Prosthetic Devices: Component Considerations

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Outline

- Principles of Prosthetic Design
  - Socket Fit and Comfort
  - Alignment Optimization
- Functional Level Assessment
- Clinical Presentation
- Suspension Systems
- Component Selection
- Insurance Justifications
Functional Level Assessment: K Level Descriptors

- **Level 0**
  Does not have the ability or potential to ambulate or transfer safely with or without assistance and a prosthesis does not enhance their quality of life or mobility.

- **Level 1**
  Has the ability or potential to use a prosthesis for transfers or ambulation on level surfaces at fixed cadence. Typical of the limited and unlimited 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.
Functional Level Assessment: Outcome Measures

- AmpPro/NoPro
- Activity Balance Confidence (ABC)
- PLUS-M
- Houghton
- PROMIS-29
- Community Integration Questionnaire
- Coping Self-Efficacy Scale
Functional Level Assessment: AmpPro/NoPro
ABC-16 Scale

For each of the following, please indicate your level of confidence in doing the activity without losing your balance or becoming unsteady from choosing one of the percentage points on the scale form 0% to 100%. If you do not currently do the activity in question, try and imagine how confident you would be if you had to do the activity. If you normally use a walking aid to do the activity or hold onto someone, rate your confidence as if you were using these supports.

For each of the following activities, please indicate your level of self-confidence by choosing a corresponding number from the following rating scale:

0% 10 20 30 40 50 60 70 80 90 100%
no confidence completely confident

How confident are you that you will not lose your balance or become unsteady when you...

1. ...walk around the house?_____%
2. ...walk up or down stairs?  %
3. ...bend over and pick up a slipper from the front of a closet floor  %
4. ...reach for a small can off a shelf at eye level?  %
5. ...stand on your tip toes and reach for something above your head?  %
6. ...stand on a chair and reach for something?  %
7. ...sweep the floor?  %
8. ...walk outside the house to a car parked in the driveway?  %
9. ...get into or out of a car?_____%
10. ...walk across a parking lot to the mail?  %
11. ...walk up or down a ramp?  %
12. ...walk in a crowded mall where people rapidly walk past you?  %
13. ...are bumped into by people as you walk through the mall?  %
14. ...step onto or off an escalator while you are holding onto a railing?  %
15. ...step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing?  %
16. ...walk outside on icy sidewalks?  %
<table>
<thead>
<tr>
<th>Question</th>
<th>Without any difficulty</th>
<th>With a little difficulty</th>
<th>With some difficulty</th>
<th>With much difficulty</th>
<th>Unable to do</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are you able to walk a short distance in your home?</td>
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<tr>
<td>2. Are you able to step up and down curbs?</td>
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<td>3. Are you able to walk across a parking lot?</td>
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<td>4. Are you able to walk over gravel surfaces?</td>
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<td>5. Are you able to move a chair from one room to another?</td>
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<td>6. Are you able to walk while carrying a shopping basket in one hand?</td>
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<tr>
<td>7. Are you able to keep walking when people bump into you?</td>
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<td>8. Are you able to walk on an unlit street or sidewalk?</td>
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<td>9. Are you able to keep up with others when walking?</td>
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<tr>
<td>10. Are you able to walk across a slippery floor?</td>
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<tr>
<td>11. Are you able to hike down a steep gravel driveway?</td>
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<tr>
<td>12. Are you able to hike about 2 miles on uneven surfaces, including hills?</td>
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<tr>
<td>Houghton Scale of Prosthetic Use</td>
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<tr>
<td><strong>1. Do you wear your prosthesis?</strong></td>
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<tr>
<td>0: &lt; than 25% of waking hours (1-3 hours)</td>
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<tr>
<td>1: 25-50% of waking hours (4-8 hours)</td>
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<td>2: &gt; than 50% of waking hours (&gt; 8 hours)</td>
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<td>3: All waking hours (24-36 hours)</td>
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<tr>
<td><strong>2. Do you use your prosthesis to walk?</strong></td>
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<td>0: Just when visiting the doctor or limo-fitting center</td>
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<tr>
<td>1: At home but not to go outside</td>
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<td>2: Outside the home on occasion</td>
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<td>3: Inside &amp; outside all the time</td>
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<tr>
<td><strong>3. When going outside wearing your prosthesis, do you:</strong></td>
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<tr>
<td>0: Use a wheelchair</td>
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<tr>
<td>1: Use 2 crutches, 2 canes, or a walker</td>
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<td>2: Use one cane</td>
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<td>3: Use nothing</td>
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<td><strong>4. When walking with your prosthesis outside, do you feel unstable when:</strong></td>
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<tr>
<td>4a: Walking on a flat surface?</td>
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<tr>
<td>0: Yes</td>
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<tr>
<td>1: No</td>
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<tr>
<td>4b: Walking on slopes?</td>
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<td>0: Yes</td>
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<tr>
<td>1: No</td>
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<td>4c: Walking on rough ground?</td>
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<td>0: Yes</td>
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<tr>
<td>1: No</td>
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<tr>
<td>TOTAL: ___/12 points</td>
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</table>
PROMIS-29
Community Integration Questionnaire

