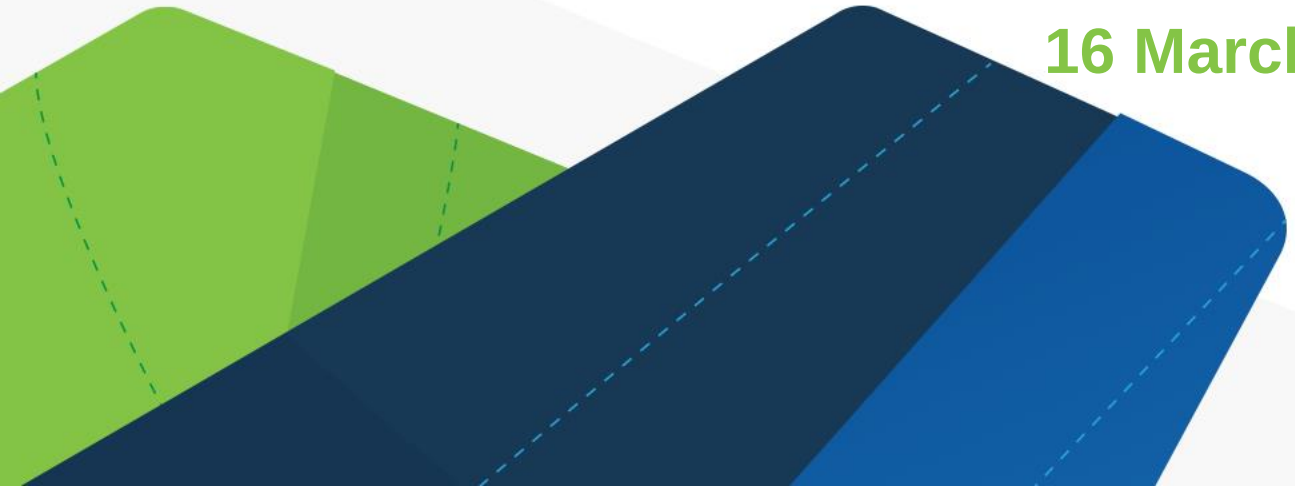
Outcome Measures for Adults with Lower and Upper Limb Amputation

Medical Aids Subsidy Scheme

16 March 2023



Queensland Government

Learning objectives

1. Be aware of a range of valid, reliable, quick and free/low cost outcome measures for adults with lower or upper limb amputation
2. Understand the use of outcome measures in the clinical justification of non-standard prosthetic componentry
3. Understand the use of outcome measures in justifying the need for non-prosthetic assistive technology (e.g., mobility aids)
4. Utilise outcome measures to identify priorities and measure service outcomes

Recap of terms

- **Validity:** Does it measure what it says it measures? Does it measure it well for this population (e.g., people with amputations)?
- **Reliability:** Do we get the same consistent results when: two assessors assess the same person, and; an assessor repeats the assessment with the same person?
- **Sensitivity & specificity:** How well does it classify / predict something accurately
- **Minimal Clinically Important Difference (MCID):** Smallest benefit of value to clients
- **Minimal Detectable Change:** Smallest change we can detect not due to normal error
- **Utility:** How easy and realistic is it to use this in everyday practice?

What's important in an outcome measure?

- Quick & efficient[1]
- Basic measurement equipment[1]
- Suitable to small spaces[1]
- < 10 mins for self-report measures[2]
- < 30 mins for performance based tests[1]
- Likely to be used[3]

1.Morgan, S., Balkman, G.S., Gaunaurd, I.A., Kristal, A., Amtmann, D., & Hafner, B.J. (2022a). Clinical resources for assessing mobility of people with lower-limb amputation: interviews with rehabilitation clinicians. Journal of Prosthetics & Orthotics, 34(2), 69-78. Doi: 10.1097/JPO.0000000000000345

2.Morgan, S., Rowe, K., Fitting, C.C., Gaunaurd, I.A., Kristal, A., Balkman, G.S., Salen, R., Bamer, A.M., & Hafner, B.J. (2022b). Use of standardized outcome measures for people with lower limb amputation: a survey of prosthetic practitioners in the United States. Archives of Physical Medicine & Rehabilitation, 103(9), 1786-1797.

3.Ostler, C., Scott, H., Sedki, I., Kheng, S., Donovan-Hall, M., Dickinson, A., & Metcalf, C. (2022). From outcome measurement to improving health outcomes after lower limb amputation – a narrative review exploring outcome measurement from a clinical practice perspective. Prosthetics & Orthotics International, 46(4), e341-350. doi: 10.1097/PXR.0000000000000100

Baseline measures required for QALS

Amputee Mobility Predictor Assessment Tool (AMPAT)

- AMPPRO (AMPAT conducted with prosthesis)
- AMPnoPRO (AMPAT) conduct with no prosthesis)

Measures for people with lower limb amputation

- Prosthetic Limb Users Survey of Mobility (PLUS-M)
- Timed Up and Go (TUG) Test / L Test
- 2MWT
- Four Square Step Test (FSST)
- Narrowing Beam Walking Test (NBWT)
- Activities Specific Balance Confidence Scale (ABC)
- Prosthetic Evaluation Questionnaire (PEQ)

Mobility

Balance

Prosthetic experience

1. Sions, J.M., Beisheim, E.H., & Seth, M. (2020). Selecting, administering, and interpreting outcome measures among adults with lower-limb loss: an update for clinicians. Current Physical Medicine & Rehabilitation Reports, 8, 92-109.
2. Condie, E., Scott, H., & Treweek, S. (2006). Lower limb prosthetic outcome measures: A review of the literature 1995 to 2005. Journal of Prosthetics & Orthotics, 18(6), 13-45.
3. Hafner, B.J., Morgan, S.J., Askew, R.L., & Salem, R. (2016). Psychometric evaluation of self-report outcome measures for prosthetic applications. Journal of Rehabilitation Research & Development, 53(6), 797-812. doi: 10.1682/JRRD.2015.12.0228
4. Yildiz, N.T., Kocaman, H., Yazıcıoğlu, F.G. (2021). Outcome measures used in lower extremity amputation: Review of clinical use and psychometric properties. Journal of Surgery & Medicine, 5(5), 00-00. doi: 10.28982/josam.789623

