An evidence-based guide to
Quantifying Fall Risk in Persons with
Lower Extremity Amputation(s)

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Objectives:
Upon completing this educational module the participant will:

– Describe the prevalence and significance of falls in lower extremity (LE) amputees
– Identify situations and circumstances most likely to cause or result in falls
– Describe functional performance measures to identify fall risk in this population
– Identify interventions to minimize falls and fall related injury in this population

Intended Audience

• The intended audience for this educational module includes clinicians and researchers involved in the rehabilitation of persons with lower extremity amputation(s).

• Authors believe the information will have particular relevance for members of specialized fall clinics or researchers conducting clinical trials that utilize falls as an outcome measure.
Module Flow Chart

Functional Performance Measures related to Fall Risk Assessment

Intervention

- Neurocom
  - Five Time Sit to Stand Test
  - Four Square Step Test
- Timed Up and Go Test
  - E up & Go
  - L Test of Function
- 180 Degrees Turn Test
- Single Limb Balance Test
- Functional Reach Test
  - Multidirectional Reach Test
- Gait Speed, Velocity
- Recall of Stumbles & Falls
- Prosthesis Evaluation Questionnaire-Addendum (PEQ-A)

Background & Significance

- There are ≈ 1.8 Million persons in the U.S. living with loss of a limb
  - This is ≈ 1 in 190 Americans
  - This number is expected to double by the year 2050.
  - The annual cost of providing care for this group of individuals on an acute and subacute basis is ≈ $4 Billion annually.
  - The majority of this group is:
    - Male
    - Elderly
    - have loss of the lower extremity due to vascular disease
    - many are veterans.

- Lower extremity amputation, regardless of etiology, is known to compromise:
  - Gait
  - Balance
  - Stability
  - Reaction to slip/fall events
  - Common comorbidities include:
    - Advanced age
    - Neuropathy of the sound side/intact limb (assuming unilateral)
    - High probability of eventual foot ulceration and/or amputation of the sound side/intact limb
    - Presbyopia and/or retinopathy

  When a limb is lost to vascular disease, numerous comorbidities and risk factors are in place further increasing the likelihood of falls in this unique population.
Background & Significance

- Falling is pervasive in persons with LE amputation.\(^1\)\(^3\)\(^9\) Falling is pervasive in persons with LE amputation.\(^2\)\(^8\)
  - \(\approx 20\%\) of LE amputees will likely fall while in the “inpatient” rehabilitation setting
    - \(\approx 18\%\) of these, will experience an injury associated with the fall
  - \(\approx 1/3\) of LE amputees will have complications associated with a fall while undergoing inpatient rehabilitation
  - The majority of falls occurred during wheelchair use:
    - Self-transfers
    - Reaching
    - Authors indicated that poor balance played a role

Background & Significance

- Risk factors associated with increased risk of falling while admitted for “inpatient rehabilitation”:\(^3\)\(^5\)\(^9\)
  - Age of > 71 yrs
  - Length of stay b/t 22-35 days
  - 4 or more comorbidities
  - Cognitive impairment
  - 2 or more as needed medications
  - Use of benzodiazepines or opiates

- Risk factors associated with fall related injury:
  - Bilateral amputation
  - Fall during the day shift

- Additional considerations:
  - Extrinsic factors (e.g. spills, obstructions, pets)
  - Intrinsic factors (poor vision, poor muscular strength, poor motor control, poor reaction strategy)

Background & Significance

- Amputees ambulating at an unlimited community level continue to suffer several falls per month.\(^6\)\(^10\)\(^11\)

**MFCL Functional Description**

<table>
<thead>
<tr>
<th>Level</th>
<th>Functional Description</th>
<th>Prosthetic Feet</th>
<th>Prosthetic Knees</th>
</tr>
</thead>
<tbody>
<tr>
<td>K0</td>
<td>Non-ambulatory. Not a candidate for a prosthesis.</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>K1</td>
<td>Limited and unlimited household ambulation. Level surfaces. Fixed cadence. Transfers and therapeutic use.</td>
<td>Basic Feet: External Keel, SACH, Single Axis</td>
<td>Basic Knees: Knee Flex, 2-Stage Knee, Static Knee</td>
</tr>
<tr>
<td>K2</td>
<td>Limited community ambulation. Able to traverse low-level environmental barriers (curbs, ramps, stairs, uneven surfaces).</td>
<td>Multi-axial feet, Flexible Keel feet, Axial rotation (ankle) unit</td>
<td>All Knees</td>
</tr>
<tr>
<td>K3</td>
<td>Community ambulation. Variable cadence gait (or potential). Most environmental barriers.</td>
<td>Dynamic response feet</td>
<td>Fluid &amp; Pneumatic knees</td>
</tr>
</tbody>
</table>
Background & Significance

