Team Approach to Traumatic Amputations: From Injury to Living with Limb Loss

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Disclosures

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Medical Life Care Planning
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Medical Advisory Committee:
Amputee Coalition, Past Chair
UT Continuing Medical Education Chair
Limb Loss Prevention Task Force
BCM Masters in O&P
O&P Education Research Foundation
Basic Concepts
Amputation Levels LE
Lower Extremity Amputation Levels

Preferred Levels:
- Transmetatarsal (TMA)
- Syme
- Transtibial (BKA)
  - Ideal 50% tibial length
  - 8cm below knee
- Transfemoral (AKA)
  - Ideal 66% femur length
  - 10cm above distal femur
Amputation Levels UE
Upper Extremity Amputation Levels

Preferred Levels:

• Below Elbow
  ideal 55-90%
  longer—pronate/supinate wrist component

• Above Elbow
  ideal 50-90%
  socket suspension elbow component
Causes of Amputations

Amputation Etiology

- PVD
- Trauma
- Malignancy
- Congenital

Seymour 2002
Braddom 2011
Vascular Amputations

Diabetes rates tripled in last two decades, yet foot amputations fell after 1996

• Patient education and monitoring
• Medicare began paying for blood sugar monitoring and protective shoes
• Large number of diagnosed because of better screening

CDC: Diabetes amputations falling dramatically
Published January 25, 2012, Associated Press
Traumatic Amputations

War Wounds (Blast Injury)
Vehicular Accidents (Motorcycles)
Natural Disasters (Haiti Earthquake)
Occupational Injuries
  • Machinery/Equipment (Crush/Sever)
  • Explosion (Crush/Burn/Electrical)
  • Limb Salvage with Late Amputation
  • Electrocution Injury (Compartment Syndrome)
History of Amputations

1500s  Hemeostasis, Ligation (Pare)
1600s  Tourniquet (Morel)
1700s  Flying Ambulance (Larrey) ‘Life Flight’
1800s  Aseptic Technique (Lister)
1900s  Anesthesia → Surgical Advances (Lisfranc, Chopart, Symes, Boyd)
1945  Walter Reed Medical Center
      VA Prosthetic Centers
1960s  Research through VA
2000s  Military Operations in Middle East
      Walter Reed General Hospital
2007  Center for the Intrepid
      Brook Army Medical Center
History of Prosthetics

1000BC  Egyptian prostheses
1500s  Prostheses (iron/leather vs peg leg)
1945  World War II advances
1965  Medicare
2001  Wars in Afghanistan and Iraq
2005  Prosthetic Parity Law (20 states)
2007  Center for the Intrepid BAMC
2011  Patient Protection & Affordable Care Act (O&P separate from DME)
2015  Local Coverage Determination
History of Limb Salvage

1970s Values: 4 principles of Medical Ethics
- Autonomy - right to refuse or choose treatment.
- Beneficence - best interest of the patient
- Non-maleficence - "first, do no harm"
- Justice - fairness and equality

2009 LEAP Lower Extremity Assessment Project
Similar outcomes limb salvage versus amputation
Decision to salvage in borderline unpredictable prognostic cases should be based on team, experience, facility, multidisciplinary approach and clinical judgment. (Korompilias et al. 2009)

2010 METALS Military Extremity Trauma Amputation/Limb Salvage
Amputees have better outcomes than limb salvage
Additional study needed to look at differences and the rehabilitation process, resources long-term (Leahy, M AAOS now 2010)

2016 Shared Decision Making
Team approach to guiding limb salvage versus amputation
Medical Management & Treating Complications
Acute Care

- Consult PM&R pre/post-op
- Coordinated team approach
  - Surgeon, Therapy, Prosthetist
- Packet of Information
  - Amputee Coalition
  - Support Group
  - Social Media
- Process
  - Insurance coverage
- Timeline
Post-op Management

- Soft dressing
- Rigid dressing
  - RRD rigid removable dressing
  - IPOP immediate post-op prosthesis

20% of lower extremity amputees fall while in the hospital
3% of all LE amputees falls result in revision surgery
47% of revision surgeries result in a higher level amputation

- Revision surgery due to a fall is reduced with RRDs
- Shorten hospital length of stay
- Cost effective intervention that improves clinical outcomes
- Reduce the risk of revision surgeries due to falls
Shaping & Shrinking
Phantom Limb Syndrome (PLS)

Phantom Limb Syndrome
Phantom Sensation “position, pressure, numbness’
Ex. Foot is present
Phantom Pain “cramping, burning, stabbing”
Ex. Foot is in a vice-grip

Mechanisms (Supra-spinal, Spinal, Peripheral)

- **Supra-spinal**
  - somatosensory cortical reorganization of the area representing the de-afferentated limb

- **Spinal**
  - reorganization in the dorsal horn occurs after de-afferentation from a peripheral nerve injury

- **Peripheral**
  - axonal nerve damage initiates inflammation, regenerative sprouting, and increased "ectopic" afferent
Post-Amputation Pain (PAP)

**Phantom Pain**
“cramping, burning, stabbing”  
Ex. Foot is in a vice-grip

**Residual Limb Pain, Neuromas**
“throbbing, pulsating, sharp, localized, electrical”  
Ex. Incision or stump

**Intrinsic pain (Residual Limb)**
“localized, aching, constant”  
Ex. Infection

**Extrinsic Pain**
“uneven pressure”  
Ex. Prosthesis

**Biomechanics of an Abnormal Gait Pattern**
- Neck & Back pain
- Joint pain
- Muscle spasms

Pain affects 95% of all amputees; ~80% phantom, 67% residual limb, 62% back pain  
(Ephraim PL et al 2005)

Phantom pain highest at 6 months post amputation and diminishes over time  
(Bosman JC et al 2010)
Pain Assessment

- Visual Analog Scale
- Description
- Sleep disturbance
- Mood disorder

**Medications:**

**Acute:**

- Opioids
  - [IV→PCA→Oral/Topical]—(hydrocodone, tramadol)

**Chronic:**

- Anti-depressant (amitryptiline, duloxetine)
- Anti-seizure (gabapentin, pregabalin)
- Anti-inflammatory (NSAIDS)
Pharmacology