Measures for people with upper limb amputation

- Prosthetic Evaluation Questionnaire (PEQ)
- Revised Upper Extremity Functional Status module of the Orthotics and Prosthetics User Survey (OPUS)
- Capacity Assessment of Prosthesis Performance for the Upper Limb (CAPPFUL)

Prosthetic experience

Self-rated function

Observed function

1. Hafner, B.J., Morgan, S.J., Askew, R.L., & Salem, R. (2016). Psychometric evaluation of self-report outcome measures for prosthetic applications. Journal of Rehabilitation Research & Development, 53(6), 797-812. doi: 10.1682/JRRD.2015.12.0228
2. Wright, V. (2009). Prosthetic Outcome Measures for Use With Upper Limb Amputees: A Systematic Review of the Peer-Reviewed Literature, 1970 to 2009. Journal of Prosthetics and Orthotics, 21(9), 3-63. doi: 10.1097/JPO.0b013e3181ae9637

Amputee Mobility Predictor Assessment Tool (AMPAT) Link to full video – 10min25sec

K-Levels

K0: Does not have the ability to ambulate or transfer without assistance.

K1: Transfers or ambulation on level surfaces at fixed cadence. E.g., household ambulator.

K2: Ability to traverse low level environment barriers such as curbs, stairs or uneven surfaces. E.g., average community ambulator.

K3: 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 use beyond simple locomotion. E.g., child or active adult.

K4: Ambulation that exceeds basic ambulation skills, exhibiting high impact, stress or energy levels. E.g., regular athlete.

AMPAT

What does it measure?	Predicted mobility restriction while using prosthesis (K-Level)
How long does it take?	10-15mins
What do I need?	At least 2 x stairs with bilateral rails, 2 x chairs with arms, 4” high box (e.g., shoebox), 12” / 30cm ruler, assessment tool.
How is it conducted?	Administered by health professional (typically at amputee rehabilitation clinic)
Notes for interpretation	Moderate evidence that can be predictive of K-level[1] More accurate for K2 and K3[2] High interrater (0.99) and intrarater (0.96) reliability[3]

1. Kaluf, B. (2014). Evaluation of mobility in persons with limb loss using the amputee mobility predictor and the prosthesis evaluation questionnaire – mobility subscale: A six-month retrospective chart review. *Journal of Prosthetics & Orthotics, 26*(2), 70-76.
2. Dillon, M.P., et al. (2018). Predict the Medicare Functional Classification Level (K-level) using the Amputee Mobility Predictor in people with unilateral transfemoral and transtibial amputation: a pilot study. *Prosthetics & Orthotics International, 42*(2), 191-197.
3. Gailey, R.S., et al. (2002). The Amputee Mobility Predictor: an instrument to assess determinants of the lower limb amputee’s ability to ambulate. *Archives of Physical Medicine & Rehabilitation, 83*(5), 613-327.

Prosthetic Limb Users Survey of Mobility (PLUS-M) Link to full video – 4min41sec

Case study: Susan

Right transfemoral amputation due to MVA
Aged 43

Can (with her prosthesis):
- push a shopping cart with little difficulty
- walk across a parking lot with much difficulty

Can’t (without a wheelchair):
- keep up with others when walking
- move a chair to another room
- sweep the floor

Try to computerised PLUS-M

PLUS-M

What does it measure?	Client self-rated mobility on various surfaces
How long does it take?	< 5 mins CAT < 2 mins
What do I need?	Choose either; 7-question short form or 12-question short form or Computer administered test (CAT)
How is it conducted?	Can be administered by health professional or self-administer by client
Notes for interpretation	Can use results of individual questions Or norm-referenced overall results MDC(CAT) = 6.42 change in T-score[1] Test-retest reliability established[1]

1. Balk, E.M., et al. (2019). Psychometric properties of functional, ambulatory, and quality of life instruments in lower limb amputees: A systematic review. *Archives of Physical Medicine & Rehabilitation, 100*, 2354-70.