Name: __________________________ Date: __________________________

**Home Integration**

1. Who usually does shopping for groceries or other necessities in your household?
   - Yourself alone (2)
   - Yourself and someone else (1)
   - Someone else (0)
   **Score:**

2. Who usually prepares meals in your household?
   - Yourself alone (2)
   - Yourself and someone else (1)
   - Someone else (0)
   **Score:**

3. In your home, who usually does normal everyday housework?
   - Yourself alone (2)
   - Yourself and someone else (1)
   - Someone else (0)
   **Score:**

4. Who usually cares for the children in your home?
   - Yourself alone (2)
   - Yourself and someone else (1)
   - Someone else (0)
   **Score:**

5. Who usually plans social arrangements such as get-togethers with family and friends?
   - Yourself alone (2)
   - Yourself and someone else (1)
   - Someone else (0)
   **Score:**

**Home Integration Total Score:** Add the above scores together.

**Social Integration**

6. How often do you travel outside the home?
   - Almost every day (2)
   - Almost every week (1)
   - Less than once per week (0)
   **Score:**

7. How often do you participate in leisure activities do you usually do this alone or with others?
   - Mostly alone (6)
   - Mostly with friends who have head injuries (1)
   - Mostly with family members (1)
   - Mostly with friends who do not have head injuries (2)
   - With a combination of family and friends (0)
   **Score:**

8. Do you have a best friend with whom you confide?
   - Yes (2)
   - No (0)
   **Score:**

**Social Integration Total Score:** Add the above scores together.

**Integration into Productive Activities**

9. Full-time employment (>20 hours/week)
   **Score:**

10. Part-time employment (≤20 hours/week)
    **Score:**

11. Not working, looking for work
    **Score:**

12. Not working, not looking for work
    **Score:**

13. Volunteer job in the community
    **Score:**

14. If the patient is retired due to age, use item 15 to score the JOBSCHOOL variable
    5 or more scores 4 points
    1 – 4 times scores 2 points
    Never scores 0 points
    **Summing Scores:**

The productivity score = item 12 score + JobSchool variable
The total CIO score = Home integration score + social integration score + productivity score
Coping
Self-Efficacy Scale

When things aren't going well for you, or when you're having problems, how confident or certain are you that you can do the following:

<table>
<thead>
<tr>
<th>Cannot do at all</th>
<th>Moderately certain can do</th>
<th>Certain can do</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>10</td>
<td></td>
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</tbody>
</table>

For each of the following items, write a number from 0 - 10, using the scale above.

