Outcome Measures for the Orthotics & Prosthetics Industry

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ISPO Sweden Short Course
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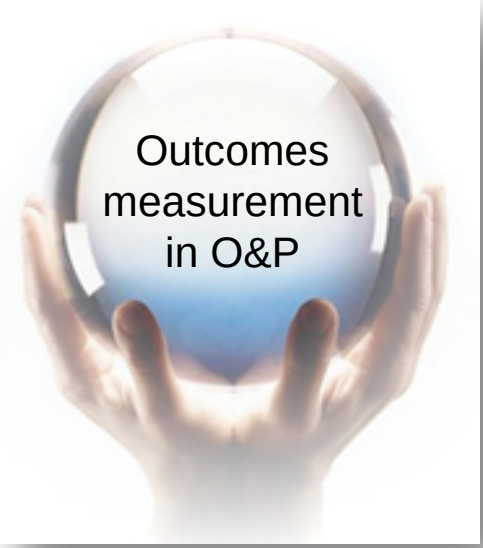
Outcomes Measurement

- Outcomes measurement is challenging
  - Takes time, experience, and resources
  - Is it going to get any easier?
- What is being done today?
  - Educational opportunities
  - Resources available to clinicians
  - Research into new measures
- What does the future hold?
  - Tools to facilitate measurement
  - Ways to measure outcomes
  - Types of outcome measures
- But first…where do we stand today?



A Survey of Prosthetists

- US prosthetists
  - Regularly provide prosthetic services to people with lower limb loss
- Provided a list of 20 measures
  - "Have you ever administered any of the following standardized outcome measures in your daily clinical practice?"

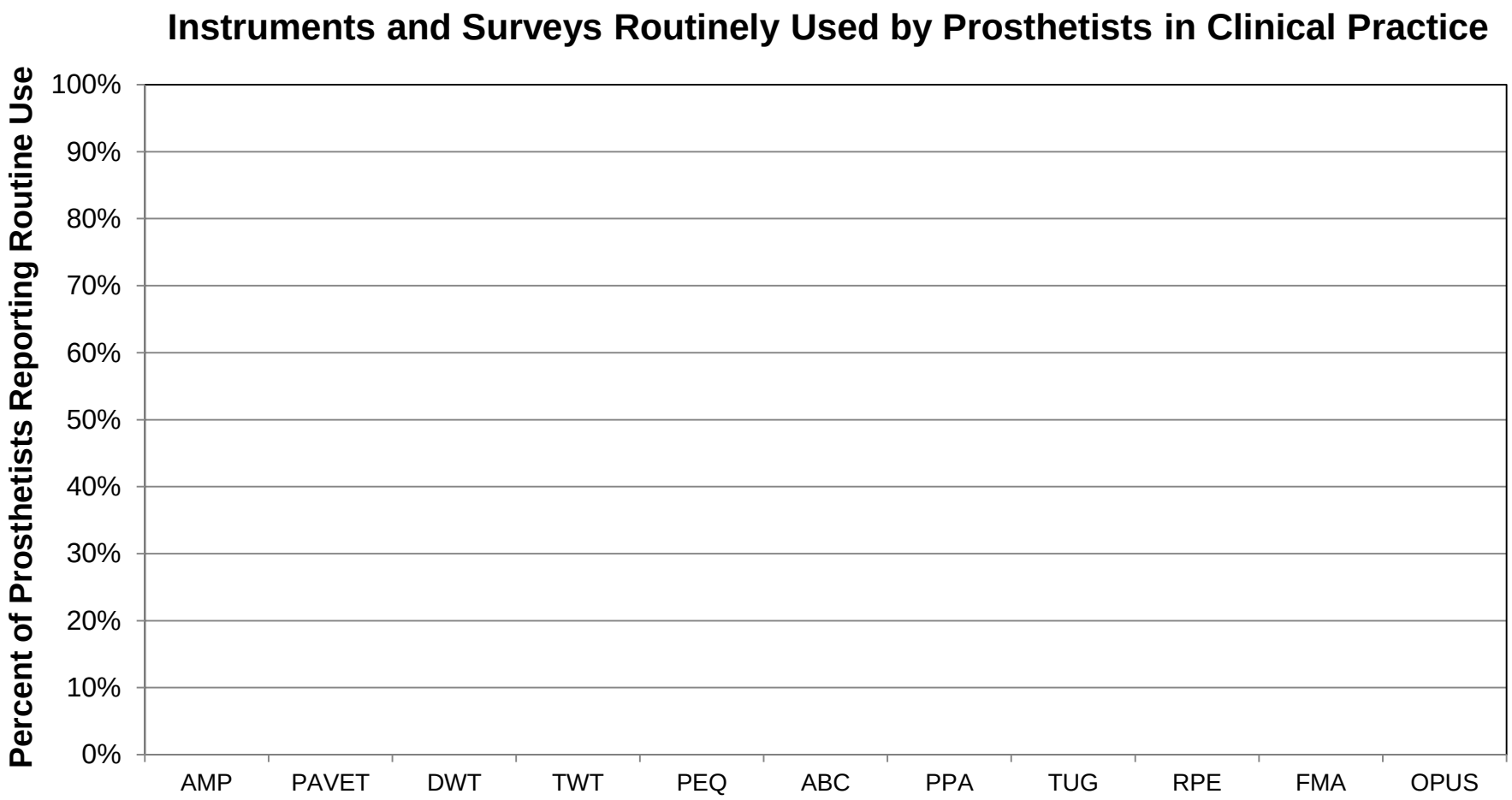
    ☐ Always ☐ Sometimes
    ☐ Often ☐ Rarely
    ☐ Never

Outcome measure name
Amputee Mobility Predictor (AMP)
Patient Assessment Validation Evaluation Test (PAVET)
Distance Walk Test (DWT) (e.g. 10-Meter Walk Test)
Timed Walk Test (TWT) (e.g. 2-Minute Walk Test)
Prosthesis Evaluation Questionnaire (PEQ)
Activities-specific Balance Confidence (ABC) Scale
Timed Up and Go (TUG)
Prosthetic Profile of the Amputee (PPA)
Borg Rating of Perceived Exertion (RPE)
Functional Mobility of the Amputee (FMA)
Orthotic and Prosthetic Users Survey (OPUS)
Short-Form 8, 12, or 36 (SF-8, SF-12, or SF-36)
Step Activity Monitor (SAM)
Berg Balance Scale (BBS)
Houghton Questionnaire
Locomotor Capabilities Index (LCI)
Lower Extremity Functional Scale (LEFS)
Rivermead Mobility Index (RMI)
Nottingham Health Profile (NHP)
Trinity Amputation and Prostheses Experience Scales (TAPES)

Gaunaurd et al. (2014)