Central alpha adrenergic agonist
- Clonidine

Alpha 2 agonist
- Clonidine
- Alcohol

NSAIDS
- Ibuprofen
- Naprosyn
- Celebrex
- Mobic

Trycyclines AD
- Amitriptyline
- Nortriptyline

Opioids
- Tramadol
- Methadone
- Hydrocodone
- Oxycodone
- Morphine

Neuromodulators
- Anticonvulsants
- Capsaicin
- Cannabinoids

NMDA blockers/antagonist
- Ketamine
- Methadone
- Tramadol
- Alcohol

Gabapentinics
- Alcohol
- Baclofen
- Propofol
- Pregabalin
- Gabapentin

Anti-convulsants (anti-epileptics)
- Gabapentin
- Pregabalin (Lyrica)
Pain Management

• Pharmacology
• Desensitization
  – Massage
  – Tapping or rubbing
• Pressure
  – Shrinker, wrapping
  – Use of a prosthesis
• Healing of residual limb
• Modalities
  – TENS
  – Mirror
  – Magnet
• Interventional
  – Accupuncture
  – Nerve blocks, trigger points
  – Botulinium toxin injections
  – Radiofrequency Ablation (RFA)
• Psychology of limb loss
  – Psychotherapy and counseling
Abuse/Misuse of Pain Medications:
Is the treatment of pain after amputation at risk?

by Danielle H. Melton, MD

For many amputees, pain is a daily part of life. Research shows that pain (phantom pain, residual pain or back/spine pain) affects 95 percent of all amputees. Pain can affect amputees, whether from acquired limb loss such as trauma, vascular causes and cancer or congenital (limb deficiency at birth) limb loss.

In 1995, the American Pain Society set forth guidelines to improve the quality of pain management. This followed with such institutions as the World Health Organization (WHO), Joint Commission Accreditation of Healthcare Organizations (JCAHO) and the Veterans Hospital Administration (VHA) recognizing Pain as the 5th Vital Sign (PVS), an initiative to raise awareness in healthcare providers to address and treat pain. PVS is widely adopted but has had mixed results in improving overall pain management.

While it is clear that pain management needs to be a priority, has the pendulum swung the other way?

In 2011, the Centers for Disease Control and Prevention (CDC) reported that 1 in 20 people over the age of 12 report using prescription painkillers for non-medical use. There are 15,000 prescription drug overdoses annually, and deaths from prescription painkillers have reached epidemic levels over the last decade.

The answer has been to change the way pain medications are prescribed. In 2014, hydrocodone combination drugs such as Norco, Vicodin and Lortab were reclassified as Schedule 2 narcotics requiring a biologic handwritten prescription monitored by the Drug Enforcement Agency (DEA), making it more difficult for patients to obtain painkillers.

While these statistics are concerning and seem to warrant efforts to address this healthcare crisis,
Genetic Testing for PLP

Medscape Medical News > Conference News

Need for High Opioid Dose Linked to CYP450

Nancy A. Melville
September 25, 2012


A review of the role of genetic testing in pain medicine.
Trescot AM¹, Faynboym S.

WALTER REED NATIONAL MILITARY MEDICAL CENTER (WRNMMC)
BETHESDA, MD

[LEAD SITE PROTOCOL]

1. GENERAL INFORMATION

1.1 Protocol Title: Study to identify the genetic variations associated with phantom limb pain
Breathing Electrical Stimulation

BreEStim
Integrating voluntary breathing-controlled aversive electrical stimulation with acupuncture points for neuropathic pain management by using different pain-modifying mechanisms.

- **Electro-acupuncture effect** (analgesic effects)
- **Habituation** to aversive stimuli
- Influence of **voluntary breathing** (cortical and subcortical activation of the insular cortex, critical in **affective processing of pain**
- **Anterograde amnesia to aversive stimulation**
  (unpleasantness of peripheral noxious stimulation is not remembered or decreased immediately after increasing the analgesic effect of stimulation)
- **Reward system is triggered** (positive feedback loop)

Shengai Li, Jeffrey C. Berliner, **Danielle H Melton**, Sheng Li
Modification of electrical pain threshold by voluntary breathing-controlled electrical stimulation (BreEStim) in healthy subjects.
PLoS One, July 24, 2013; 8(7): e70282 PMCID: PMC3722161
Mental Health

- **Grief** (Kubler Ros 5 stages of loss)
  1. Denial
  2. Anger
  3. Bargaining
  4. Depression
  5. Acceptance

- **Depression** (SIGECAPS)
  - Sleep, Interest, Guilt, Energy
  - Concentration, Appetite, Psychomotor & Suicide

- **Anxiety**
- **PTSD**
- **Life after Limb Loss**
# Musculoskeletal Complications

<table>
<thead>
<tr>
<th>Bone/Muscle</th>
<th>Heterotopic Ossification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bony Prominences</td>
</tr>
<tr>
<td></td>
<td>Degenerative Arthritis</td>
</tr>
<tr>
<td></td>
<td>Joint Contractures (HFC, KFC)</td>
</tr>
<tr>
<td>Skin</td>
<td>Adherent Grafts</td>
</tr>
<tr>
<td></td>
<td>Insensate Skin</td>
</tr>
<tr>
<td>Pain</td>
<td>Neuromas</td>
</tr>
<tr>
<td></td>
<td>Phantom Limb Syndrome</td>
</tr>
<tr>
<td></td>
<td>LBP from compensated biomechanics</td>
</tr>
</tbody>
</table>
Heterotopic Ossification

Treatment:
- Prosthesis modification
- Prophylactic radiation therapy
- NSAIDS
- Bisphosphonates
- Surgical excision

HO in traumatic amputations is more common than previously suggested in literature, Level II

(Potter, BK et al 2006)
Skin Problems

- Allergic dermatitis, Eczema
- Epidermoid cyst
- Folliculitis, Boil, Abscess
- Cellulitis
- Fungal infections (Tinea corporis)
- Hyperhidrosis
- Ulcer
- Chocked stump syndrome