1. Keep from getting down in the dumps. ........................................... 99
2. Talk positively to yourself. ......................................................... 99
3. Sort out what can be changed, and what cannot be changed. .............. 99
4. Get emotional support from friends and family. .............................. 99
5. Find solutions to your most difficult problems. ............................... 99
6. Break an upsetting problem down into smaller parts. ......................... 99
7. Leave options open when things get stressful. .................................. 99
8. Make a plan of action and follow it when confronted with a problem. .... 99
9. Develop new hobbies or recreations. ................................................ 99
10. Take your mind off unpleasant thoughts. ......................................... 99
11. Look for something good in a negative situation. .............................. 99
12. Keep from feeling sad. ................................................................. 99
13. See things from the other person's point of view during a heated argument. 99
14. Try other solutions to your problems if your first solutions don't work. . 99
15. Stop yourself from being upset by unpleasant thoughts. ................. 99
16. Make new friends. ......................................................................... 99
17. Get friends to help you with the things you need. ............................. 99
18. Do something positive for yourself when you are feeling discouraged. ... 99
19. Make unpleasant thoughts go away. ................................................ 99
20. Think about one part of the problem at a time. ................................ 99
21. Visualize a pleasant activity or place. .............................................. 99
22. Keep yourself from feeling lonely. .................................................. 99
23. Pray or meditate. ........................................................................... 99
24. Get emotional support from community organizations or resources. .... 99
25. Stand your ground and fight for what you want. ............................... 99
26. Resist the impulse to act hastily when under pressure. ...................... 99
### Self-reported and performance-based outcome measures for 3 Houghton Scale ability categories

<table>
<thead>
<tr>
<th>Outcome Measures</th>
<th>Independent Community</th>
<th>Limited Community Household</th>
<th>Limited Household</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Houghton Scale</strong></td>
<td></td>
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<tr>
<td><strong>TUG Test (s)</strong></td>
<td></td>
<td></td>
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<tr>
<td><strong>2MWT (m)</strong></td>
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<td></td>
<td></td>
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<tr>
<td><strong>Walking speed</strong></td>
<td></td>
<td></td>
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<tr>
<td>(m/s)*</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Walking speed range</td>
<td></td>
<td></td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>(m/s)</td>
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</tbody>
</table>

**NOTE:** Values are mean SD or as otherwise indicated. All ability categories were significantly different from each other for all outcome measures.

**Abbreviations:**
- PEQ-MA = Prosthetic Evaluation Questionnaire mobility subscale
- 3-BBS = total sum score of 3 BBS items

*Calculated from the 2MWT distance*
Functional Level Assessment: Socket Comfort Score

- Ask patient to rate the comfort of their socket on a 0 - 10 scale where 0 and 10 represented the most uncomfortable and the most comfortable socket imaginable.
Clinical Presentation

- Prosthetic History
- Limb Length
- Limb Condition
- ROM/MMT
- Cognitive ability to manage new technology
Clinical Presentation: Prosthetic History

- Cause of amputation
- How long since amputation
- What suspension system has the patient used
- What type of components has the patient used
- Has patient attended PT
Clinical Presentation: Limb Length

- Component and suspension/selection based on limb length

<table>
<thead>
<tr>
<th>Limb Length</th>
<th>Benefits</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short</td>
<td>No limit on build heights of components</td>
<td>Decreased muscles strength, Decreased lever arm Increased energy expenditure required</td>
</tr>
<tr>
<td>Long</td>
<td>Less energy expenditure, more control, and leverage</td>
<td>Limitations due to build heights of components</td>
</tr>
</tbody>
</table>
Clinical Presentation: Limb Condition

- Skin Grafts
- Nueromas
- Pain
- Distal padding
- Soft tissue
- Shape - bulbous, cylindrical, conical
- Adhesion
Clinical Presentation: ROM/MMT

- Contractures
  - Transfemoral - Hip Flexion, Hip Abduction
  - Transtibial - Knee flexion

- Strength
  - Include upper extremity/dexterity
Clinical Presentation: Cognition

- Ability to understand suspension systems
- Ability to manage new technology
  - Charging and battery, etc.
- “Gadget Tolerance”
Suspension Systems

- Suction
  - Skin fit
  - Sleeve
  - Seal-in Liner
- Pelvic Band/Hip Joint
- Pin Lock
- KISS/Strap
- BOA
- Magnet
- Elevated Vacuum
  - Manual/Electric
Suspension Systems: Suction