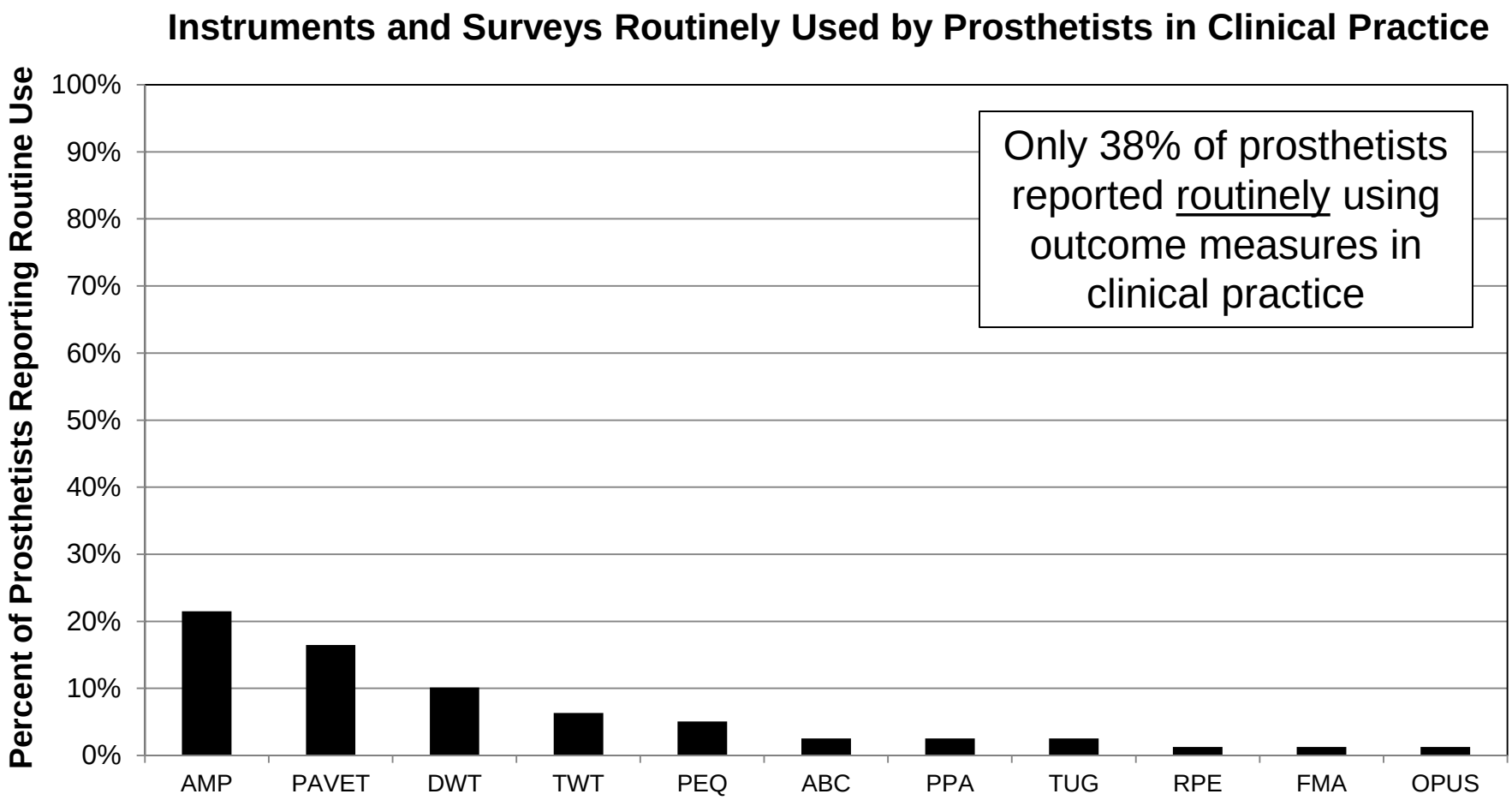
  - Routine users = "always" or "often" used the measure

Outcome Measure Use in O&P



Gaunaurd et al. (2014)

Outcome Measure Use in O&P



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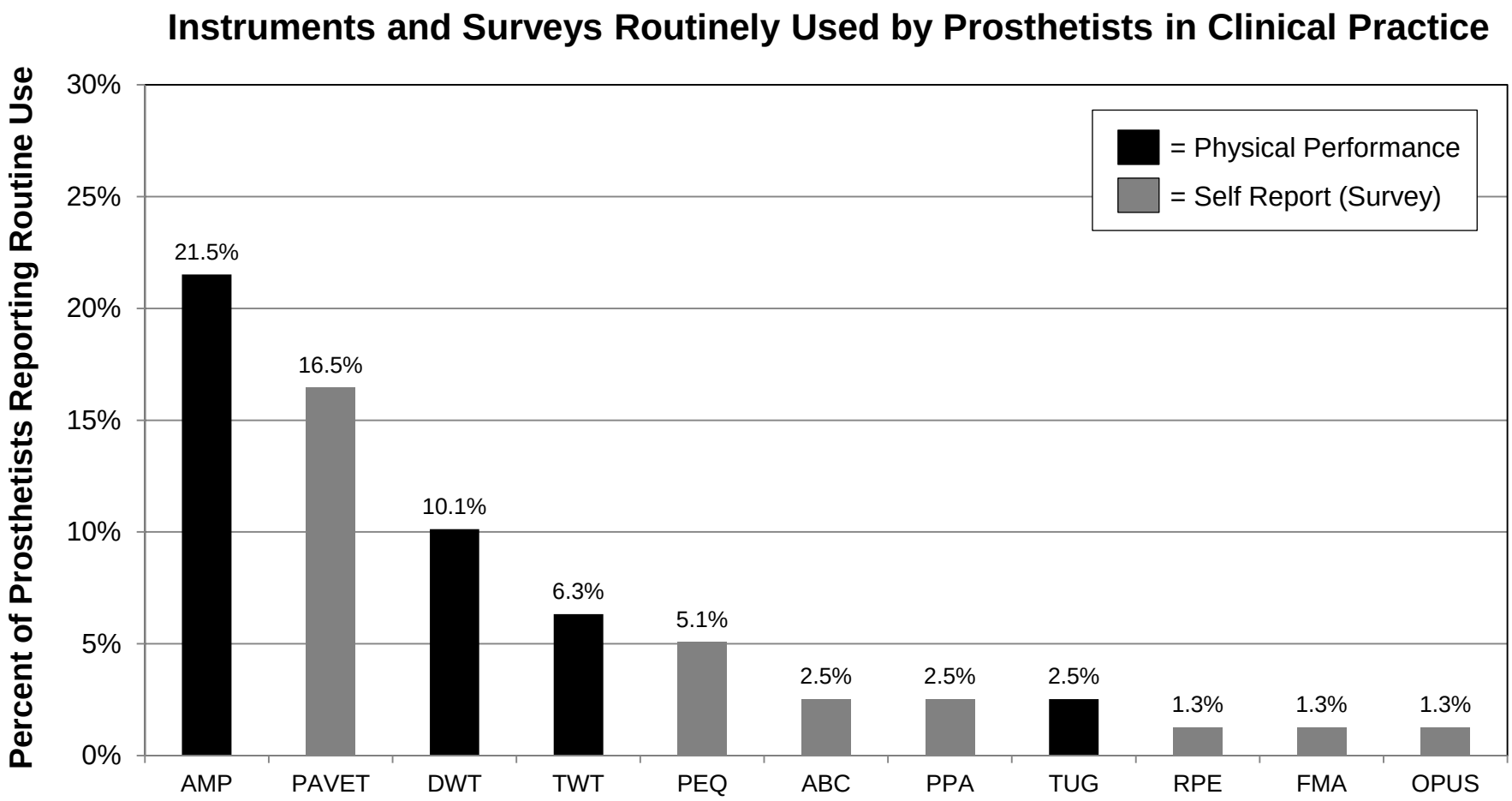
Outcome Measure Use in O&P