Verrucous hyperplasia
Treatment for Skin Issues

Infection (folliculitis/boil/abscess)
- ½ cup bleach in bath
- Benzoyl peroxide wash (OTC)
- Bactrim DS (2 weeks twice daily)
- Prophylactic Bactrim DS (daily)
- Liner-liner (Silver—antimicrobial)

Allergic Reaction
- Change liner (Dermo)
- Steroid cream

Chocked stump/pressure
- Prosthetic modification (alignment, socket adjustment/new)
Treatment for Skin Issues

Fungal infections (skin, nails)

- Antifungal cream (Lamisil, Naftin)
- Oral Lamisil for 3 months (check liver function—LFTS)
- Podiatry for nail clipping
- Skin checks (long hand held mirror)
- Clean skin with antibacterial soap
- Clean liners daily
- Antiperspirant
Overuse Syndrome

Treatment

Occurs at **joints** *(shoulder, elbow, wrist)* of affected limb (contralateral to amputation)

- Modification/Avoidance of aggravating activity
- Bracing (counterforce, elbow pad, wrist splint, thumb spica)
- NSAIDs (oral or topical)
- Therapy (strengthening, ROM)
- Steroid injection
- Surgery as last resort
Overuse Syndrome

Key Points

- **Prevention** is best, followed by **early detection** & **immediate intervention**
- Preservation of the remaining sound limb (early focus)
- Use of a functional prosthesis (not passive/cosmetic)

- *The more the impaired limb (higher the amputation) the more likely the sound limb will suffer overuse*
- *Insurance treats sound limb issues as a separate entity independent of amputated side*
- *Amputations require compensatory strategies therefore overuse issues are likely if not inevitable.*
Neuromas

- Diagnose by clinical exam
- Reproducible by palpation
- Causes electrical nerve pain

**Treatment:**
- Medication
- Surgical Excision
- Radiofrequency Ablation
  - Diagnostic mapping
  - Fluoroscopy lab

Improved pain
Increased prosthetic wearing time
Increased return to work
Shorter recovery and down-time

*Melton et al, AAP poster presentation*
**Radiofrequency Ablation for Amputation Neuromas**

Danielle H. Melton MD, Ahmed Khalifa MD, Amanda Steen MD
TIRR Memorial Hermann and University of Texas Health Science Center in Houston, Texas

**INTRODUCTION**

Amputation stump pain has many causes. The reported incidence of neuromas – a proliferation of nerve growth following amputation – is about 80%. While there are several surgical techniques used to prevent neuroma formation, once a neuroma forms, minimally invasive procedures that remove the neuroma are limited. Our case series shows that radio frequency ablation can be used to treat neuromas successfully.

**THE MEDICAL PROBLEM**

Neuroma formation following an amputation is common. There are different surgical techniques used to prevent neuroma formation. The most popular technique is to implant the amputated stump deep in muscle away from a weight-bearing area. Other techniques include capping the nerve stump, transcutaneous electrical nerve stimulation, and using lidocaine and steroids instead of electrical stimulation. Regardless of the surgical technique, neuromas continue to be a painful problem for many amputees. Currently, surgical resection is an established effective treatment for neuromas. This technique leaves an area of scar tissue in the amputee’s stump, which can be painful and scar tissue, and weeks of healing time, during which the patient is unable to wear a prosthesis and ambulate. Attempts to find a non-invasive treatment for neuromas have had very limited success. Pharmacologic therapies (anticonvulsants, antidepressants, and antispasmodics) and injections of botulinum toxin, steroids, and other substances can limit neuromas. Prophylactic ablation in patients’ neuromas pain.

**RADIOFREQUENCY ABLATION**

Radiofrequency ablation (RFA) is a minimally invasive procedure that has been common, used to locate medial nerve branches in management of spinal facet pain. It is performed under fluoroscopic guidance and uses radiofrequency energy to increase the temperature of the desired tissue to destroy that tissue.

**Clinical Diagnosis of Neuromas by Physical Exam**

**Prosthetic Wearing Time Increase (hrs)**

Patient 2 is a 25-year-old male who had a work-related injury on an upper level where the amputated stump was cut off, resulting in a short BKA stump below the foot. He presented to our clinic a month later with depression, PTSD, and neuropathic pain. Medications included gabapentin, hydrocodone-acetaminophen, and amitriptyline. Improved the pain with two doses of anti-thrombotic pain control between the foot and toes, and had developed limited tenderness to palpation and rated as 6-10. He had a trial pain medication increased to 6 hours per day and thereby placed on hold. He underwent RFA and had pain improvement at seven months. A two-week follow-up showed neuroma pain resolution of 100%. He increased the prostatic wearing time to 12 hours per day and requested to return to work.

Patient 3 is a 41-year-old male who described a metatarsophalangeal amputation stump pain after a work-related crush injury to his left foot. For more than 3 months, he had severe pain for which he was treated with several physicians offering medications, local injections, and oral medication. He had significant pain and was unable to walk, which led him to seek medical advice. His pain was constant and severe, rating 10 on the Visual Analog Scale. He was referred to our ambulatory clinic and underwent a comprehensive pain program. Three of gabapentin, amitriptyline, and diclofenac topical patches caused intolerable side effects or were ineffective. Pain, described as burning, tingling, stabbing, and shooting, ranged from 0-6/10 throughout the day. He limited his sleep, ambulation, and ability to work. He was then referred to our ambulatory clinic and underwent a comprehensive pain program. After successful diagnostic and treatment, RFA was performed resulting in pain relief and phantom pain resolution of 100% at one month follow-up. The patient still suffers from muscle spasms in the first and second toes and prostatic wearing time at this latest follow-up.

Patient 4 is a 37-year-old male involved in a work-related crush injury to both legs resulting in a right BKA and multiple fractures on the left requiring an external fixator that severely limited his mobility. He remained non-weight bearing awaiting bony healing for several months. In an amputee clinic, he described a temporary prosthesis to assist with transfers, but his limited mobility resulted in a heel pressure ulcer, which required skin grafting. X-rays showed a long bone and he was referred for revision at ten months from date of injury. His definitive prosthesis was completed and he stated walking the prostatic wearing time 6 hours per day.