- Several physical rehabilitation strategies, assessment tools and interventions are described in the literature to identify and ameliorate the incidence and complications associated with falling and mortality in this group.\(^9,12,13\)

- They range from:
  - very global strategies to maximize functional recovery and optimize coordination of care
    - i.e. post-operative discharge destination
    - persons admitted to "inpatient rehabilitation" immediately following "acute care" have a significantly higher survivability one year post-amputation than those individuals discharged to either skilled nursing facilities or home.
    - Unfortunately, it is reported that "inpatient rehabilitation" is insufficiently utilized following amputation secondary to vascular disease.
  - to very specific, individualized interventions
    - i.e. use a stump protector while in "inpatient rehabilitation".
    - i.e. use of a chair alarm wheelchair skills training or patient education to prevent falls from wheelchair during self transfer.

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Functional Performance Measures related to Fall Risk Assessment

Please Note:

1. This is not an exhaustive list.
2. The majority of these assessments have not been validated in the amputee population. However, they are widely used in practice despite their lack of a robust evidentiary basis.

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Please Note:

- Use of these assessments and interventions should be conducted by a trained and appropriately credentialed professional.
- Important considerations include sound clinical judgment, proper safety equipment and an appropriate skill level of the patient.
- For instance, comorbidities that degrade stability and increase fall risk should all be considered in advance of selecting an appropriate fall risk assessment and/or intervention.
Functional Performance Measures related to Fall Risk Assessment

- The following tools will be reviewed:
  - Neurocom
  - Five Time Sit to Stand Test
  - Chair Stand Test
  - Four Square Step Test
  - Timed Up and Go Test
  - 8 Up & Go
  - L Test of Function
  - 180 Degrees Turn Test
  - Single Limb Balance Test
  - Functional Reach Test
  - MultiDirectional Reach Test
  - Gait Speed, Velocity
  - Prosthesis Evaluation Questionnaires: Addendum (PEQ-A)
  - Recall of Stumbles & Falls

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**Neurocom**

**Purpose:** Evaluate the contribution of sensory inputs and motor control in balance.

**Reference Values:**
- Non-Amputee: n/a
- Amputee: n/a


**Limitations:**
- Expensive equipment. Time consuming to administer evaluation. Specialized training required.

**Benefits:**
- Considered the Gold Standard for Balance Assessment.
- In non-amputees, able to differentiate between sensory and motor impairments contributing to balance deficits.

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**Procedure:**
- Patient stands on a moveable dual force platform while harnessed for safety.
- Depending on the selected test, the visual surround and/or forceplate(s) move.
- Forceplate accurately measures movement of the Center of Gravity.
5 times sit to stand test

<table>
<thead>
<tr>
<th>Purpose</th>
<th>To measure the amount of time required to rise from a chair 5 times. Evaluates lower extremity strength, power, endurance and center of gravity control.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Values: Non-Amputee</td>
<td>For non-amputees, normative values are available for the following age ranges: 11.4 sec. (60 to 69 years); 12.6 sec. (70 to 79 years); 14.8 sec. (80 to 89 years). Increased risk for falls in community dwelling elderly if unable to rise from a chair without arm use.</td>
</tr>
<tr>
<td>Reference Values: Amputee</td>
<td>N/A</td>
</tr>
<tr>
<td>Limitations</td>
<td>Potential for compensatory strategies (i.e. un-weight prosthetic limb during task). Some patients are unable to stand five times.</td>
</tr>
<tr>
<td>Benefits</td>
<td>Negligible time, negligible equipment, minimal space requirement.</td>
</tr>
</tbody>
</table>

Procedure:
- Patient sits on a standard height chair with their arms crossed over their chest.
- Therapist times how long it takes for the patient to perform the task of sit to stand task five times.
- Time begins when therapist vocalizes the “go” instruction and stops when patient returns to a sitting position following his fifth repetition.