Gaunaurd et al. (2014)

Outcome Measure Use in O&P

- Limited adoption of outcome measures in O&P
- No specific preference for types of measures
  - Physical Performance
  - Self-Report
- What are the barriers?

Potential Barriers to Use

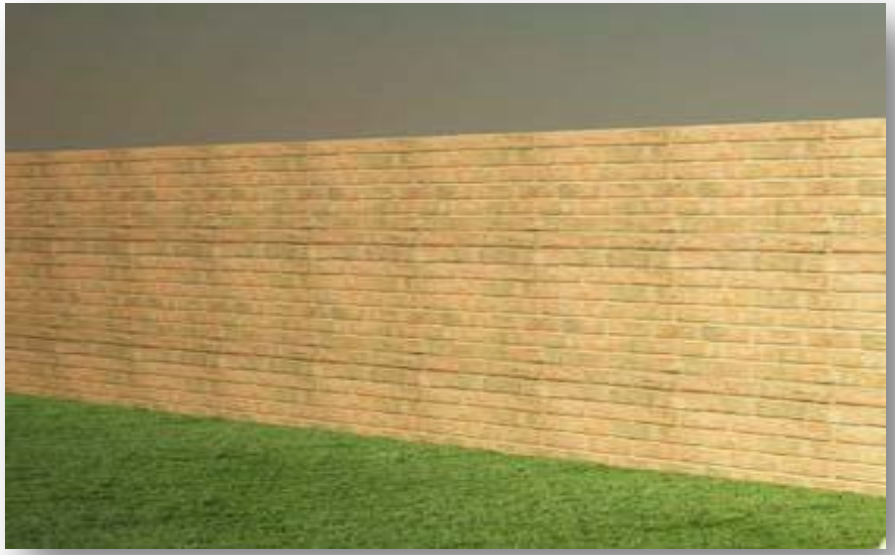
"Factors such as the time-consuming nature of the administration of standardised tests, lack of specificity and sensitivity to capture the outcomes of occupational therapy, lack of client-centredness in available outcome measures, lack of knowledge of available tools and lack of knowledge regarding the administration and scoring of the available measures were all reported [by occupational therapists] as obstacles to the use of standardised measures in practice." **Stapleton (2009)**

"[Physical therapists] indicated lack of familiarity with, lack of training in, and lack of access to measures were barriers." **Jette (2009)**

"The most frequent barrier to using standardised outcome measures for clinicians [of various disciplines] was resource limitations. This included lack of time, both to complete them and score them, lack of training on how to use the measures and lack of other resources." **Burton (2013)**

Barriers

- Insufficient time
- Not sensitive enough
- Not patient-centered
- Lack of knowledge
- Limited experience
- Not accessible
- Too much paperwork
- Burden on patients
- No support system



Facilitators

- No single answer
- Need a **cultural** change
- Many possible solutions
  - Academic standards
  - Educational opportunities
  - Resources
  - Measures
  - Technologies

"[Therapists] recognized the need to change their attitudes and behaviors and to employ strategies to manage barriers, allowing them to engage in activities to improve their knowledge and skills."

Bowman (2006)

Academic Standards

Academic Standards

- ISPO
  - Category I educational standards
- Outcomes measurement
  - Included as part of the professional profile
  - Described under “research and development”

2.5 Research and development

2.5.1 Conducts continuing evaluation of his/her activities.

2.5.2 Develops and actively participates in formal evaluation and research programmes.

2.5.3 Participates in scientific/professional meetings and contributes papers to scientific/professional journals.

2.5.4 Use outcome measures to review treatment procedures to determine best practice.

WHO (2005)

Academic Standards

- NCOPE (USA)
  - Masters (entry-level) degree educational standards
- Outcomes measurement
  - Included under foundational content areas and patient assessment
  - Described under provision of clinical care ("follow-up")

The graduate must demonstrate the ability to develop and implement an effective follow-up plan to assure optimal fit and function of the orthosis or prosthesis and monitor the outcome of the treatment plan.

C.5.1 Provide continuing patient care and periodic evaluation to assure, maintain and document optimal fit and function of the orthosis or prosthesis.

C.5.2 Develop an effective long-term follow-up plan for comprehensive orthotic or prosthetic care.

C.5.3 Provide adequate education to assure the patient and caregivers understand the importance of adhering to the treatment plan and regular follow-up visits.

C.5.4 Document all interactions with the patient and caregivers.

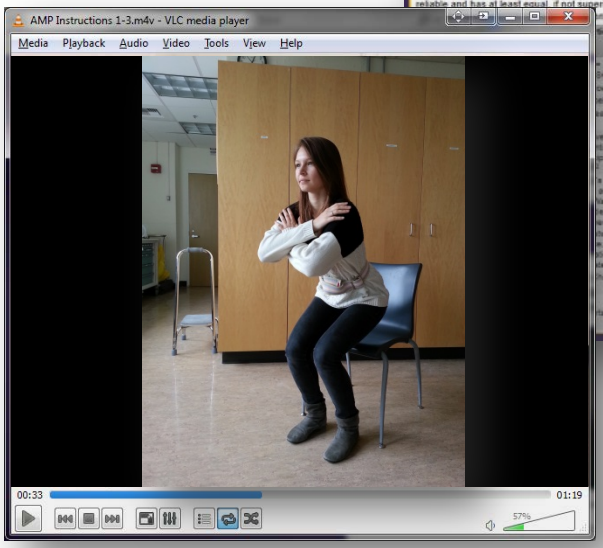
C.5.5 Demonstrate follow-up assessment regarding fit and function of the device.

C.5.6 Assess the function and reliability of the device using scientifically-validated outcome measures.