Timed Up and Go (TUG) Test Link to full video – 28sec

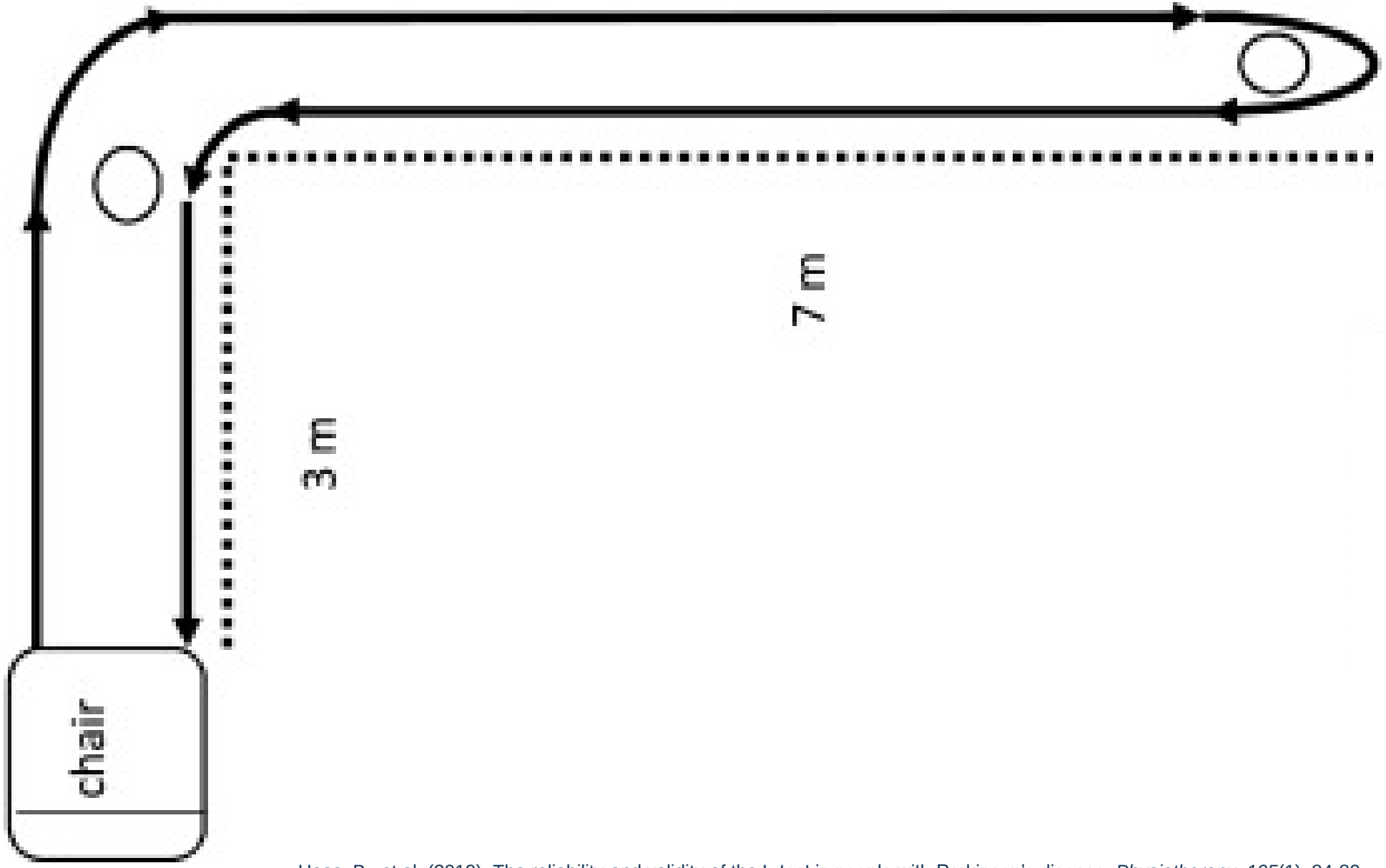
Timed Up and Go (TUG) Test

What does it measure?	Walking speed, transfer speed, predictor of falls risk
How long does it take?	< 5 mins
What do I need?	Tape measure, chair, stopwatch, marker (for noting where to turn around)
How is it conducted?	Administered by health professional Instructions
Notes for interpretation	Over 19 second places people with unilateral LL amputation at high risk of ≥ 2 falls by 6 months[1,2] MDC = 1.28-3.6sec[2] Well established test-retest and interrater reliability[2]

1. Hunter, S.W., et al. (2016). Risk factors for falls in people with a lower limb amputation: A systematic review. *PM & R, 9*(2), 170-180.
2. Balk, E.M., et al. (2019). Psychometric properties of functional, ambulatory, and quality of life instruments in lower limb amputees: A systematic review. *Archives of Physical Medicine & Rehabilitation, 100*, 2354-70.

L Test Link to full video – 43sec

L Test



Haas, B., et al. (2019). The reliability and validity of the L-test in people with Parkinson's disease. *Physiotherapy, 105*(1), 84-89.