Chair Stand Test

<table>
<thead>
<tr>
<th>Purpose</th>
<th>To measure the number of repetitions of the sit to stand task a patient can perform in 30 seconds. Evaluates lower extremity strength, power, endurance and center of gravity control.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Values: Non-Amputee</td>
<td>N/A for fall risk. Increased risk for falls in community dwelling elderly if unable to rise from a chair without arm use.</td>
</tr>
<tr>
<td>Reference Values: Amputee</td>
<td>N/A</td>
</tr>
<tr>
<td>Limitations</td>
<td>Potential for compensatory strategies (i.e. un-weight prosthetic limb during task).</td>
</tr>
<tr>
<td>Benefits</td>
<td>Preferable for patients who are only able to perform minimal repetitions. Minimal space requirement, minimal equipment and minimal time.</td>
</tr>
</tbody>
</table>
Chair Stand Test

**Procedure:**
- Patient sits on a standard height chair with their arms crossed over their chest.
- Participant is instructed to rise to a full stand and return back to a fully seated position after the signal "go!" is given.
- The score is the total number of stands executed correctly within 30 seconds. If executed correctly within 30 seconds, if the patient is more than half way up at the end of 30 seconds, it is counted as a full stand.

Four square step test

**Purpose:**
To assess the patient's ability to step over low lying objects, rapidly transfer weight from one leg to another and change directions in a coordinated manner.

**Reference Values:**
- **Non-Amputee:**
  - > 15 seconds indicates an increased risk for falls in community dwelling older adults.
- **Amputee:**
  - > 24 seconds identifies multiple fallers in unilateral transtibial amputees.

**Selected References**
- Dite W. Arch Phys Med Rehabil. 2002.16

**Limitations:**
Not validated beyond unilateral transtibial amputee involvement.

**Benefits:**
- Patient can use preferred walking aid.
- Incorporates more complex, high level stepping movements and direction changes.
- Minimal space requirement, equipment and time.

**Procedure:**
- Square formed with 4 canes on floor.
- Patient instructed to step forward, right, backward and left then return to starting square.
- Timing starts at first foot contact with floor in square 2 and ends with last foot contact in square 1.
- Patient can use preferred walking aid.

Start time
End time
Timed Up and Go (TUG) Test

Purpose
To test functional mobility. Specifically, TUG measures a patient’s ability to stand up, walk 10 ft, perform a 180-degree turn and return to the start position.

Reference Values:
Non-Amputee
> 13.5 seconds identifies increased risk for falls in community dwelling older adults.
> 30 sec indicate probable difficulties performing ADLs.

Amputee
> 19 sec identifies multiple fallers in unilateral transtibial amputees.

Selected References

Limitations
Not validated beyond unilateral transtibial amputee involvement.
Task may be too simple for higher level patients.

Benefits
Allows for analysis of a combination of functional tasks (transfers, turning, ambulation).
Minimal space requirement, equipment and time.
Patient can use preferred walking aid.

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Timed up and go (TUG) test

Procedures:
• Patient is asked to stand up, walk to a line placed on the floor 10 feet away, turn around and return to the original seated starting position.
• Patient is requested to perform task at comfortable walking speed.
• Time begins when the "go" signal is verbally given.
• Time is stopped once the patient has returned to a seated position.
• Use of preferred walking aid is permitted.

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8 ft Up and Go Test

Purpose
To test functional mobility. Specifically to measure patient’s ability to stand up, walk around a cone located 8 feet away and return to the start position.

Reference Values:
Non-Amputee
> 8.5 seconds identifies increased risk for falls in community dwelling older adults.

Amputee
N/A

Selected References

Limitations
Not validated in the amputee population.
Task may be too simple for higher level patients.

Benefits
- Allows for analysis of a combination of functional tasks (transfers, turning, ambulation).
- Minimal space requirement, equipment and time.
- Patient can use preferred walking aid.
- Cone provides a strong visual turning cue for patients.
- Requires less space to perform compared to the Timed Up and Go (TUG) Test.
8 ft Up and Go Test

**Procedures:**
- Patient is asked to stand up, walk around a cone placed on the floor 8 feet away and return to the original seated starting position.
- Patient is requested to perform task as quickly as possible.
- Time begins when the “go” signal is verbally given by the therapist.
- Time is stopped once the patient has returned to a seated position.
- Use of habitual walking device is permitted.