NCOPE Masters Core Curriculum Guide (2010)

Academic Standards

- New courses / content
  - Psychometric properties
  - Selection
  - Recommendation
  - Administration
  - Scoring
  - Interpretation



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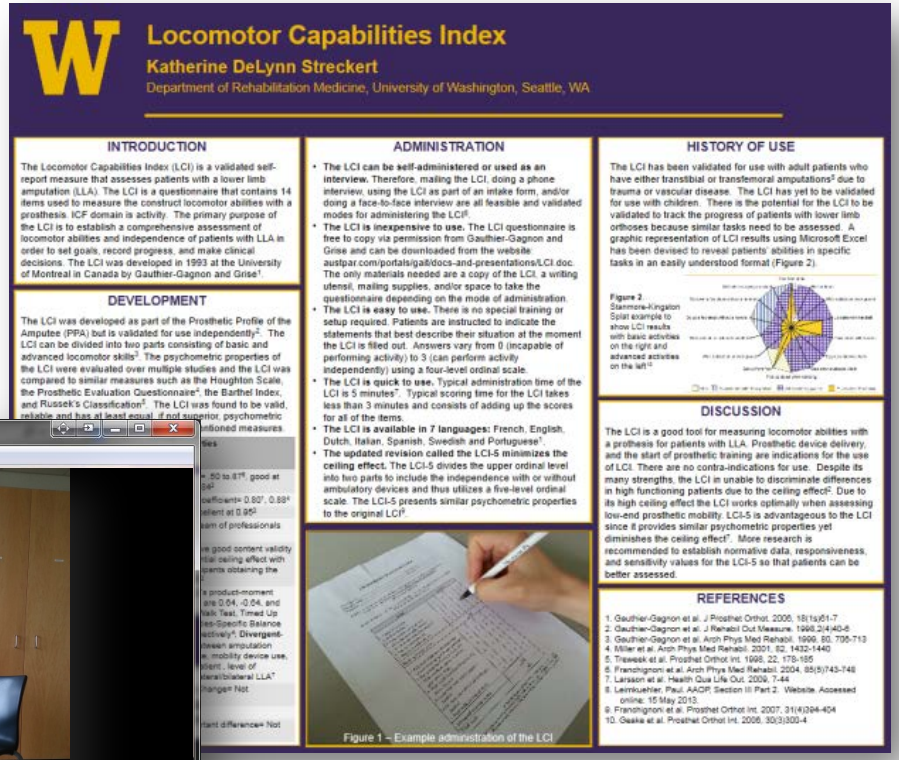

Locomotor Capabilities Index

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INTRODUCTION

The Locomotor Capabilities Index (LCI) is a validated self-report measure that assesses patients with a lower limb amputation (LLA). The LCI is a questionnaire that contains 14 items used to measure the construct locomotor abilities with a prosthesis. ICF domain is activity. The primary purpose of the LCI is to establish a comprehensive assessment of locomotor abilities and independence of patients with LLA in order to set goals, record progress, and make clinical decisions. The LCI was developed in 1993 at the University of Montreal in Canada by Gauthier-Gagnon and Grise[1].

DEVELOPMENT

The LCI was developed as part of the Prosthetic Profile of the Amputee (PPA) but is validated for use independently[2]. The LCI can be divided into two parts consisting of basic and advanced locomotor skills[3]. The psychometric properties of the LCI were evaluated over multiple studies and the LCI was compared to similar measures such as the Houghton Scale, the Prosthetic Evaluation Questionnaire[4], the Barthel Index, and Russek's Classification[5]. The LCI was found to be valid, reliable and has at least equal, if not superior, psychometric

ADMINISTRATION

- **The LCI can be self-administered or used as an interview.** Therefore, mailing the LCI, doing a phone interview, using the LCI as part of an intake form, and/or doing a face-to-face interview are all feasible and validated modes for administering the LCI[6].
- **The LCI is inexpensive to use.** The LCI questionnaire is free to copy via permission from Gauthier-Gagnon and Grise and can be downloaded from the website: austpar.com/portals/gait/docs-and-presentations/LCI.doc. The only materials needed are a copy of the LCI, a writing utensil, mailing supplies, and/or space to take the questionnaire depending on the mode of administration.
- **The LCI is easy to use.** There is no special training or setup required. Patients are instructed to indicate the statements that best describe their situation at the moment the LCI is filled out. Answers vary from 0 (incapable of performing activity) to 3 (can perform activity independently) using a four-level ordinal scale.
- **The LCI is quick to use.** Typical administration time of the LCI is 5 minutes[7]. Typical scoring time for the LCI takes less than 3 minutes and consists of adding up the scores for all of the items.
- **The LCI is available in 7 languages:** French, English, Dutch, Italian, Spanish, Swedish and Portuguese[1].
- **The updated revision called the LCI-5 minimizes the ceiling effect.** The LCI-5 divides the upper ordinal level into two parts to include the independence with or without ambulatory devices and thus utilizes a five-level ordinal scale. The LCI-5 presents similar psychometric properties to the original LCI[8].

Figure 1 – Example administration of the LCI

HISTORY OF USE

The LCI has been validated for use with adult patients who have either transtibial or transfemoral amputations[9] due to trauma or vascular disease. The LCI has yet to be validated for use with children. There is the potential for the LCI to be validated to track the progress of patients with lower limb orthoses because similar tasks need to be assessed. A graphic representation of LCI results using Microsoft Excel has been devised to reveal patients' abilities in specific tasks in an easily understood format (Figure 2).

Figure 2. Stanmore-Kingston Spiar example to show LCI results with basic activities on the right and advanced activities on the left[10]

DISCUSSION

The LCI is a good tool for measuring locomotor abilities with a prothesis for patients with LLA. Prosthetic device delivery, and the start of prosthetic training are indications for the use of LCI. There are no contra-indications for use. Despite its many strengths, the LCI in unable to discriminate differences in high functioning patients due to the ceiling effect[2]. Due to its high ceiling effect the LCI works optimally when assessing low-end prosthetic mobility. LCI-5 is advantageous to the LCI since it provides similar psychometric properties yet diminishes the ceiling effect[7]. More research is recommended to establish normative data, responsiveness, and sensitivity values for the LCI-5 so that patients can be better assessed.