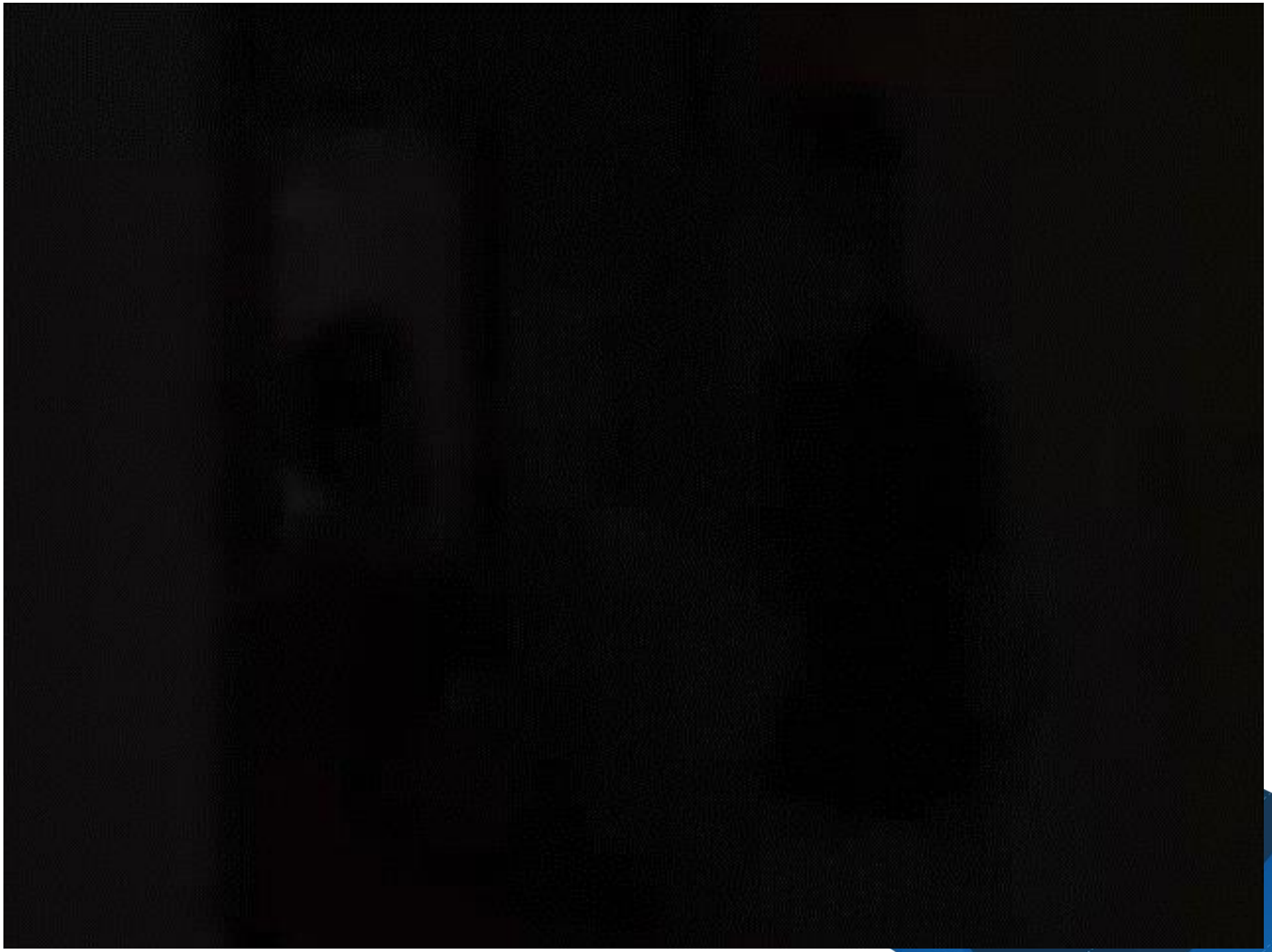
L Test

What does it measure?	Walking speed, transfer speed, **turning,** predictor of falls risk Avoids TUG ceiling effect
How long does it take?	< 5 mins
What do I need?	Tape measure, chair, stopwatch, 2 x markers (for noting where to turn and turn around)
How is it conducted?	Administered by health professional Instructions
Notes for interpretation	MDC = 6.2sec[1] MCID = 4.5sec[1] Interrater and test-retest reliability established[2]

1. Balk, E.M., et al. (2019). Psychometric properties of functional, ambulatory, and quality of life instruments in lower limb amputees: A systematic review. *Archives of Physical Medicine & Rehabilitation, 100*, 2354-70.
2. Deathe, A.B., & Miller, W.C. (2005). The L Test of Functional Mobility: Measurement properties of a modified version of the Timed “Up & Go” Test designed for people with lower-limb amputations. *Physical Therapy, 85*(7), 626-635.

2MWT

Link to full video – 1min15sec



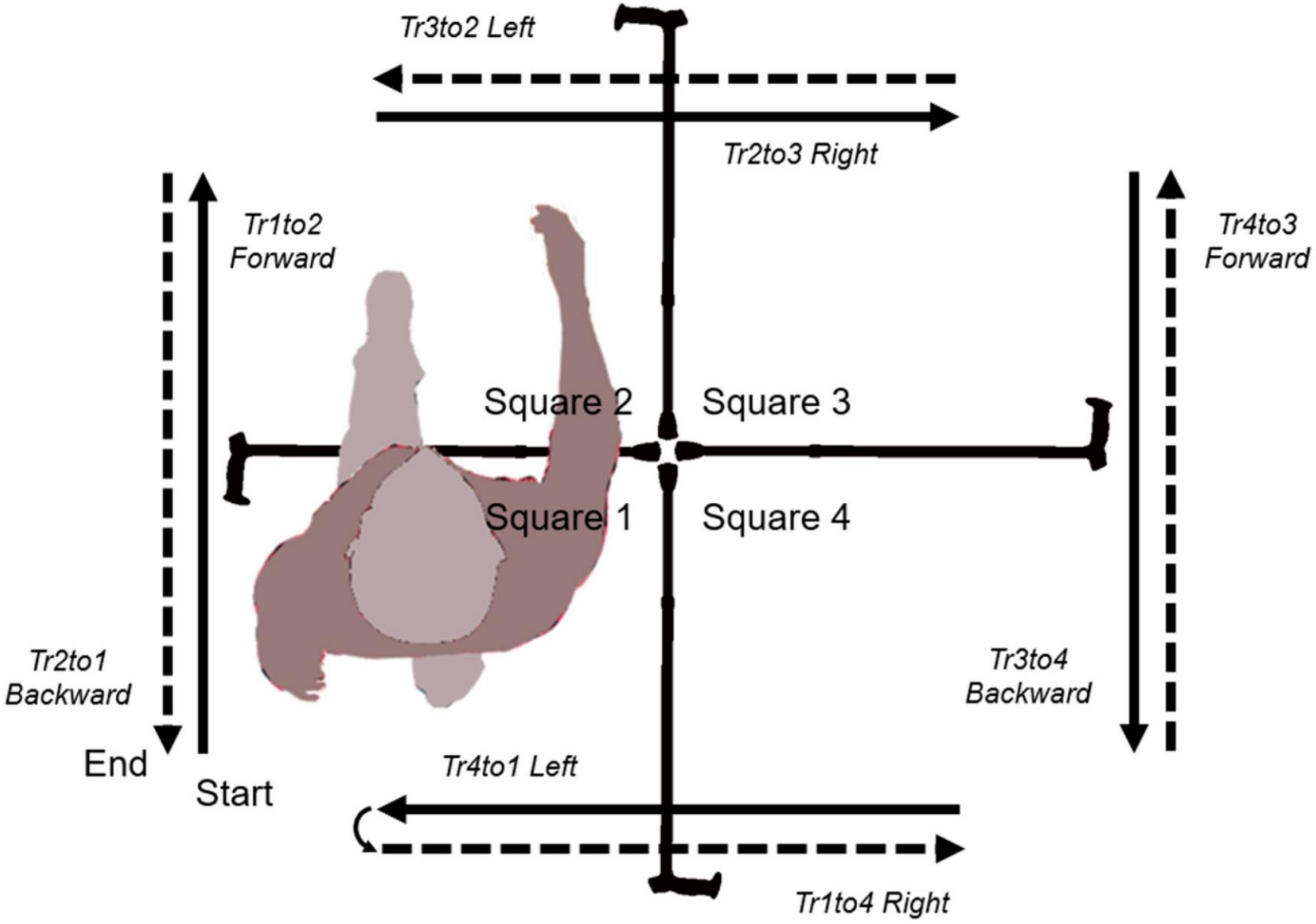
2MWT

What does it measure?	Walking speed
How long does it take?	< 5 mins
What do I need?	Hallway / clear area, 2 x markers (e.g., cones), stopwatch, tape measure
How is it conducted?	Administered by health professional Instructions
Notes for interpretation	MDC = 34.3m[1]

1. Balk, E.M., et al. (2019). Psychometric properties of functional, ambulatory, and quality of life instruments in lower limb amputees: A systematic review. *Archives of Physical Medicine & Rehabilitation, 100*, 2354-70.