**Pain Improvement**

**CONCLUSION**

Post-amputation stump neuromas continue to be a problem for many amputees, despite meticulous surgical procedures to prevent them. Neuromas can be debilitating for amputees, leading to escalating pain mediation requirements, often with little improvement in symptoms. Neuromas not only cause the amputee to suffer from multiple neuroesthetic pains, but prostatic wearing can be equally painful and unacceptable. This patient series illustrates the success and limitations of neurosis and the pain management strategies that are available.
Rehabilitation
Rehabilitation Team

- Patient
- Family/caregivers
- Therapists (PT, OT)
- Prosthetist
- Nursing
- Social Worker
- Case Manager
- Vocational counselor
- Psychologist
- Surgeon
- Rehab physician
Multi-disciplinary Treatment

Residual limb care
- Wound healing, Skin care, Hygiene
- Wrapping/shrinking/shaping
- Desensitization and Pain Control

Functional Status
- Range of Motion (prevent contractures)
- Balance, Mobility

Pneumatic Post Amputation Mobility
- Strength and Endurance
- Gait training, Alignment

Home & Community Environment
- Assistive devices for ADLs
- Medical Equipment evaluation
- Wheelchair evaluation
- Driving and Transportation

Prosthesis
- Candidate for prosthesis
- Components Prescribed
Activities of Daily Living

Assistive Devices
- Bidet
- Dressing Tree
- Body Dryer
- Grooming
- Meal Preparation

Home Modifications
- Light switches, Door knobs
- Voice Controlled Devices
- Grab Rails
- Widened doors
Partial Hand Amputations
### Energy Expenditure for Amputation

<table>
<thead>
<tr>
<th>Amputation level</th>
<th>Energy above baseline, %</th>
<th>Speed, m/min</th>
<th>Oxygen cost, mL/kg/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long transtibial</td>
<td>10</td>
<td>70</td>
<td>0.17</td>
</tr>
<tr>
<td>Average transtibial</td>
<td>25</td>
<td>60</td>
<td>0.20</td>
</tr>
<tr>
<td>Short transtibial</td>
<td>40</td>
<td>50</td>
<td>0.20</td>
</tr>
<tr>
<td>Bilateral transtibial</td>
<td>41</td>
<td>50</td>
<td>0.20</td>
</tr>
<tr>
<td>Transfemoral</td>
<td>65</td>
<td>40</td>
<td>0.28</td>
</tr>
<tr>
<td>Wheelchair</td>
<td>0-8</td>
<td>70</td>
<td>0.16</td>
</tr>
</tbody>
</table>

### Amputation Level and Amount by Which Energy Expenditure Exceeds That of Able-Bodied Persons (%)

<table>
<thead>
<tr>
<th>Amputation Level</th>
<th>Amount by Which Energy Expenditure Exceeds That of Able-Bodied Persons (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transtibial</td>
<td>9-20</td>
</tr>
<tr>
<td>Transfemoral</td>
<td>45-70</td>
</tr>
<tr>
<td>Bilateral transtibial</td>
<td>41</td>
</tr>
<tr>
<td>Bilateral transfemoral</td>
<td>Up to 300</td>
</tr>
</tbody>
</table>

Seymour 2002
**K levels**

<table>
<thead>
<tr>
<th>Medicare Functional Levels</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 4</td>
<td>Ability for prosthetic ambulation exceeding basic skills, exhibiting high impact stress or energy levels typical of child, active adult or athlete</td>
</tr>
<tr>
<td>Level 3</td>
<td>Ability for prosthetic ambulation with <strong>variable cadence traversing environmental barriers</strong> (uneven terrain) typical of an <strong>unlimited community ambulator</strong></td>
</tr>
<tr>
<td>Level 2</td>
<td>Ability for prosthetic ambulation traversing low-level environmental barriers typical of <strong>limited community ambulator</strong></td>
</tr>
<tr>
<td>Level 1</td>
<td>Ability to use a prosthesis for transfers or ambulation ambulation on level surfaces a fixed cadence typical of <strong>household ambulator</strong></td>
</tr>
<tr>
<td>Level 0</td>
<td>Does not have the ability to ambulate or transfer with or without assistance prosthesis does not enhance quality of life or mobility typical of <strong>wheelchair bound non-ambulatory amputee</strong></td>
</tr>
</tbody>
</table>
Walking Speed vs O2 Consumption

**WS** inversely proportional to **O2 cost** when comparing:
- **Levels** (distal to proximal)
- **Unilateral vs Bilateral** $BTF >> UTF > BTT > UTT$
- **Dysvascular** slower than **Traumatic** with short stride lengths
Transfemoral Prosthetics

**Prosthetic Candidate**

Therapy Milestones
- Parallel bars
- Balance
- Transfer independently

Functional outcome measures (AmpNoPro, Pavet)

**Bilateral AK (TF)**
- Start with Non-articulated AK prostheses “Stubbies”
- Progress to articulated
Justification for BLE
Prosthetics
Prosthetist

Certifications:
• American Board of Certification in Orthotics & Prosthetics (ABC)
• Board for Orthotic/Prosthetic Certification (BOC)
• Masters Programs in O&P (MSOP)

Considerations:
• Experience
• Licensed/certified
• Facility accredited
• Accessibility
• Patient’s Goals
• Component Choice
• Rapport
• Follow-up
LE Prosthetic Components

- Socket
- Pylon
- Grips

Below-the-knee Prosthesis

- Structural Interface (Socket)
- Suspension (Suction valve in socket)
- Microprocessor knee component (Joint)
- Skeletal Components
- Control System (Computer in knee)
- Prosthetic Foot (Joint)

Above-the-knee Prosthesis

- Socket
- Knee
- Shank
- Ankle and Foot
LE Components

**Trans-femoral (AKA) Socket**
- Ischial containment (NML)
- Quadrilateral

**Suspension**
- Suction (seal-in liner)
- Sleeve
- Vacuum assist
- Liner Pin
- TES belt
- Silesian belt
- Hip Joint/pelvic band

**Knee**
- Fluid Controlled
  - Microprocessor
  - Mechanical
    - Pneumatic
    - Hydraulic
- Polycentric (4-bar)
- Manual lock
- Stance control (wt activated)
- Single axis (constant friction)