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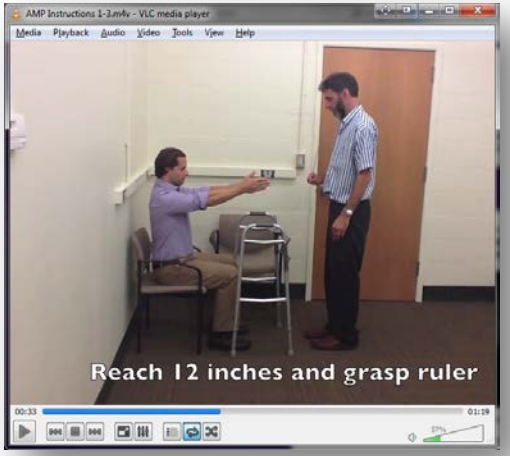
Educational Opportunities

Professional Training

- Written materials
  - Instructions
  - Required equipment
- Training videos
  - Setup
  - Administration
  - Scoring



University of Miami & University of Washington

Professional Training

- In-person training
  - Reasons for measurement
  - Candidate patients
  - Psychometric properties
  - Limitations
  - Setup
  - Administration
  - Practice
  - Q&A

University of Washington

Professional Training

- Measure toolkits
  - Manual
    - Setup instructions
    - Administration instructions
    - Scoring instructions
  - Equipment
    - Tape measure
    - Stopwatch
    - Ruler
    - Cones
    - Foam block
  - Forms
    - Scoring sheets
    - Surveys
  - Other
    - Clipboard
    - Pens

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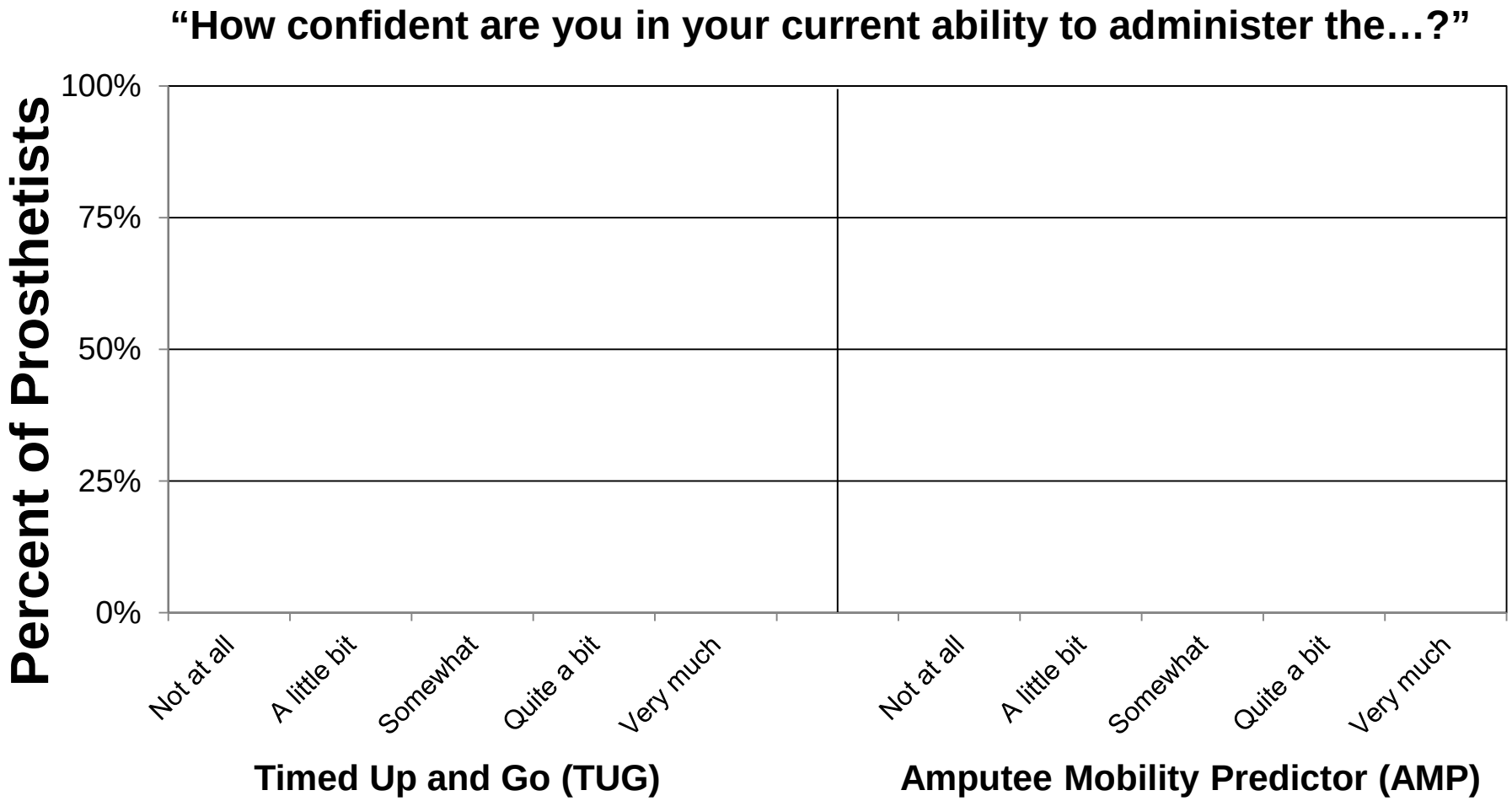
Professional Training



Gaunaurd et al. (2014)