L Test of Functional Mobility

**Modification of the TUG for persons with LE amputation**

**Purpose:** To test functional mobility. Specifically measures an amputee’s ability to perform two transfers and four turns over a total distance of 20 meters.

**Reference Values:**
- **Non-Amputee:** N/A
- **Amputee:**
  - Transtibial Amputees: 29.5 (± 12.8) sec
  - Transfemoral Amputees: 41.7 (± 16.8) sec

**Selected References:**
- Deathe AB. Phys Ther. 2005.20

**Limitations:** Requires more space than TUG.

**Benefits:**
- More complex than the TUG test; requires different types of turns (90 and 180 degree turns) in different directions.
- Patient can use preferred walking aid.
- Cone provides a strong visual turning cue for patients.
- Minimal equipment and time requirements.

**L Test of Functional Mobility**

**Modification of the TUG for persons with LE amputation**

**Procedures:**
- Patient is asked to stand up, walk 3 meters, turn left around a cone placed on the floor, walk 7 meters, turn around cone and return along the same path finishing in the original seated starting position.
- Patient is requested to perform task at comfortable walking speed.
- Time begins when the “go” signal is verbally given by the therapist. Time is stopped once the patient has returned to a seated position.
- Use of habitual walking device is permitted.
180 degrees turn test

**Purpose**
To objectively quantify, by step count or time, the common, yet often problematic mobility task of turning around.

**Reference Values:**
- **Non-Amputee**
  - Turn steps > 5 steps

- **Amputee**
  - Unilateral Transtibial Amputees:
    - Turn time of > 3.7 seconds
    - Turn steps > 6 steps

**Selected References**

**Limitations**
- Not validated beyond unilateral transtibial amputee involvement.
- Methods vary in literature. Recommend measuring performance in both directions.
- Only evaluates a single task.
- Challenging to guard patient without influencing outcome. Consider a harness.

**Benefits**
- Specifically evaluates ability to turn around.
- Patient can use preferred walking aid.
- Minimal space requirement, equipment and time.

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Single Limb Stance Test

**Purpose**
To quantify the amount of time an individual can stand on 1 foot.

**Reference Values:**
- **Non-Amputee**
  - Single Limb stance time of < 30s is associated with an elevated fall risk in older, community dwelling adults.

- **Amputee**
  - N/A

**Selected References**

**Limitations**
- Performance may be dependent upon componentry in patients with amputation.

**Benefits**
- Higher level balance test
- Minimal space requirement, equipment and time.

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180 degrees turn test

**Procedures:**
- Patient is positioned in standing in an uncluttered space.
- Patient instructed to turn 180 degrees towards the sound limb.
- Test repeated turning towards the involved limb.
- Record turning time and/or number of steps.
Single Limb Stance test

Procedures:
• Patient is asked to cross arms over chest (or clasp hands) and lift one foot off the floor.
• Timing is initiated when foot is lifted off the floor and stops when any portion of the foot touches the floor.
• Testing is performed on each leg and recorded separately.

Safety:
• Parallel bars
• Gait Belt

Test sound & amputated sides

Functional Reach Test

Purpose
To examine a commonly performed functional task. Specifically, to objectively measure an individual’s maximal ability to voluntarily reach forward without moving their feet.

Reference Values:

<table>
<thead>
<tr>
<th>Non-Amputee</th>
<th>Reach &lt;10 inches: 2x more likely to become a recurrent faller*</th>
<th>Reach &lt;6 inches: 4x more likely to become a recurrent faller*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amputee</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Selected References

Limitations
• Permits compensation via abnormal trunk motions.
• Test score not standardized for patient height.
• Voluntary reaching performance may be confounded by other variables including fear of falling and back pain.

Benefits
• Minimal space requirement and time.
• Measures a commonly performed functional task.

* Recurrent faller is classified as 2 or more falls in a 6 month period.

Functional Reach Test

Procedure:
• Place a yardstick on the wall at the level of the patient’s acromion process.
• Instruct the patient to reach as far as possible in the forward direction without losing balance or moving feet.
• Score recorded is the difference between ending and starting distance reached as measured by the position of the index finger.
• Two trials are permitted.
• Patient’s feet must remain flat on the floor at all times. Trunk rotation and other extraneous movements are permitted but should be noted.
Multi-Directional Reach Test

**Purpose**
To objectively measure an individual's maximal ability to voluntarily reach forward, backwards, to the left and to the right without moving their feet.