**K3/K4 Level**

**Trans-tibial (BKA) Socket**
- PTB
- TSB

**Suspension**
- SC
- SCSP
- Straps/Cuffs
- Hinge and Thigh Corset
- Suction (Seal-in liner)
- Sleeve
- Pin lock with silicone liner

**Foot**
- SACH
- Single axis
- Flexible Keel
- Multi-axis
- Dynamic response
- Hybrid (Articulated/Dynamic)
- Specialty (Heel Ht adjustable)
Prosthetic Components

- Functional **K Level** determines **Prosthetic Knees & Feet**
  - **K1/K2** Basic Mechanical Knees
  - **K3/K4** Dynamic Response/Multiaxis Feet
    Microprocessor Knees/Feet

- Upper limb Pattern Recognition

- Restoration of Function and Body Image
  - Activity Specific
  - Special Adaptations
  - Cosmetic gloves
Upper Extremity Prosthesis

Body Powered
(cable & harness system)

Myo-Electric
(battery operated)

Passive
(cosmetic)

Terminal Device
Hook
Prehensor
Hand
Special Adaptations
Activity Specific
Basic vs Higher Level (K3) Prosthesis
Basic: Developing Countries

RCIC plastic prosthesis
Basic—Stair Walking
Microprocessor Components
Leading Edge Prosthesis
Bionic Prosthetics

Robotic limbs and hands
Power Knee
Proprio Foot
X3 Microprocessor Knee
Power Knee
Microprocessor Feet
BIOM Ankle System

THE BIONIC MAN

A mountain-climbing tragedy cost him both legs, so Hugh Herr set about reinventing the artificial limb.
By Adam Piore
Photography by Bob O'Conner

...in those devastating early days after the operation, Hugh Herr had a recurring dream. He was running through the walkable, flat-lake basement in rural Pennsylvania, going impossible fast, his toes and the wind on his face. Almost flying. The controllable sensation of weightlessness earned him the nickname. Now the 4-year-old would wake up to the echoes of his legs. He sits on his feet and remembers. Both his legs have been amputated five inches below the knees. The doctors said he would never run again.

They were wrong. Now, every other day for three years now, Herr has been pacing the 3-mile woodlot loop around Williams Pond in Massachusetts in specially designed prosthetics. "You just run out to run," he says. "It's a beautiful run."

For Herr, science is a virtually personal. Before his accident, he was a world-class rock climber; but at 48, and a high-school student, he attended vocational school at night and "didn't know what to do."

Today, he has a master's degree in mechanical engineering from MIT and a Harvard Ph.D. in biotechnology, and he is working around on motorized knees. "I think that's what the future is. Medicine just around a second later..."
Neuroprosthetics have the promise of turning dreams into realities… [but] because of costs… unlikely in the near-term…

“Neuroprosthetics have the promise of turning dreams into realities… [but] because of costs… unlikely in the near-term…”
Cost
## Upper Extremity Prosthesis

<table>
<thead>
<tr>
<th>Type</th>
<th>Advantage</th>
<th>Disadvantage</th>
<th>Approximate Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body Powered</strong></td>
<td>Cost</td>
<td>Appearance</td>
<td>BE $8-15,000</td>
</tr>
<tr>
<td>Harness/Cable</td>
<td>Durability</td>
<td>Physical operation</td>
<td>AE $12-25,000</td>
</tr>
<tr>
<td></td>
<td>Light-weight</td>
<td></td>
<td>5-function wrist</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>With Tools</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$20,000</td>
</tr>
<tr>
<td><strong>Electric</strong></td>
<td>Cosmetic</td>
<td>Expensive</td>
<td>BE $35-120,000</td>
</tr>
<tr>
<td>Myosite/Pressure</td>
<td>Strong grip</td>
<td>Heavier</td>
<td>AE $55-200,000+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Battery life</td>
<td>Hybrid $30-90,000</td>
</tr>
<tr>
<td><strong>Passive Oppositional</strong></td>
<td>Cosmetic</td>
<td>Non-functional</td>
<td>Hand $10-20,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>BE/AE $20-35,000</td>
</tr>
</tbody>
</table>
# Prosthetic Component Cost

<table>
<thead>
<tr>
<th><strong>Knees</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Mechanical</td>
<td>$5,000</td>
</tr>
<tr>
<td>Hydraulic Mechanical</td>
<td>$7,000</td>
</tr>
<tr>
<td>Microprocessor (C-leg)</td>
<td>$25,000</td>
</tr>
<tr>
<td>Microprocessor (X3)</td>
<td>$75,000</td>
</tr>
<tr>
<td>Microprocessor (Power)</td>
<td>$60,000</td>
</tr>
<tr>
<td>Microprocessor (Helix)</td>
<td>$7,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Feet</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SACH (basic wooden)</td>
<td>$200</td>
</tr>
<tr>
<td>Single Axis</td>
<td>$500</td>
</tr>
<tr>
<td>Carbon Fiber (MA/DR)</td>
<td>$3,000-8,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Microprocessor Ankle</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Proprio foot</td>
<td>$16,000</td>
</tr>
<tr>
<td>BIOM ankle system</td>
<td>$85,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Skins/Coverings</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard/Custom BKA</td>
<td>$500-12,000</td>
</tr>
<tr>
<td>Standard/Custom AKA</td>
<td>$900-15,000</td>
</tr>
</tbody>
</table>
## Lower Extremity Prosthetic Cost

