doesn't fit well, nothing else matters…)
Easy to don and doff
Lightweight
Durable
Cosmetically pleasing/acceptable
Improves function ("tool")
Reasonable maintenance
Customization

Prescribing a Prosthesis

What must be considered when determining the prosthetic prescription?

Considerations
Amputation level
Contour/length of the residual limb
Skin/soft tissue mass, mobility, tenderness
Cognitive function
Functional goals
Cosmetic importance
Single vs multiple prostheses (e.g., work prosthesis, home/hobby prosthesis)
Early fitting/training
Expertise of/proximity to prosthetist (‘art and science’ of fitting, alignment)
Expertise of/proximity to physical therapist (especially microprocessor knees)

Medicare Amputee Functional Levels

How are the various levels defined?

K0	Does not have the ability or potential to ambulate or transfer safely w/ or w/o assistance; prosthesis does not enhance quality of life - ***non-ambulator.***
K1	Has the ability or potential to use prosthesis for transfers or ambulation on level surfaces at fixed cadence - ***household ambulator.***
K2	Has the ability or potential for ambulation with the ability to traverse low-level environmental barriers, such as curbs, stairs or uneven surfaces - ***limited community ambulator.***
K3	Has the ability or potential for ambulation with variable cadence, with the ability to traverse most environmental barriers; may have vocational, therapeutic or exercise activity that demands prosthetic use beyond simple locomotion - ***community ambulator***
K4	Has the ability or potential for prosthetic ambulation that exceeds basic ambulation skills, exhibiting high impact, stress or energy levels, typical of prosthetic demands of a child - ***active adult or athlete***

Prescribing a Prosthesis

What are the components of a transtibial prosthetic prescription?

Prescription	Components
Socket	Patella Tendon Bearing (PTB) Total Surface Bearing (TSB)
Suspension Mechanism	Gel liner with exterior suspension sleeve
	Locking gel liner (distal pin/shuttle lock in bottom of socket)
	Seal-in gel liner (gasket(s) forming seal inside socket)
	Vacuum Assisted Suspension System – VASS (mechanical foot pump vs battery powered pump)
Prosthetic Foot	Options: shock absorption, torsion control - intrinsic vs add-on (length issue)

Prescribing a Prosthesis

What are the prosthetic foot options/costs?

K-Level	Category	Prosthetic Feet	Cost
1-2	Non-Dynamic	**SACH**, **Single Axis**, **Flexible Keel**	$1,200
3-4	Dynamic Foot, Solid Ankle (aka "stored energy")	**Flex Foot**, **Renegade**	$5-7K
	Dynamic Foot, Mobile Ankle	**College Park** (bumper control)	
		Echelon, **Kintera** (hydraulic fluid control)	
	Microprocessor w/ Active Ankle (electromechanical motor)	**Proprio**, **Triton Smart Ankle** (active DF/mechanical ankle)	$20K
		Elan (active DF/ hydraulic ankle)	
		BioM (active DF + power PF)	$70K

Prescribing a Prosthesis

What are the components of a transfemoral prosthetic prescription?

Components	Options
Socket	Ischial Containment Total Contact vs Hybrid
Suspension Mechanism	Suction socket (no liner, one way valve/low pressure vacuum)
	Locking gel liner
	Seal-in gel liner
	Vacuum Assisted Suspension System – VASS
Prosthetic Knee	(next slide)
Prosthetic Foot	(previous slide)

Prescribing a Prosthesis

What are the prosthetic knee options/costs?