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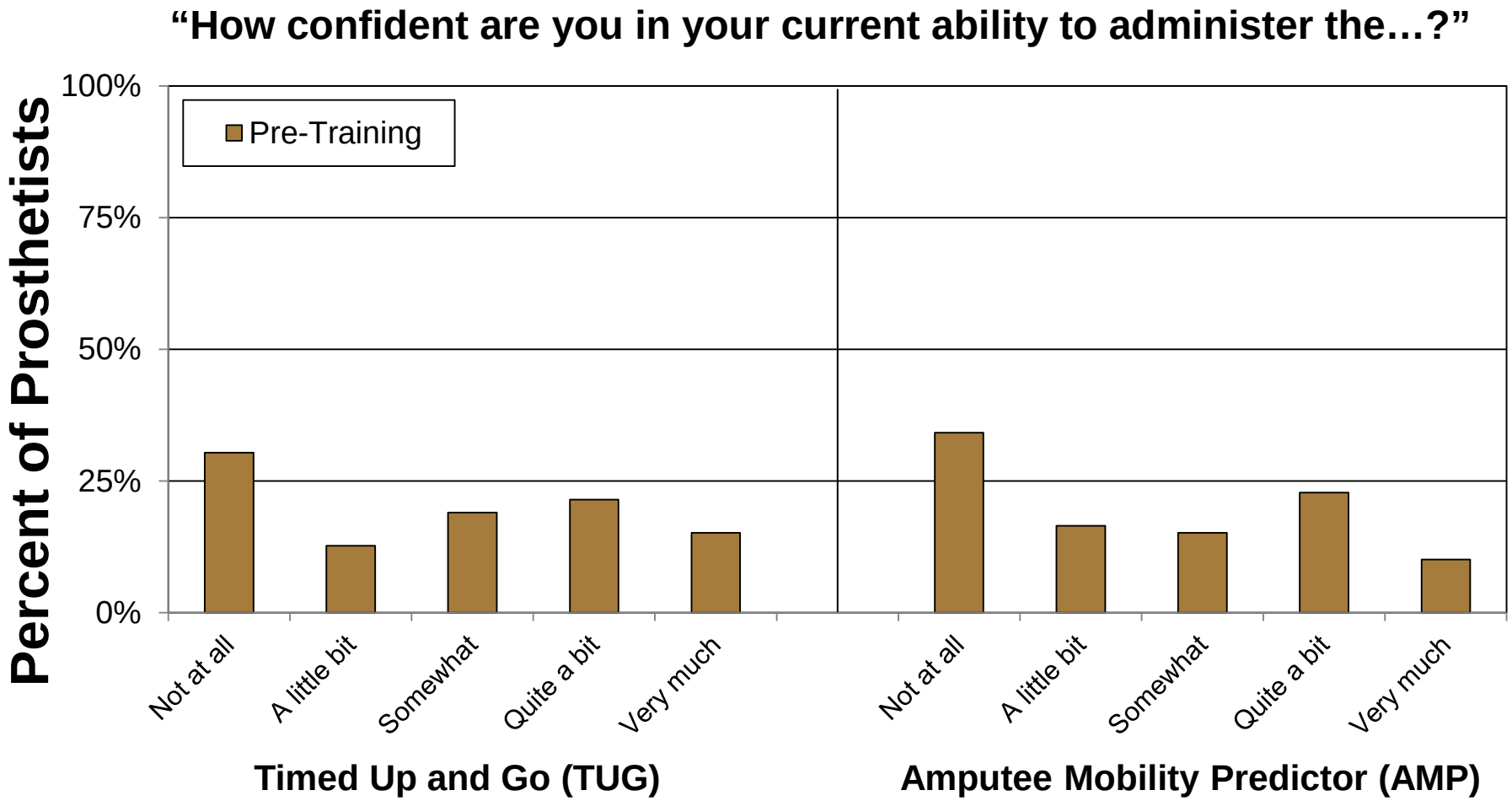

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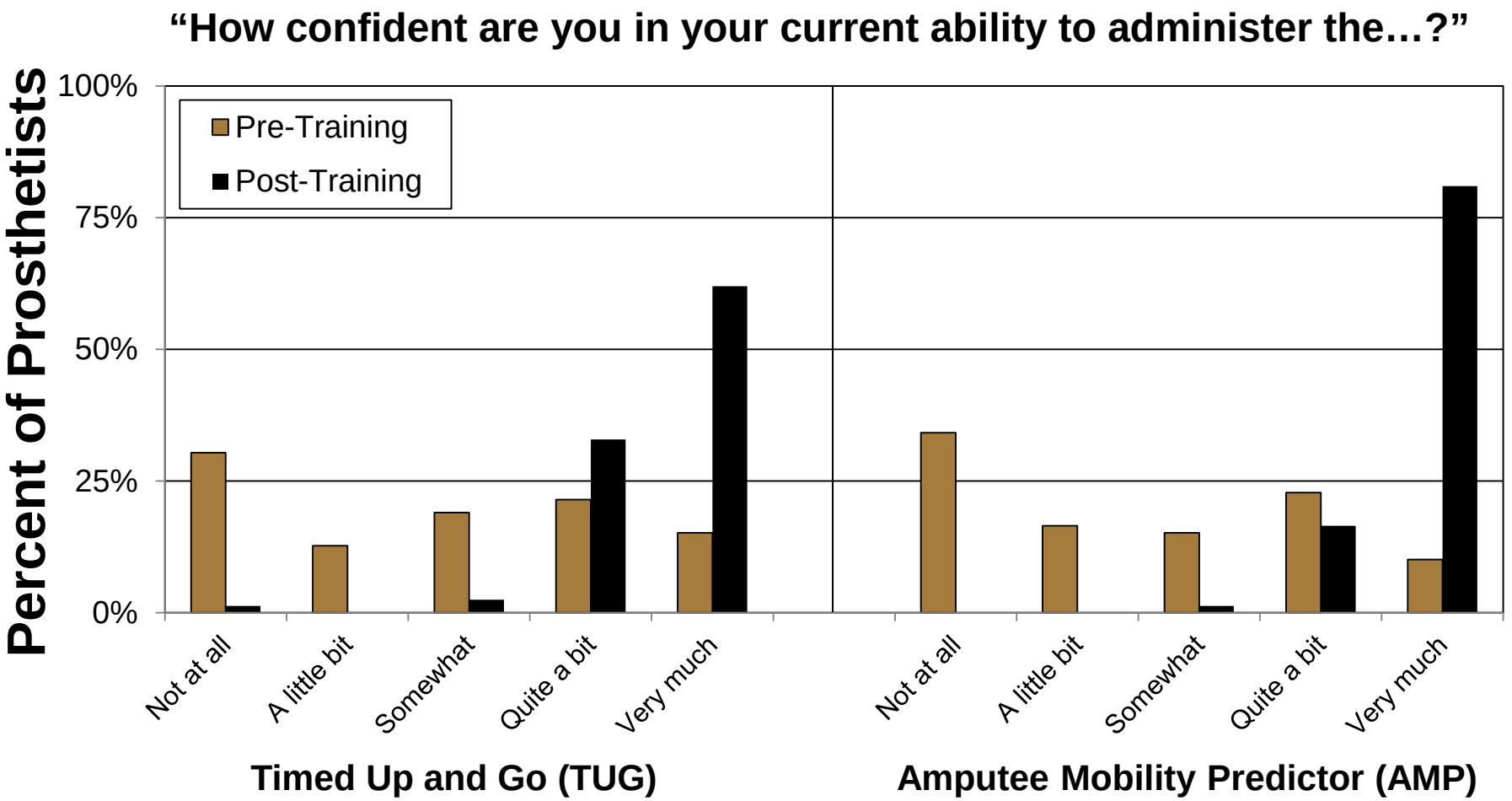