<table>
<thead>
<tr>
<th>Extremity</th>
<th>Preparatory</th>
<th>Definitive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Below Knee (BKA, TT)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICRC Red Cross (Peg leg)</td>
<td>$250</td>
<td></td>
</tr>
<tr>
<td>Preparatory</td>
<td>$5,000</td>
<td></td>
</tr>
<tr>
<td>Definitive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-range</td>
<td>$10,000</td>
<td></td>
</tr>
<tr>
<td>High-range</td>
<td>$20,000</td>
<td></td>
</tr>
<tr>
<td><strong>Above Knee (AKA, TF, KD)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preparatory</td>
<td>$8,000</td>
<td></td>
</tr>
<tr>
<td>Mechanical</td>
<td></td>
<td>$15,000-35,000</td>
</tr>
<tr>
<td>Computer knee</td>
<td></td>
<td>$50,000-130,000</td>
</tr>
<tr>
<td>Hip Disarticulation (HD)</td>
<td></td>
<td>$85,000-150,000</td>
</tr>
<tr>
<td><strong>Activity Specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dancing</td>
<td>$500</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>$5,000</td>
<td></td>
</tr>
<tr>
<td>Running</td>
<td>$30,000</td>
<td></td>
</tr>
<tr>
<td><strong>Research Based</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peripheral EMG control</td>
<td>$250,000</td>
<td></td>
</tr>
<tr>
<td>Central Neuroprosthesis</td>
<td>~ $6,000,000??</td>
<td></td>
</tr>
</tbody>
</table>
### Prosthetic Life Span

<table>
<thead>
<tr>
<th>Prosthesis</th>
<th>Replacement needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 1st preparatory (temporary)</td>
<td>3 mo—2 years</td>
</tr>
<tr>
<td>• 1st definitive prosthesis</td>
<td>2—4 years</td>
</tr>
<tr>
<td>• Socket revisions</td>
<td>6 mo—2 years</td>
</tr>
<tr>
<td>• Subsequent prosthesis</td>
<td>3—5 years</td>
</tr>
<tr>
<td>• Liners</td>
<td>Annual</td>
</tr>
<tr>
<td>• Socks, Shrinkers</td>
<td>Annual</td>
</tr>
</tbody>
</table>
Advances in Surgery
IPOP limb salvage

- Limb salvage with Ilizarov frame
- Severely limited ROM
- X-rays show non-union & HO
Limb Salvage vs. Amputation

- BKA
- IPOP attached to frame
- WBAT
- Aggressive PT for ROM
- Shared decision making
- Patient directed care
- Better outcomes
**Primary Outcomes:**
- Function
- Depression
- PTSD

**Secondary Outcomes:**
- Pain
- HR QOL
- Return to Activity
- Self Efficacy

**Proposed Intervention**
- Opioid Wean
- Psychological Intervention
  - Anxiety
  - Depression
  - PTSD

**Innovative health care models improve when “informed, activated” patients interact with “prepared, proactive practice teams.” patients and their families to assume greater responsibility for their care and recovery. health care system and providers to train and support patients and families in these recovery activities.**
Osseointegration
Osseointegration

Advantages
• No socket (pain, sweating, irritation)
• Easy to Don/Doff
• Excellent suspension
• Comfort in sitting
• Hip movement not restricted

Disadvantages
• Longer rehab (protocol dependent)
• Infection
• Loosening of hardware
• No high activity
• No swimming in public facilities
• Daily care, cosmesis abutment

Contraindications
• Obesity
• Contractures
• Skin problems
• DM, PVD

Denmark (dental)

Current Sites Performing
• Sweden
• Germany
• England
• Australia
• Spain

Pending FDA approval
USA (Utah, Las Vegas)
Ertl Procedure

Osseoperiosteal tibiofibular synostosis

Prosthetic fit at 6-8 wks

**Advantages:**
- Eventual weight bearing
- Improved gait and comfort
- Prevent bone atrophy

**Disadvantages:**
- Delayed prosthetic fit
- Delayed functional mobility
Ertl Procedure

Navy Seals + Ertl Procedure

-------------------------
Productive Team Member
Targeted Nerve Muscle Reinnervation (TNMR)
Neuroprosthesis: Control with Thoughts
Model System of Care
Healthcare Crisis
2009:  80,000 major amputations performed
       Exceeding $8,300,000,000 hospital charges

2010:  507 amputations every day (~85% preventable)
       19,000,000 people with Diabetes
       – 4% will develop ulcer
       – 6% will have an amputation
       – 45% mortality rate with ulcer or amputation at 1 year

2014:  1,900,000 Americans living with limb loss
       Double to ~ 4,000,000 by 2050
O&P Industry

CMS Medicare Fraud
- Taxpayers
- Health care Audits
- Patient Care

The $60 Billion Fraud
October 25, 2009 5:00 PM

Medicare and Medicaid fraudsters are beating U.S. taxpayers out of an estimated $90 billion a year using a billing scam that is surprisingly easy to execute. Steve Kroft investigates

Read Story: Medicare Fraud: A $60 Billion Crime
Office of Inspector General
OIG report 2011

$43M Prosthetics overpaid
$61M No referring MD in previous 5 years

Criticized Medicare for no oversight requiring new screening for HC providers

Results:
Delivery delays
MD administration burden
“Dear Doctor” letters (AC)
Rehabilitation & Prosthetics

Medicare pays more in HC $ when Bracing and Prosthesis are NOT provided

**Bracing**
- saved 10% in HC costs
- more rehabilitation
- able to stay in home (not NH)

**Prosthesis**
- more OP rehabilitation
- less ER visits
- less acute hospitalizations
- equivalent cost in HC

**K1/2 amputees (compared to K3/4)**
- more HC costs (despite prosthetic cost)
- more OT/PT
- rely on SNF/HH
Health Care Reform

11TH CONGRESS
2d Session

LEGISLATIVE COUNSEL

COMPILATION OF PATIENT PROTECTION
AND AFFORDABLE CARE ACT

[As Amended Through May 1, 2010]

INCLUDING
PATIENT PROTECTION AND AFFORDABLE CARE ACT
HEALTH-RELATED PORTIONS OF THE HEALTH CARE AND
EDUCATION RECONCILIATION ACT OF 2010

PREPARED BY THE
Office of the Legislative Counsel
FOR THE USE OF THE
U.S. HOUSE OF REPRESENTATIVES

MAY 2010

APPROVED
MAR 2 3 2010

OBAMACARE
UPHELD.