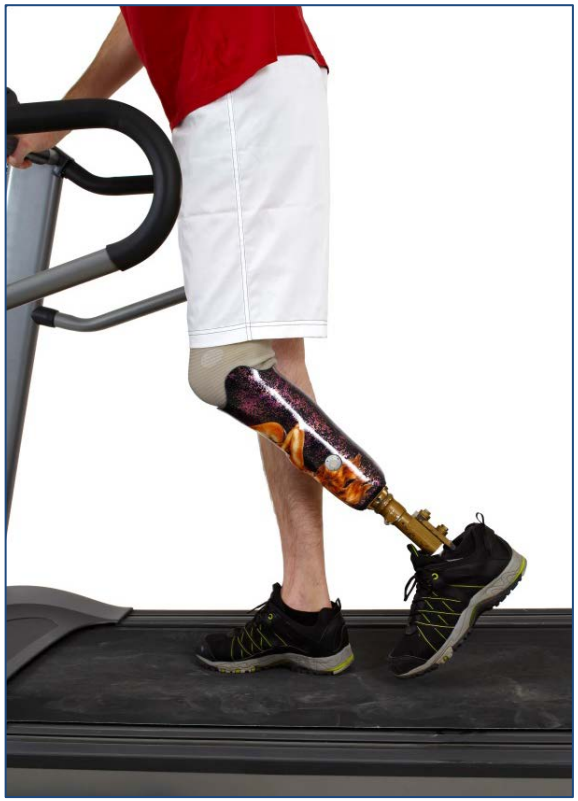
Control Mechanism	K-Level	Prosthetic Knees	Cost
Passive Control Systems (mechanical friction, fluidic flow control)	1-2	**Single Axis, Constant Friction** (hinge joint, single gait speed)	<$1K
		Polycentric (moving center of rotation, stable in extension)	$9-12K
	2-3	**Hydraulic** (variable friction, allows for variable gait speed)	
Adaptive Control Systems (microprocessor monitoring intrinsic sensors, continuous/rapid friction change)	3-4	**C-Leg**, **Plie'** (constant stance)	$30-40K
		Rheo (weight activated stance)	
		Genium (can lock knee/use hip extensors to ascend step-over-step)	$75K
	4	**X-3** (true running model/waterproof)	$90-115K
Active Control Systems (electromechanical motor)		**Power Knee** (powered knee extension)	$75K

Prosthetic Training

What training is involved with a new lower limb prosthesis?

Typically Outpatient Physical Therapy

- Shrinker sock
- Preparatory vs definitive prosthesis
- Proper prosthetic donning/doffing technique
- Progressive wearing & weight bearing tolerance
- Learning to 'listen to your body', adjust number of socks
- Prosthetic gait training => smooth & symmetric, safe
- Progress to minimum/no assistive device, higher cadence
- Progress to stairs, inclines, uneven surfaces
- Strengthening & conditioning
- Energy conservation strategies
- Care & cleaning of prosthesis, liners, socks
- Hygiene for residual limb



Post Amputation Complications

There are many possible complications.

Skin Complications

- Incision Healing
  - Delayed healing, wound dehiscence
- Hyperhidrosis, maceration, heat rash
  - Antiperspirants
    - Drysol (20% aluminum chloride)
  - Botox injections
    - Inject every square cm, q 3-6 months
- ST adherence/bony prominences
  - Shear friction from pistoning, bell clapping
  - Excessive pressure from poor fit

  => erythema/pain, blister, ulcer
- Scar Tissue/STSG: ⇓pressure/shear tolerance
- Proximal flesh roll, redundant distal residual limb soft tissue
- Folliculitis/furuncle (boil)/epidermoid cysts
  - Proper hygiene (hibiclens)
- Contact Dermatitis
  - Lotion, detergent, alcohol
  - Allergies
  - Poor skin & liner hygiene
- Cellulitis
- "Choke Syndrome" => verrucous hyperplasia
- Edema - CRF/HD, CHF, post-DVT
- Opposite Limb Status

Post Amputation Complications

There are many possible complications.

Pain Complications

- **Phantom Sensation (90+%)**
  - Reassure & educate
  - Paresthesias (tingling, itching, pulling)
  - Telescoping over time
- **Residual Limb Pain (70+%)**
  - Correlate location with socket
  - Timing, aggravating/relieving factors
  - Inflammation: skin/ST/bursa/tendon
  - Pressure vs shear stress
- **Painful neuroma (60+%)**
  - Irritation within socket
  - Local vs dermatomal distribution

- **Phantom Limb Pain (60% to 80%)**
  - Burning, shooting, electric shock-like
  - Related to pre-amputation pain?
  - Often episodic (weather changes)
  - Varying duration (minutes to days)
  - Unpredictable course
  - Prevention: massage, shrinker, prosthesis
  - Therapeutic heat/cold, vibration, TENS
  - Acupuncture, mirror therapy
  - Relaxation, self-hypnosis, visual imagery
  - Membrane stabilizers
    - Neurontin (gabapentin)
    - Lyrica (pregabalin)
  - Augmentative medications
    - TCA's, SSRI's, anticonvulsants
  - Opioids, muscle relaxers (esp at night)
  - Capsaicin, lidocaine

Post Amputation Complications

There are many possible complications.