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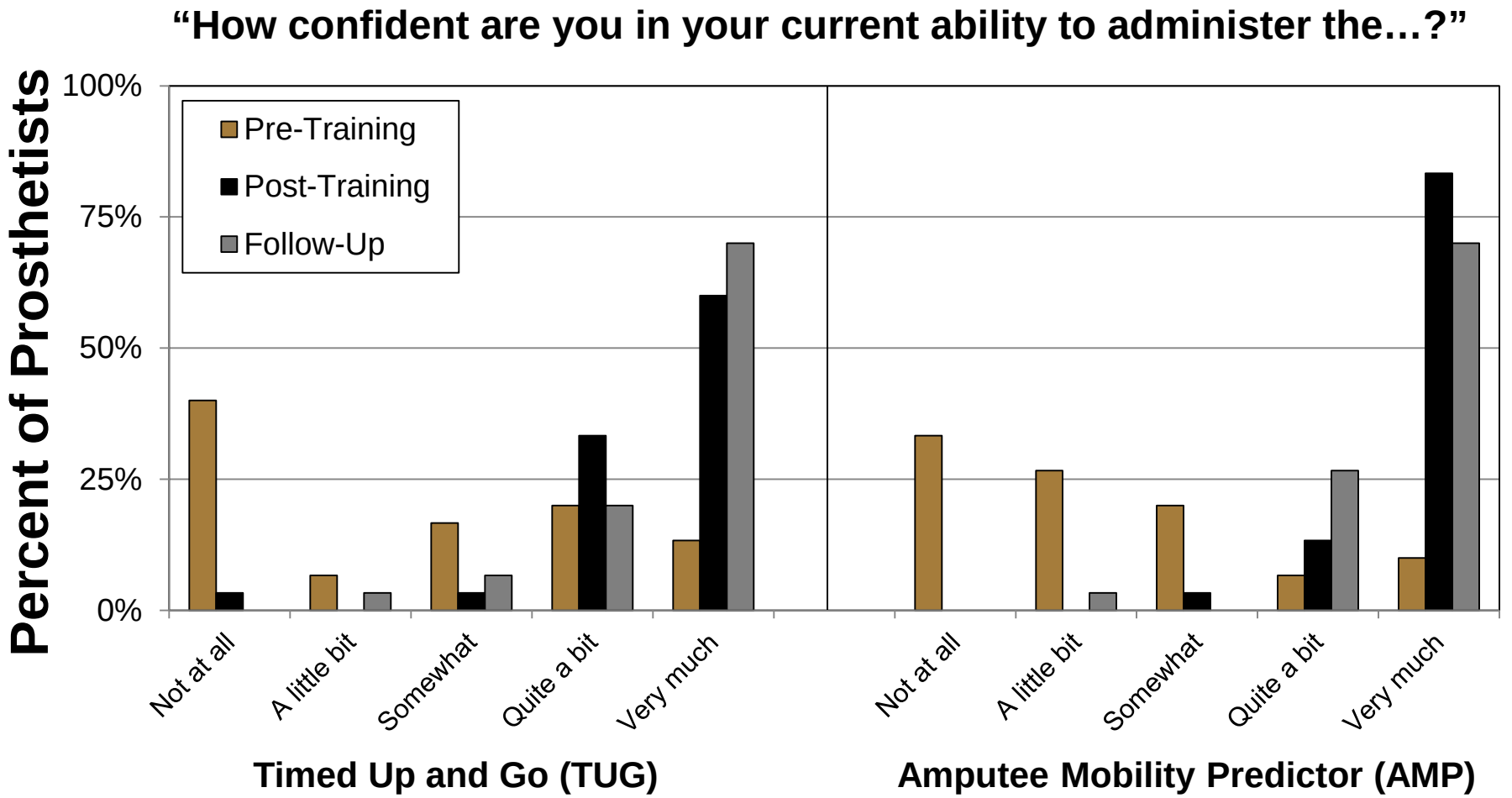
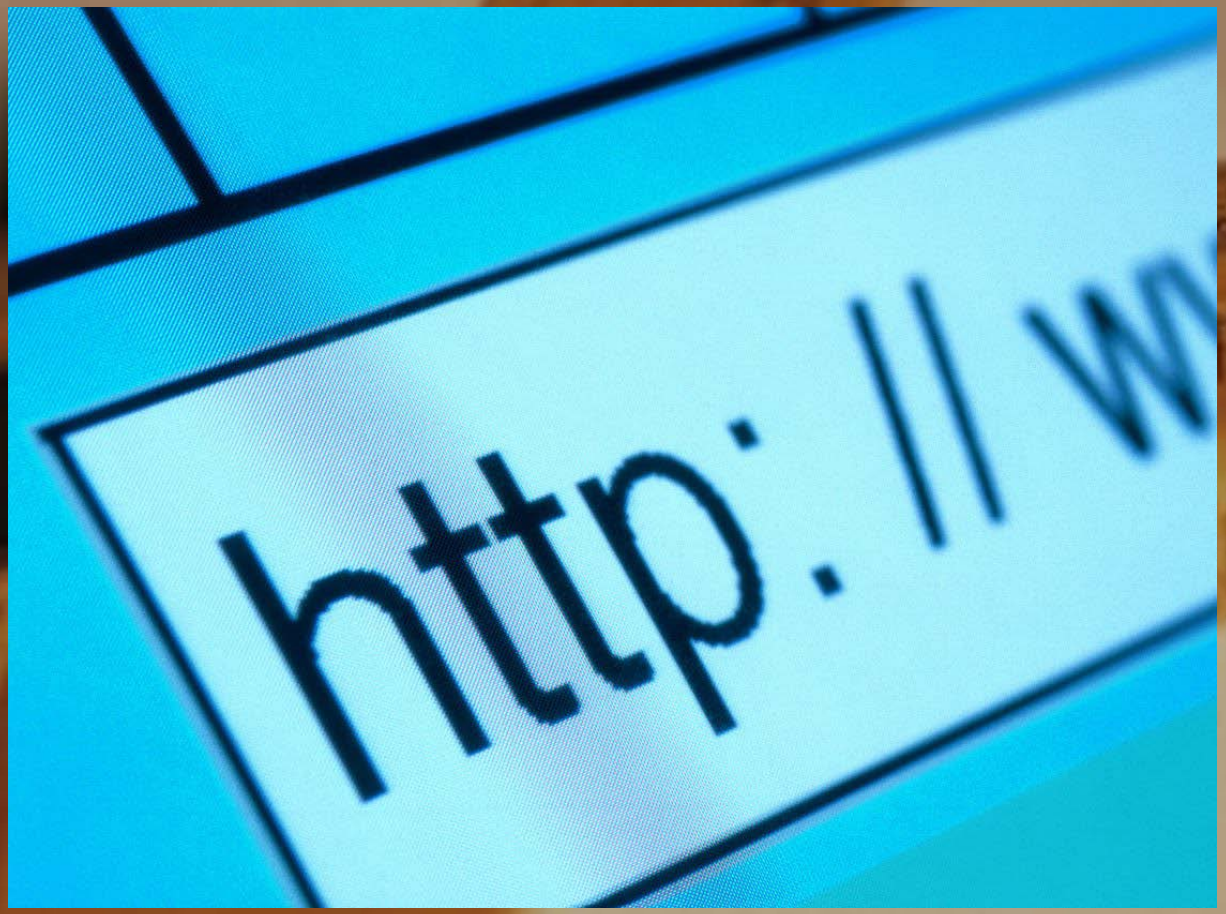