Four Square Step Test (FSST) Link to full video – 50 sec

FSST



Gouelle, A., & Highsmith, M.J. (2020). Instrumented Four Square Step Test in adults with transfemoral amputation: Test-retest reliability and discriminant validity between two types of microprocessor knees. *Sensors, 20*, 4782.

FSST

What does it measure?	Balance, stepping in multiple directions **(including backwards)**
How long does it take?	< 5 mins
What do I need?	4 walking sticks (or fabricated cross), stopwatch
How is it conducted?	Administered by health professional Instructions
Notes for interpretation	Over 24 second places people with unilateral LL amputation at high risk of ≥ 2 falls by 6 months[1]

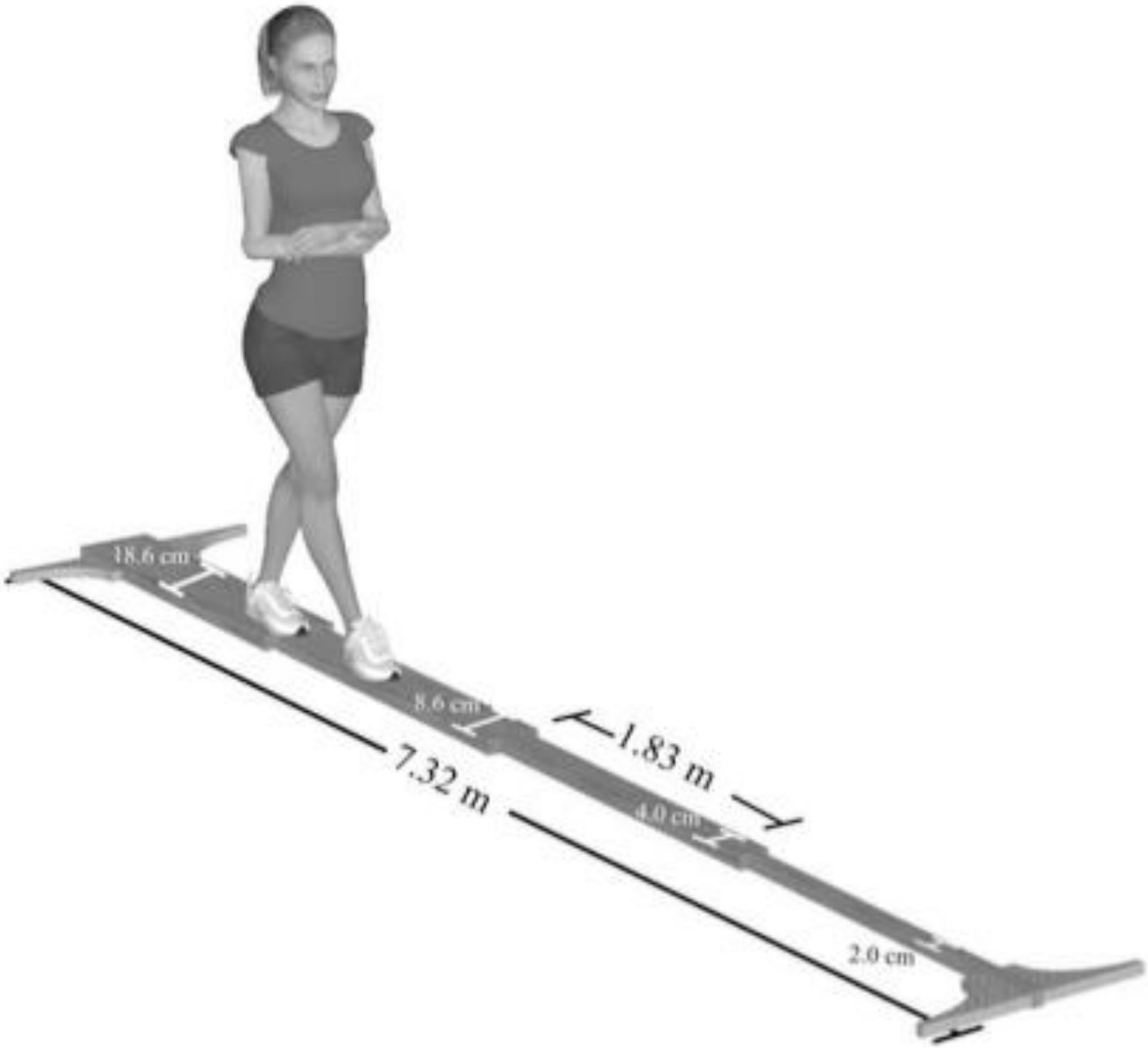
1. Hunter, S.W., et al. (2016). Risk factors for falls in people with a lower limb amputation: A systematic review. *PM & R, 9*(2), 170-180.

Narrowing Beam Walking Test (NBWT) Link to full video – 4min9sec

NBWT

What does it measure?	Balance during gait Avoids floor and ceiling effects
How long does it take?	< 10 mins
What do I need?	Fabricate your own narrowing walking beam
How is it conducted?	Administered by health professional
Notes for interpretation	Minimal learning effect[1] MDC_{90} = 0.16[2] Interrater and intrarater reliability established[2] If scores ~ quarter of beam likely to be at high risk of ≥ 2 falls in 6 months[3]

1. Sawers, A., & Hafner, B.J. (2018). Narrowing beam-walking is a clinically feasible approach for assessing balance ability in lower-limb prosthetic users. *Journal of Rehabilitation Medicine*, 50(5), 457-464.
2. Sawers, A., et al. (2020). Interrater and test-retest reliability of performance-based clinical tests administered to established users of lower limb prostheses. *Physical Therapy, 100*(7), 1206-1216.
3. Sawers, A., & Hafner, B. (2020). Using clinical balance tests to assess fall risk among established unilateral lower limb prosthesis users: Cutoff scores and associated validity indices. *PM & R,* 12(1), 16-25.