MSK/Neurological/Other Complications

- Bursitis, Traumatic Bursa
- Bone Spurs, Heterotopic Bone
- Joint Contractures
  - Knee, hip (inter-relationship)
- Joint Arthritis & Instability
  - Knee, hip
  - Same and/or opposite side
- Low Back Pain – often related to gait mechanics
- Cardiopulmonary Co-morbidity
  - CAD/Angina, CHF
  - COPD
  - Decreased activity tolerance
- Prosthetic Fit Issues (weight gain/loss > 10#)
- Alignment Problems
  - Ant/Post: excess flex/ext moment
  - Med/Lat: varus/valgus angulation
- Prosthetic Component Failure
  - High end users, inappropriate activities
  - Normal wear and tear
  - Exceeding weight limits for components
- Poor Functional Outcome
  - Inadequate training/practice
  - Limited tolerance/pain
- Prosthetic Non-User

Post Amputation Complications

Psychological issues must be monitored and addressed.

Mourning the Loss
- Feelings can be overwhelming (anger, sadness, embarrassment)
- All aspects of life changed (forever)
- Gradual perspective – takes time
- ⬆ function => ⬇ sense of loss

Depression
- Ubiquitous – variable timing/severity
- Vicious cycle - ⬇ motivation => ⬇ progress
- Recognize & treat
- Gradual adjustment

Body Image & Disfigurement
- Staring at empty place
- Feelings of low self esteem & disappointment ("deformity", "unattractive")
- Hope limb will grow back
- Prosthesis function vs cosmesis
- Inevitable disappointment with prosthesis: "never as good" as the limb they lost

Adjustment to Disability
- "I am still me"
- Time and perspective
- Strategies: preparation & encouragement; peer amputees
- Help others be at ease

Vocational Rehab & Counseling

What is there to consider for lower limb amputees when returning to work?

Factors Contributing to Successful Return To Work

- Length of premorbid employment
- Type of premorbid work: “cognitive” activities vs manual labor
- Pre-morbid job satisfaction, level of education
- Employer support/flexibility: potential for part time/limited duty work
- Stable medical status (esp. pain management)
- Functional independence with prosthesis
- “Successful” adaptation to disability, coping mechanisms
- Functional Capacity Evaluation
  - IW + employer confidence in ability to return to work
- Job coaching, training and education

Additional Rehab Considerations

What are the absolute principles to abide by?

- **Fundamental for function**
  - Socket fit, comfort and alignment
  - Appropriate training and practice ("tool")
  - IW reliability/adherence to Rx recommendations
- **Prosthetic componentry**
  - Focus on functional needs/potential
  - Tradeoff of lightweight vs durability of components
  - Consider practical issues of battery life, recharging
  - Factor in maintenance needs
  - Newer technology not always better
- **New Technology**
  - Usually ***heavier*** (e.g., electronics, batteries)
  - Always ***costs [a lot] more***
  - Usually requires ***more frequent maintenance***
  - Often ***uncertain durability***
  - ***Constantly evolving => moving target***

Bottom line: The aim should be **realistic**

Case Management Considerations

Laurie Anderson

Case Management Considerations

What should case managers and claims professionals consider?

- Surgical goals
- Surgical procedures to optimize medical outcome and function
- Rehabilitation plan
- Treatment team
- Have the appropriate medical, rehabilitation and prosthetic professionals been identified?
- What's the best prosthetic given all the options?
- Rapidly evolving prosthetic technology – what's next?
- Outcomes and Return to Work

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Question and Answer Session

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Dr. Gary Clark

Laurie Anderson

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