APPROVED
MAR 2 3 2010

OBAMACARE
UPHELD
JUNE 28, 2012
I was very clear with the prescription I wrote.
LONG-TERM CARE for the DISABLED?
Dear Doctor:

The purpose of this letter is to update you about what Medicare now requires for me to obtain necessary prosthetic care from my prosthetist. While Medicare has always required a physician prescription, recent guidance makes clear that your notes regarding my condition are a key element for my claim to be successfully processed. Without detailed notes and findings from you, Medicare will refuse to pay for this medically necessary prosthetic care and my prosthetist will be unable to deliver me the item(s) I need.

Medicare has specifically identified the items that must be in your medical record to support the prescription. Medicare has further made clear that (1) this documentation cannot be contained solely in the prosthetist’s records, and (2) the prosthetist cannot create that documentation for you (i.e., by sending you a form that you initial and insert in your records - Medicare considers this “ancillary to” the physician records). The required documentation includes:

1) A complete assessment of my physical and cognitive capabilities (be sure to include symptoms limiting ambulation or dexterity, diagnosis-causing symptoms or co-morbidities affecting ambulation).
2) A description of my pre- and post-amputation capabilities in a way that Medicare can see from reading your record a full picture of my functional abilities and limitations on a typical day. Please include as much objective data as possible.
3) Clinical notes with clear data and observations to support classifying my rehabilitation potential using Medicare’s K level system (0 through 4). The record must document my current functional capabilities and my expected functional potential, including an explanation for the difference, if any, between the two.

Level 0 - Does not have the ability or potential to ambulate or transfer safely with or without assistance and prosthesis does not enhance quality of life or mobility. This level does not warrant a prescription for a prosthesis.

Level 1 - Has the ability or potential to use a prosthesis for transfers or ambulation on level surfaces at fixed cadence. This is typical of a household ambulator.

Level 2 - Has the ability or potential for ambulation with the ability to traverse low-level environmental barriers such as curbs, stairs or uneven surfaces. Typical of the limited community ambulator.

Level 3 - Has the ability or potential for ambulation with variable cadence. Typical of the community ambulator who has the ability to traverse most environmental barriers and may have vocational, therapeutic or exercise activity that demands prosthetic utilization beyond simple locomotion.

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.

Thank you in advance for helping me. While this documentation may be more extensive than what you’ve historically recorded in my medical record, it is now required by Medicare for me to get the prosthetic care and treatment that I need.

Very Truly Yours,

Ampusee Coalition
900 East Hill Avenue, Suite 290
Knoxville, TN 37922-2568
Physician Clinic Documentation for Lower Limb Amputee Management and Care

Reason for visit/Chief Complaint:
- Prosthesis and rehabilitation evaluation
- Requesting new prosthesis or artificial limb
- Problem with prosthesis or artificial limb
- Amputation History (History of Present Illness)
- Trauma
- Diabetes/Diabetic foot care
- Infection
- Vascular Disease
- Cancer/Tumor
- Other:
- Date of Amputation(s):
- Amputation level:
- Above knee (Trans-femoral)
- Below knee (Trans-tibial)
- Symes (Ankle disarticulation)
- Partial Foot
- Toe(s)
- Prognosis of amputation with prosthesis:
- Good
- Fair
- Poor
- Motivated to use/wear a prosthesis
- Wants therapy for prosthetic training
- Functional level(s)
- Goals for using a prosthesis:
- Vocational requirement
- Athletic goal
- Basic locomotion
- Past Medical/Surgical History:
- V P C: Patient has Diabetes
- Peripheral vascular disease
- High Blood Pressure
- Congestive heart failure
- Chronic Lung Disease
- Arthritis
- Renal disease
- Seizure
- Recent amputation complications
- Past amputation complications
- Planned surgical revision of amputation
- Social History:
- If patient cannot lift or walk to bed: (V/N)
- Needs a stronger hip joint or prosthetic (V/N)
- Needs to go up or down steps (V/N)
- Recent medical changes
- Mental status of patient
- Constitutional Changes in weight of greater than 10 lbs
- Eyes: Poor vision limiting safe walking with prosthesis
- Kidney: Necessity of dialysis
- Bowel: Stool softer than usual
- Skin: Amputated limb skin breakdown
- Cognitive: Memory impaired
- Emotional: Non-treated Depression from limb loss?

Patient's Functional Status
- CURRENT Activities of Daily Living (ADLs):
  - Independent, some assistance needed, N/A, not applicable
  - Bathing
  - Dressing
  - Toilet training
  - Transfer
  - Walking
- MOBILITY STATUS:
  - Assistive Devices: Walker
- MOBILITY STATUS:
  - Ambulatory: Independent, some assistance needed
- Balance and Coordination:
  - Normal
  - Other:
  - Transfers:
    - Transfers independently from WC
    - Transfers using a sliding board
    - Unable to transfer (requires lift or assistance)
  - Toileting
  - Walking

Physical Exam:
- Vital Signs
  - Temperature
  - Blood pressure
  - Pulse
  - Respiratory rate
  - Body weight

Standing:
- Able to stand from a seated position
- Gait:
  - Non-ambulatory, wheelchair
  - Ambulatory, steady, symmetrical
  - Ambulation device:
    - Crutches
    - Walker
    - Use of cane
- Eyes:
  - Normal visual acuity
  - Bilateral vision
  - Other:
  - Upper extremities:
    - Normal
    - Other:
  - Lower extremities:
    - Normal
    - Other:
  - Range of Motion:
    - Normal
    - Other:
  - Neurological:
    - Normal
    - Other:
  - Integument:
    - Normal
    - Other:

Skin Incision:
- Unhealed
- Scar
- Keloid
- Prosthetic attachments (Prosthetic socket):
  - Normal
  - Other:
  - Musculoskeletal:
    - Normal
    - Other:

Physical Exam:
- Vital Signs
  - Temperature
  - Blood pressure
  - Pulse
  - Respiratory rate
  - Body weight

Standing:
- Able to stand from a seated position
- Gait:
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  - Other:
  - Upper extremities:
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    - Other:
  - Lower extremities:
    - Normal
    - Other:
  - Range of Motion:
    - Normal
    - Other:
  - Neurological:
    - Normal
    - Other:
  - Integument:
    - Normal
    - Other:

Skin Incision:
- Unhealed
- Scar
- Keloid
- Prosthetic attachments (Prosthetic socket):
  - Normal
  - Other:
  - Musculoskeletal:
    - Normal
    - Other:
Step Into the Ring
Advocating is a great way to get involved.