NBWT

Beam height 3.8cm

Sawers, A., & Hafner, B.J. (2018). Narrowing beam-walking is a clinically feasible approach for assessing balance ability in lower-limb prosthetic users. *Journal of Rehabilitation Medicine, 50*(5), 457-464.

Activities Specific Balance Confidence Scale (ABC)

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 tiptoes 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 mall?	
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?	

Rate your confidence from 0 to 10 that you could do each activity without losing your balance or becoming unsteady

ABC

What does it measure?	Balance confidence with activities
How long does it take?	5 - 10 mins
What do I need?	Copy of scale
How is it conducted?	Administered as part of interview or self-administered by client
Notes for interpretation	Scores > 80% high functioning 50-80% moderate functioning <50% low functioning MDC = 0.49[1] Test-retest reliability and internal consistency established[1]

1. Balk, E.M., et al. (2019). Psychometric properties of functional, ambulatory, and quality of life instruments in lower limb amputees: A systematic review. *Archives of Physical Medicine & Rehabilitation, 100*, 2354-70.

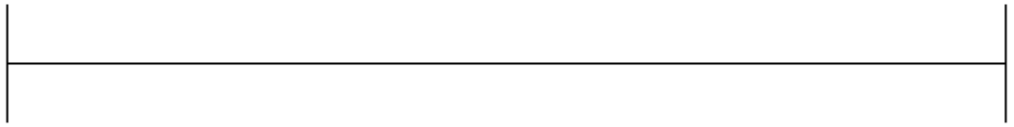
Prosthetic Evaluation Questionnaire (PEQ)

Subscales

- Satisfaction
- Wellbeing
- Prosthesis utility
- Appearance
- Sounds
- Residual limb health
- Pain
- Perceptions of others
- Frustration
- Social burden
- Ambulation
- Transfers
- Prosthetic care
- Self-efficacy
- Importance of different aspects of the prosthesis

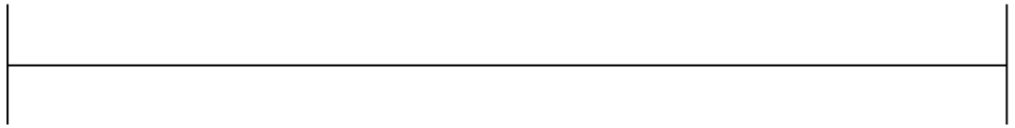
PEQ Examples

D. **Over the past four weeks, rate how you have felt about being able to walk down stairs *when using your prosthesis.***



CANNOT NO PROBLEM

T. **Over the past four weeks, rate any rash(es) that you got on your residual limb.**



EXTREMELY BOTHERSOME NOT AT ALL

OR check __ I had no rashes on my residual limb in the last month.

PEQ

What does it measure?	Subjective experience of a prosthesis
How long does it take?	Depends on number of subscales used
What do I need?	Copy of questionnaire
How is it conducted?	Self-administered by client
Notes for interpretation	Can analyse individual questions or subscale scores Mobility Scale MDC = 0.55[1] Test-retest reliability and internal consistency established[1]

1. Balk, E.M., et al. (2019). Psychometric properties of functional, ambulatory, and quality of life instruments in lower limb amputees: A systematic review. *Archives of Physical Medicine & Rehabilitation, 100*, 2354-70.

Revised Upper Extremity Functional Status Module of the Orthotics and Prosthetics User Survey (OPUS-UEFS v3)

Range of difficulty for unilateral amputation[1]

- Easier, e.g.,
  - Brush / comb hair
- Moderate, e.g.,
  - Open an envelope
- Difficult, e.g.,
  - Attach end zipper and zip jacket

Please Indicate How Easily You Perform the Following Activities	3 = Very Easy 2 = Easy 1 = Difficult 0 = Not Able NA = Not Applicable					Do You Usually Perform this Activity Using Your Prosthesis?	
	3	2	1	0	NA	Yes	No
1. Wash Face							
2. Put Toothpaste and Brush Teeth							
3. Brush/Comb Hair							
4. Put on and Remove T-Shirt							
5. Button Shirt with Front Buttons							
6. Attach End of Zipper and Zip Jacket							
7. Put on Socks							
8. Tie Shoe Laces							
9. Use Fork/Spoon							
10. Poor from 12 oz Can							
11. Write Name Legibly							
12. Use Scissors							
13. Open Door with Knob							
14. Carry Laundry Basket							
15. Dial Touch Tone Telephone							
16. Fold Bath Towel							
17. Open Envelope							
18. Stir in Bowl							
19. Put on and Take off Prosthesis							

1. Burger, H., et al. (2008). Validation of the Orthotics and Prosthetics User Survey Upper Extremity Functional Status Module in people with unilateral upper limb amputation. *Journal of Rehabilitation Medicine, 40*, 393-399.
2. Van der Niet, O. (2013). Functionality of i-LIMB and i-LIMB Pulse hands: Case report. *JRRD, 50*(8), 1123-1128.

OPUS-UEFS v3

What does it measure?	Self-rated ability to complete upper limb activities
How long does it take?	5 – 10 mins
What do I need?	Copy of questionnaire
How is it conducted?	Self-administered by client or administered as part of health professional interview
Notes for interpretation	Validity established[1] If needing more psychometric data, consider an alternative such as the QuickDASH[2]

1. Burger, H., et al. (2008). Validation of the Orthotics and Prosthetics User Survey Upper Extremity Functional Status Module in people with unilateral upper limb amputation. *Journal of Rehabilitation Medicine, 40*, 393-399.
2. Resnik,L., & Borgia, M. (2015). Reliability, validity, and responsiveness of the QuickDASH in patients with upper limb amputation. *Archives of Physical Medicine & Rehabilitation, 96*(9), 1676-1683.