**Reference Values:**
- **Non-Amputee**: N/A
- **Amputee**: N/A

**Selected References**

**Limitations**
- Test scores not standardized by patient height
- Voluntarily reaching performance may be confounded by other variables including fear of falling and back pain.
- Permits compensation via abnormal trunk motions.

**Benefits**
- Test is a portable, valid measure of limits of stability
- Minimal space requirement and time

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**Procedure:**
- Place a yardstick on an IV pole, tripod or back of a rolling mirror at the level of the patient's acromion process.
- Position yard stick level to the floor.
- Instruct the patient to reach as far as possible in the forward direction without losing balance or moving feet.
- Score recorded is the difference between ending and starting distance reached as measured by the position of the index finger.
- Repeat procedure in backwards and sideways directions.
- Two trials are permitted in each direction.
- Patient's feet must remain flat on the floor at all times. Trunk rotation and other extraneous movements are permitted but should be noted and accounted for in interpretation of the results.

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Gait Speed, Velocity

**Purpose**
To objectively measure the speed a patient walks over a given distance. Measure is often used to describe mobility status or monitor functional change over time.

**Reference Values:**
- **Non-Amputee**: < 0.56 m/s for risk of recurrent falls
- **Amputee**: No known reference values to identify fall risk.

**Selected References**

**Limitations**
- Potentially space depending on distance used
- Patient's feet must remain flat on the floor at all times. Trunk rotation and other extraneous movements are permitted but should be noted and accounted for in interpretation of the results.

**Benefits**
- Commonly used outcome measure
- Minimal equipment and time
- Patient can use preferred walking aid
Gait Speed, Velocity

Procedures:
- Time is recorded as a patient walks a known distance.
- Many different distances have been used in the literature (e.g. 8ft, 15ft, 50ft, 75m).
- Gait speed determined via simple calculations.
- Pt allowed to use habitual walking device.
- Test generally performed at habitual/self-selected walking speed however may also perform test at maximal speed to assess ability to adjust speed (functional significance).
- Accommodate for patient acceleration and deceleration by demarcating 3 ft on either side of the distance to be timed.

Distance/Time:
- Clinical measures (commonly) = feet/second
- Literature (commonly) = m (or cm)/second
- So, convert:
  1 foot = 30.48 cm or .3048 m

Example: 15 feet / 5 sec
15 feet x .3048 m = 4.57 m
4.57 m / 5 sec = .914 m/s

Prosthesis Evaluation Questionnaire-A
(PEQ-A)

**Purpose:**
To establish thru patient recall via a survey instrument, the estimated number of stumbles, semi-controlled and uncontrolled fall events experienced within a given time frame.

**Reference Values:**
- Non-Amputee
  - N/A: Amputee instrument.

- Amputee
  - Stumbles (Range): Frequency 66-83, Number 3.1-5.7
  - Semi-controlled Falls (Range): Frequency 91-95, Number 0.4-3.2
  - Uncontrolled Falls (Range): Frequency 89-98, Number 0.2-0.7

**Selected References:**

**Limitations:**
- Not all items are related to stumbles and falls
- Requires literacy

**Benefits:**
- Brief, written instrument
- Reference values available in the literature

Prosthesis Evaluation Questionnaire-A
(PEQ-A)

**Procedure:**
- Patients complete the 14 items below.
  - Items B, C and D are visual analogue items
  - Items B1, C1 and D1 are open ended items.
Recall of Stumbles and Falls

**Purpose**
To establish thru patient recall the estimated number of stumbles and/or falls experienced within a given time frame.

**Reference Values:**
Descriptive studies report that over 33% of individuals over the age of 65 fall at least once in a 12 month period. This number increases with age and co-morbidities.29,30

**Reference Values: Amputee**
Descriptive studies report that ≈ 52% of lower extremity amputees fall at least once in a 12 month period of time.7 Transfemoral amputees fall 1-3 times in a 60 day period depending on type of prosthetic knee.6