- Skin Fit - mature limb, stable volume, sound skin integrity, patient didn’t tolerate liner

- Sleeve - One way expulsion valve, mature limb, sound hand dexterity, mostly BKA

- Seal-in liner - Liner serves as seal, mature limb, stable volume, more room for components
Suspension Systems: Pelvic Band/Hip joint

- Short limb
- Proximal instability/weakness
- Difficulty with donning
Suspension Systems: Pin Lock

- Distal suspension
- Poor hand dexterity
- Sound skin integrity/distal soft tissue
- Easy to don with practice - must align pin
Suspension Systems: KISS/Strap

- Distal suspension
- Easy to don but requires hand dexterity
- Can don sitting down and then stand to adjust
Suspension Systems: BOA

- Fluctuating volume throughout the day
- Gadget friendly user
- Reduces need for socks
Suspension Systems: Elevated Vacuum

- Controls volume and reduces fluctuations, enhances suspension, promotes skin and limb health
- Electronic pump or manual pump (vacuum pulled from heel compression)
Component Selection

- Transtibial
  - Foot selection
- Transfemoral
  - Knee selection
- Activity Specific
Components: Foot Selection

- K1 - SACH
- K2 - Non Carbon Fiber/Dynamic Response, Flexible Keel
- K3 - Dynamic Response, Shock Absorber, Torque Adaptor
- K4 - Dynamic Response, Shock Absorber, Torque Adaptor

- Non K-Level specific (K2-K4) - Adjustable heel height, hydraulic ankle, multiaxial feature
Components:
K1 Foot

- SACH - Solid Ankle Cushioned Heel
- Stable
- Only allows DF/PF
- Durable
Components:
K2 Foot

- Flexible Keel
- Multi or Single Axis
- NO carbon fiber!
Components: K3/K4 Feet

- ESAR - Energy Storing and Return
- Can have torsion/shock adaptors
- Typically carbon fiber
Components:
Activity Specific Feet, other features
Components: Knee Selection

- Terminology
  - Axis - Single Axis, Multi Axis, Polycentric (4 bar, 7 bar linkages)
  - Control - Constant friction, Hydraulic, Pneumatic, Microprocessor
- Other Features:
  - Stance Flexion, Extension Assist, Manual Lock
Components: Knee Selection

- **K1** - Single/Multi Axis, Constant Friction
  - Common to have manual lock feature
- **K2** - Single/Multi Axis, Constant Friction
  - Extension Assist/Stance Flexion
- **K3 & K4** - Single/Multi Axis, Hydraulic, Pneumatic, Microprocessor
Components:
K1 Knee

- K1 - Single/Multi Axis, Constant Friction
  - Common to have manual lock feature
  - Used for transfers/short distance ambulating within the house
Components: K2 Knee

- K2 - Single/Multi Axis, Constant Friction
  - Extension Assist/Stance Flexion
  - No hydraulics or microprocessor control
Components: K3/K4 Knees

- K3/K4 - Single/Multi Axis, Hydraulic, Pneumatic, Microprocessor
- K4 - high activity frames are covered
  - Water resistant vs submersible
Components:
Other

- Transfemoral
  - Rotation Adaptor - Assist in ADLs (dressing), getting into and out of car
    - Requires a shorter limb length for space
Insurance Justifications for Componentry

- K3/K4 level feet and knees
- Activity specific components
- “Medical Necessity”
**Prosthetic Assessment Form**

![Prosthetic Assessment Form](image-url)
Questions?

Image references

- http://www.ottobock.co.uk/prosthetics/lower_limb_prosthetics/prosthetic-product-systems/genium_x3-prosthetic-leg/
- Oandp.com
- https://www.clickmedical.co/store/revofit/revo/
- https://twitter.com/RegalProsthesis
- https://www.ossur.co.uk/prosthetic-solutions/products/dynamic-solutions/proprio-foot
- https://www.freedom-innovations.com/category/feet/