Capacity Assessment of Prosthesis Performance for the Upper Limb (CAPPFUL)

11 tasks:

1. Place weights in crate
2. Lift and carry crate
3. Zip vest
4. Pick up dice
5. Tie shoelaces
6. Lift plate
7. Cut putty with a fork and knife
8. Squeeze bottle
9. Turn oven style knob
10. Place three coins in a slot
11. Hang a picture

1. Boyle, A., et al. (2020). Capacity assessment of prosthetic performance for the upper limb (CAPPFUL): Characterization of normal kinematics and performance. *PM & R, 12*(9), 870-881.

CAPPFUL

Total score = total control skills + total component utilisation + total maladaptive compensatory strategies + total task completions – (0.5 x number of adaptive compensatory strategies used)

Each activity is scored on 5 domains

1. Control skills
2. Component utilization
3. Maladaptive compensatory strategies
4. Adaptive compensatory strategies
5. Task completion

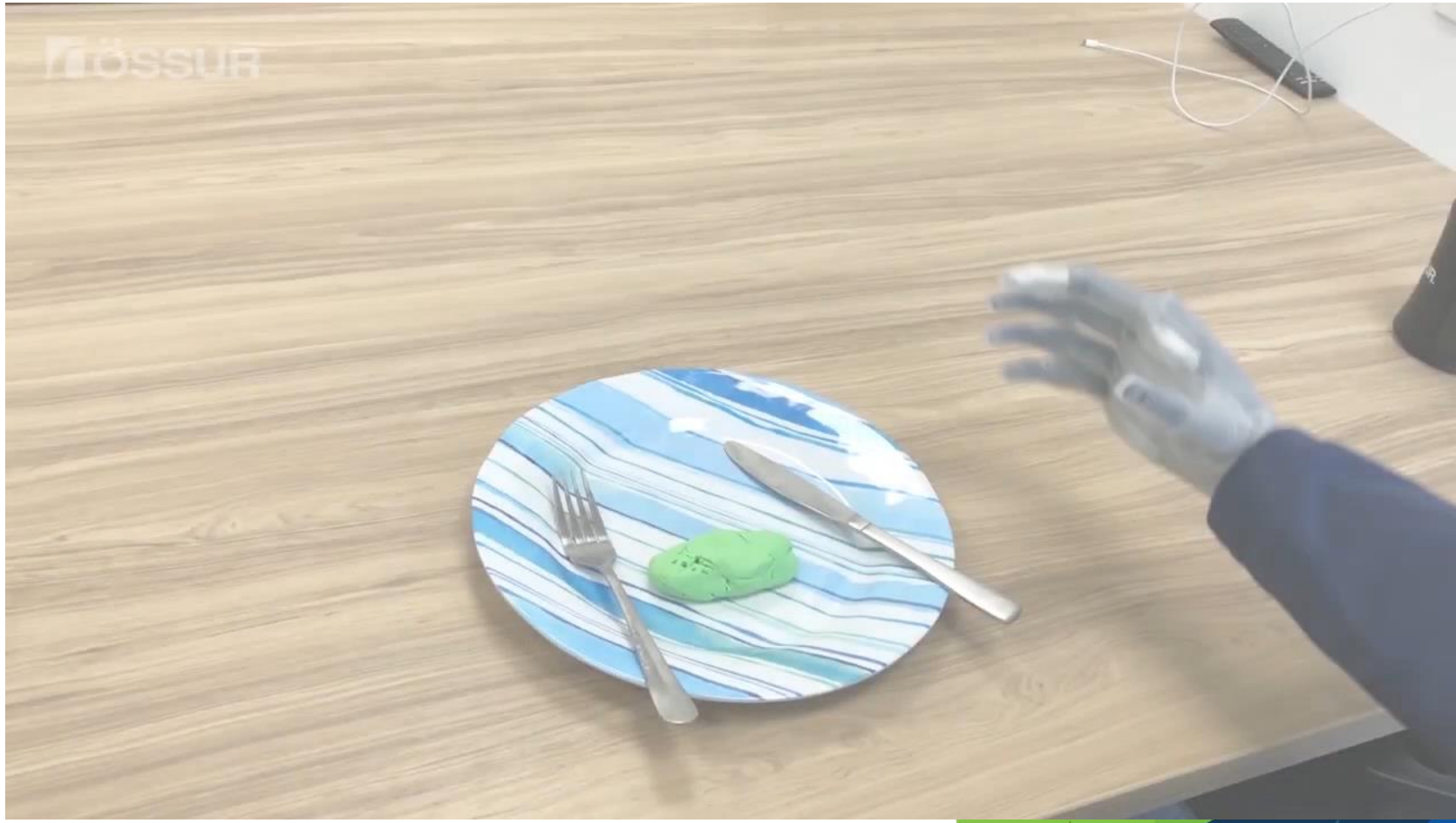
2	No errors
1	1 or more errors
0	Unable to initiate / attempt task

2	Manipulates or adjusts prosthetic componentry
0	No adjustments required

2	Completes within 90 seconds
0	Does not complete within 90 seconds

CAPPFUL

1. Control skills
2. Component utilization
3. Maladaptive compensatory strategies
4. Adaptive compensatory strategies
5. Task completion



Link to full video

CAPPFUL

What does it measure?	Ability to complete upper limb activities
How long does it take?	25 - 35 mins if completing all tasks
What do I need?	Weights, crate, vest with zip, dice, shoelaces, coins and slot, plate, table, shelf, squeeze bottle, knife, fork, putty, oven with knob, picture, picture hook
How is it conducted?	Administered by health professional
Notes for interpretation	Can score individual tasks or full score Interrater reliability is established[1]

1. Kearns, N.T., et al. (2018). Development and psychometric validation of capacity assessment of prosthetic performance for the upper limb (CAPPFUL). *Archives of Physical Medicine & Rehabilitation, 99*(9), 1789-1797.