**Selected References**

**Limitations**
- Patient recall
- Misunderstanding of the definition of a stumble vs. fall vs. general instability

**Benefits**
- Not a surrogate measure. Directly measures outcome of interest.

Recall of Stumbles & Falls

**Procedure**
- Options to query the number of stumbles and falls include:
  - Calendar marking
  - Journaling
  - Questioning the number of stumbles/falls in a given time
- Methods for questioning number of stumbles/falls in a given time
  - Over how long of a period are you asking the patient to recall?
    - Less than 3 months is ideal
    - Less than 12 months maintains some level of validity/reliability assuming stable cognition
    - A different assessment should be used beyond 12 months of recall
- Be sure the patient knows exactly what you are asking them to recall
  - Define and clarify the difference between a stumble and a fall:
    - A stumble is an event in which you thought you were actually going to fall to the ground or a lower level but did not
    - A fall is an event in which you unintentionally lose balance and/or stability and landed on the ground or lower level

Activity-specific Balance Confidence Scale (ABC)

**Purpose**
To objectively assess self-perceived balance confidence. Specifically, this 16-item questionnaire assesses patient balance confidence in performing various mobility related functional tasks.

**Reference Values: Non-Amputee**
Maximum score=100 with higher scores indicating increased balance confidence. Scores >80 generally indicate high functioning, active older adults.

**Reference Values: Amputee**
Mean score for 245 community-dwelling, unilateral amputees was 63.8. Further analysis revealed mean of 54.1 for vascular amputees and 74.7 for traumatic amputees

**Selected References**

**Limitations**
- Includes questions regarding confidence/perceived ability to walk on icy sidewalks which may not be applicable in all regions.

**Benefits**
- Describes activities (i.e. reaching) in a task-specific, easy to understand manner.
- Good reliability shown in patients with amputation.
- Good construct validity with TUG test and 2 minute walk test in patients with amputation.
Functional Performance Measures related to Fall Risk Assessment

**Advantages:**
- Repeated Measures of a patient over time to monitor change
- Reference values available for select fall risk assessments in the literature
- Objective & Quantifiable

**Limitations:**
- Many are not validated in this population
- Lack of cut points for fall risk in this population
- Reference values are not available for all levels of amputation

Evidence-Based Intervention

- This section provides a glimpse of evidence-based interventions
- It is not exhaustive as certainly, other interventions exist but currently their efficacy has not been determined scientifically.

Intervention

- In 1997, only 12-16% of those with lower extremity amputation secondary to vascular disease were discharged to an inpatient setting for rehabilitation
  - Regional differences
    - Maryland had 12%
    - Massachusetts had 16%
- Therefore, rehabilitation and fall prevention spans multiple different healthcare settings (e.g. inpatient, outpatient, home therapy, long term care)
Intervention

- Multidisciplinary approach
  - Environmental assessment of patient’s room
  - Evaluation/modification of medications
  - Wheelchair skills training program

Remember these...

Intervention

- 89% of amputees were discharged from rehabilitation with prosthesis when they received:
  - An average of 16.4 therapy sessions (5 to 47 ± 7.7)
    - Assistive devices (AD) in the following progression:
      - Parallel bars
      - Four-footed walkers
      - Two-wheeled walkers
      - Two canes
      - Four-wheeled walkers
      - Two crutches
      - One cane
  - The mean number of AD’s used was 2.9 ± 1.0

Intervention

- Falling affects amputees during
  - Transfer
  - Ambulation

Thus, a balance training program in addition to fitting the patient with a prosthesis was recommended:
  - 20 min balance training per day x 5 days
    - Balance ReTrainer

As a result of the program, the following improved:
  - Standing tolerance
  - TUG
  - Walking speed

No indication if falls decreased
Intervention

- Interventions to consider during inpatient rehabilitation:\(^1\)
  1. Patient education
  2. Environmental modification
  3. Stump protector
  4. Wheelchair skills training

- These interventions:
  - **Did not** reduce the number of falls
  - **Did** reduce the number of falls that resulted in injuries

As indicated by Miller et al\(^3\), the following are areas related to decreased balance confidence in community dwelling unilaterally involved LE amputees:
- Mobility device use
- Need to concentrate while walking
- Limitations in ADL
- Depression
- Fear of falling

The majority of these areas can be addressed in physical rehabilitation

In anticipation of a slip and fall event, J Yang et al\(^3\) indicate that training the following muscles:
- Transversus Abdominus & Erector Spinae
- Rectus Femoris & Biceps Femoris
- Gluteus Maximus & Gluteus Medius

Could provide the following benefits:
- Slip event detection, prevention and control of falls
- The most crucial muscle in these roles seems to be the Gluteus Maximus
References

Additional General References