With the limb loss community's estimated 1.5 million people spread out across a country of 300 million people, it's easy to see how the amputee's message can get diluted with the myriad of other concerns affecting our country. It's also easy to understand the importance of ensuring that amputees and professionals get an ear in the halls.

Dr. Jennifer Shepard, M.D., medical director of Amputee Health Care at University of Iowa Hospitals & Clinics, has been an ardent advocate for improving access to care for people with limb loss. She has been a driving force in the创建 of the Amputee Coalition, which has grown from a small grassroots organization to a national force for change.

Shepard credits the coalition's success to its ability to engage both members of Congress and the public in the fight for improved limb loss care. "The coalition has been able to bring together people from all walks of life who are affected by limb loss, and it has been instrumental in reaching out to elected officials and policy makers to ensure that the needs of people with limb loss are being addressed," she said.

Shepard believes that the coalition's success is due in part to its ability to mobilize people around a common cause. "When you have a group of people who are passionate about a cause, they are able to mobilize others to take action," she said. "And when people come together, they can make a real difference."

The coalition's advocacy efforts have led to significant improvements in the care of people with limb loss, including increased access to prosthetics and other medical devices, more resources for rehabilitation, and greater public awareness of the challenges faced by people with limb loss. "I think we have made real progress in improving the lives of people with limb loss," Shepard said. "But there is still so much work to be done."

The coalition is currently working on several key initiatives, including increasing federal funding for research into limb loss, improving access to Medicare coverage for prosthetics and other medical devices, and advocating for policies that ensure people with limb loss have access to the care they need. "We are just getting started," Shepard said. "But we are determined to make a difference, and we are not going to stop until we achieve our goals."

Shepard encourages people who are affected by limb loss to get involved in the coalition's efforts. "If you want to make a difference, there is no better way to do it than by getting involved with the coalition," she said. "Together, we can make a real difference in the lives of people with limb loss."
Meeting with CMS

March 2014
Documentation needed to support medical necessity.

CMS LLPECT is long and cumbersome to complete.
Long term plan is care by team (including MD, PT, CP)

Evidence Based Medicine (EBM) not arbitrary diagnoses (COPD)

Audits (RAC, MAC) based on EBM not cost cutting at expense of patients

August 2015
Local Coverage Determination

Denials of prosthetics preventing patient access

Other Insurances following CMS guidelines (vacuum system denied by United Health
Team Approach--LCD

- Therapists
  Outcome Measures, Gait, ROM

- Prosthetists
  K level, Components, Gait, Fittings

- Physicians
  - Surgeons
  - Primary Care Physicians
  - PM&R physicians
    Medical Necessity, Team Integration

- Patient
- Family/caregivers
Medicare Update

- Local Coverage Determination (LCD)

- 100,000 signatures largely supported by the AC

- White House: “will not finalize the draft Lower Limb Prostheses Local Coverage Determination (LCD) (DL33787) at this time.”

- “Workgroup in 2016, comprised of clinicians, researchers, policy specialists and patient advocates from different federal agencies”

- Re-imbursement for prosthetics are based on components not clinical time and expertise 2011 ACA (RAC audits)
Quality of Life & Functional Outcomes
Amputee Coalition

Amputee Coalition Mission:

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.

History:
1986  Support Group Leaders (today 300+) Amputee Coalition of America
1991  Certified Peer Visitor program (~1000)
1997  Center for Disease Control & Prevention → National Limb Loss Resource Center
2010  Limb Loss Task Force Summit (I, II, III)
2010  April is National Limb Loss Awareness Month
2012  Limb Loss Education Day
2016  30th Anniversary AC
Amputee Coalition

Scientific Medical Advisory Committee

- BMI calculator
- CMS physician documentation
- Limb Loss Awareness Day
- Limb Loss Task Force
- Research for Evidence Based Medicine
- Video Resources for People with Limb Loss
- Certified Peer Visitor Program, Hospital based
Living with an Amputation

Education & Resources

• Amputee Coalition
• Peer Visitors (AC trained) partner with hospitals
• Local Support Groups
• Psychological Counseling patient and family
• Vocational Rehabilitation
• DARS
• RSVP
Health and Well being (Weight Loss)

I finally got rid of the 25 pounds that I spent years trying to lose.
BMI Calculator for Individuals with Limb Loss
Click here to find a tool to help you access your weight status by calculating your body mass index (BMI).
Expected Outcomes

Return To Work
• Functional Capacity Evaluation (FCE)
• Work Hardening and Conditioning
• Neuropsychiatric Evaluation
• Vocational Rehabilitation
• Accommodations for Restrictions
  Sedentary, Duty level
  Safety Instruction and Training

Workers Compensation
• Texas Department of Insurance (TDI)
• Maximal Medical Improvement (MMI)
• Impairment Rating (IR)

Disability & Legal issues
LLTF I April 2010

Roadmap January 2011

LLTF II February 2012

White Paper September 2012

LLTF III March 2015
Medicare Poised to Fund First Prevention Program, for Diabetes

Mary Agnes Carey
March 24, 2016

As the health law turned six Wednesday, federal officials proposed the expansion of a Medicare diabetes prevention program funded by the landmark measure.

The pilot program, developed and administered by the YMCA, helped Medicare enrollees at high risk of developing the disease improve their diets, increase their exercise and lose about 5 percent of their body weight.

Beneficiaries in the program, funded by an $11.8 million grant provided by the health law, attended weekly meetings with a lifestyle coach to develop long-term changes to their diet, discussed ways to get more physical activity and made behavior changes that would help control their weight and decrease their
Evidence Based Medicine

ACL
Administration for Community Living

BADER
Bridging Advanced Developments for Exceptional Rehabilitation

METRC
Major Extremity Trauma Research Consortium
Improving outcomes through collaborative research

National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR)

PALS

Limbloss
Research & Statistics Program
Promoting Amputee Life Skills

ampuTEE coalition

Putting Patients First
National Health Council Standards of Excellence Certification Program