Other examples of outcome measures not covered here

What does it test	
Balance / transfers	Five Time Sit to Stand Test Timed Single Leg Stance Test Berg Balance Scale
Gait	Edinburgh Visual Gait Score Dynamic Gait Index
Functional ambulation	Timed Ten Meter Walk Test Modified Emory Functional Ambulation Profile Accelerometers
Upper limb function	Box & Block Test
Function in daily activity	Patient-Specific Functional Scale
Subjective experience	Trinity Amputation & Prosthesis Experience Scales (TAPES & TAPES-R)

Using outcome measures in the clinical justification of non-standard componentry

Possible reasons for applying[1];

- Close to or exceeds safe working load of similar standard componentry
- Environmental conditions in home environment (severe dusty or wet location)
- Clinical justification for standard day-to-day activity

Ineligible reasons;

- Individual lifestyle needs (e.g. leisure, community, volunteering)
- Work demands
- Advancements in component technology

1. Must still comply with MASS Guidelines for Queensland Artificial Limb Service

Example

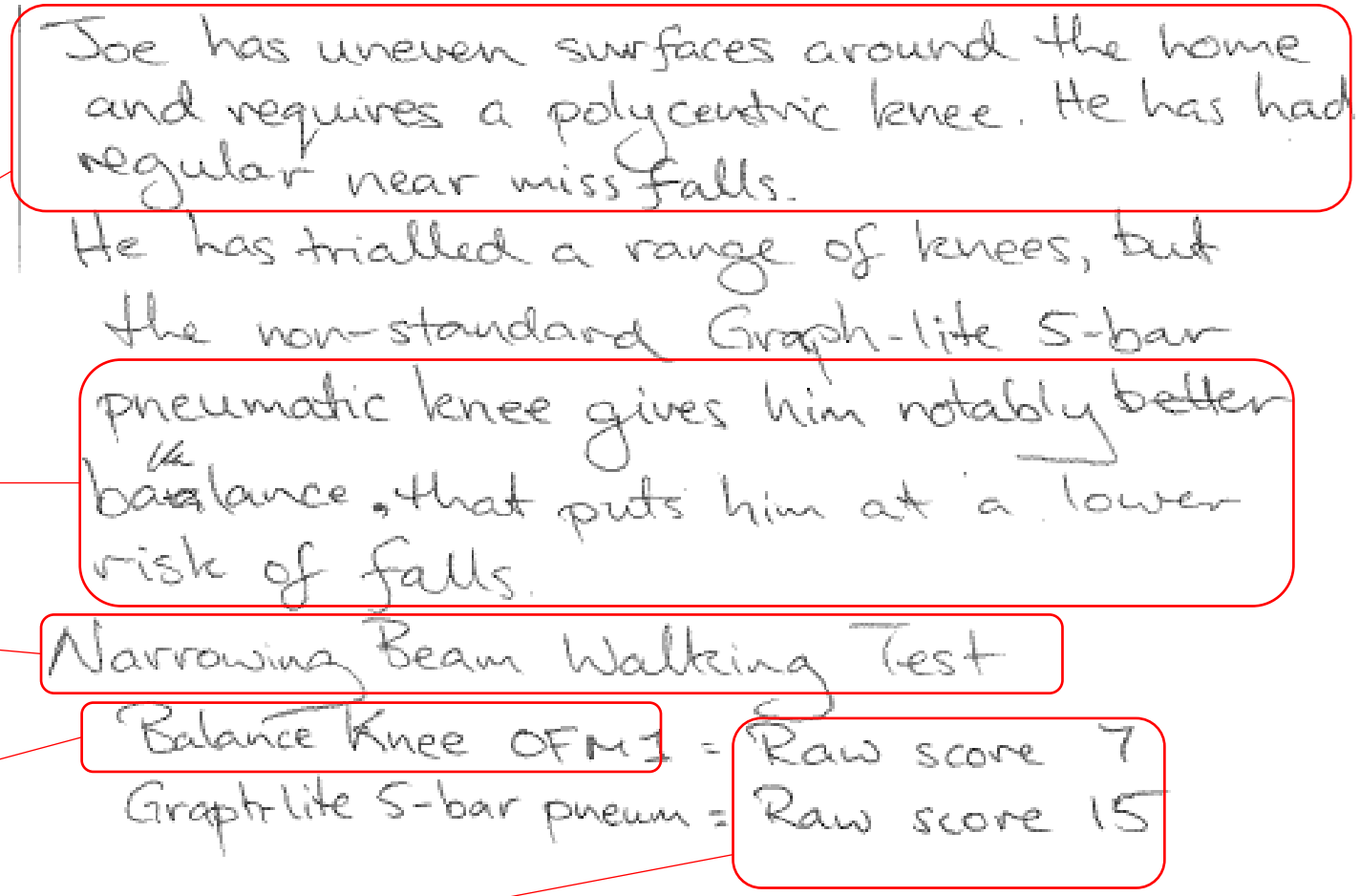
Why do they need that type of component? How does it relate to basic mobility around the home?

What was the important outcome?

How was it measured?

What was the standard componentry it was compared against?

How much better did the non-standard componentry perform?



Using outcome measures in the justification of non-prosthetic assistive technology

Susan can push a shopping cart with some difficulty using her prosthesis, and can walk across a parking lot with much difficulty, however she can't keep up with others when walking, move a chair to another room or sweep the floor without a wheelchair.

PLUS-M™ T-Score

The respondent's PLUS-M™ T-score is:

PLUS-M T-score	Standard Error
32.4	2.7

PLUS-M™ CAT Interpretation*

A PLUS-M™ T-Score of **32.4** indicates that the respondent's level of mobility is better than:

- 2.8% of people with unilateral lower limb amputation
- 4.1% of women with unilateral lower limb amputation
- 4.7% of people 65 or more years old with unilateral lower limb amputation
- 0.8% of people with unilateral amputation above the knee from non-dysvascular causes

MASS eApply

Additional Functional Information

Provide additional information:

The client's T-score on the PLUS-M was 32.4 indicating function below the 5th percentile with her prosthesis. She requires a wheelchair for tasks such as keep up with others, moving a chair to another room, and sweeping the floor.

TUG with prosthesis = 24 (high risk of falls)

Using outcome measures to establish priorities and evaluate service outcomes

1. Use measures on intake to establish priorities
2. Use routine measures at each visit to monitor change
3. Select individual measures for each client goal
4. Periodic service evaluation (e.g., St Vincent's Health project)

Thank you!

Link to webinar feedback form