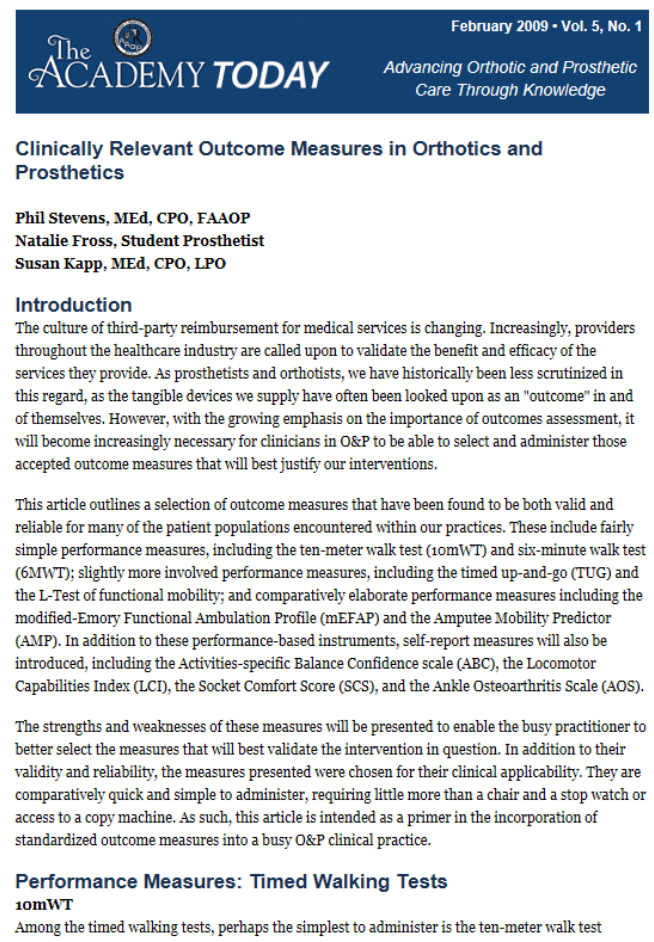
Spaulding et al. (2015)



Resources

Clinical Literature

- Introduce terminology
  - Types of measures
  - Psychometric properties
- Share experiences
  - Instruments well suited to O&P
  - Practical challenges
  - Realistic solutions
- Provide recommendations
  - Measures sensitive to interventions
  - Measures sensitive to change



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Advancing Orthotic and Prosthetic Care Through Knowledge

Clinically Relevant Outcome Measures in Orthotics and Prosthetics

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Susan Kapp, MEd, CPO, LPO

Introduction

The culture of third-party reimbursement for medical services is changing. Increasingly, providers throughout the healthcare industry are called upon to validate the benefit and efficacy of the services they provide. As prosthetists and orthotists, we have historically been less scrutinized in this regard, as the tangible devices we supply have often been looked upon as an "outcome" in and of themselves. However, with the growing emphasis on the importance of outcomes assessment, it will become increasingly necessary for clinicians in O&P to be able to select and administer those accepted outcome measures that will best justify our interventions.

This article outlines a selection of outcome measures that have been found to be both valid and reliable for many of the patient populations encountered within our practices. These include fairly simple performance measures, including the ten-meter walk test (10mWT) and six-minute walk test (6MWT); slightly more involved performance measures, including the timed up-and-go (TUG) and the L-Test of functional mobility; and comparatively elaborate performance measures including the modified-Emory Functional Ambulation Profile (mEFAP) and the Amputee Mobility Predictor (AMP). In addition to these performance-based instruments, self-report measures will also be introduced, including the Activities-specific Balance Confidence scale (ABC), the Locomotor Capabilities Index (LCI), the Socket Comfort Score (SCS), and the Ankle Osteoarthritis Scale (AOS).

The strengths and weaknesses of these measures will be presented to enable the busy practitioner to better select the measures that will best validate the intervention in question. In addition to their validity and reliability, the measures presented were chosen for their clinical applicability. They are comparatively quick and simple to administer, requiring little more than a chair and a stop watch or access to a copy machine. As such, this article is intended as a primer in the incorporation of standardized outcome measures into a busy O&P clinical practice.

Performance Measures: Timed Walking Tests

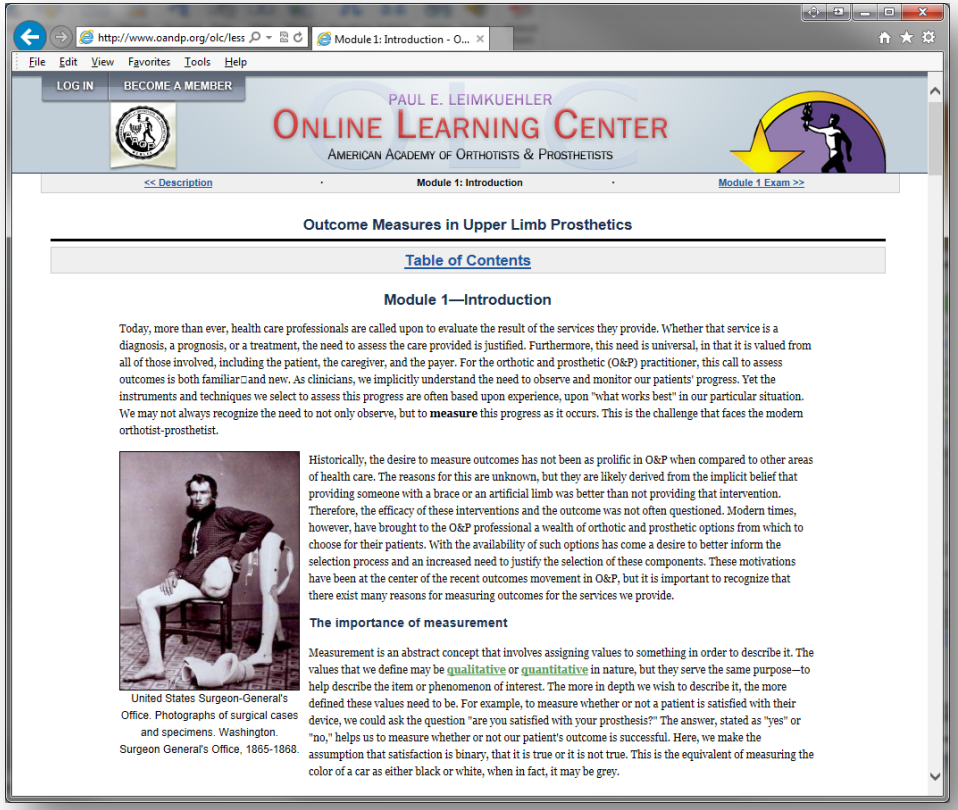
10mWT

Among the timed walking tests, perhaps the simplest to administer is the ten-meter walk test

American Academy of Orthotists & Prosthetists

Online Courses

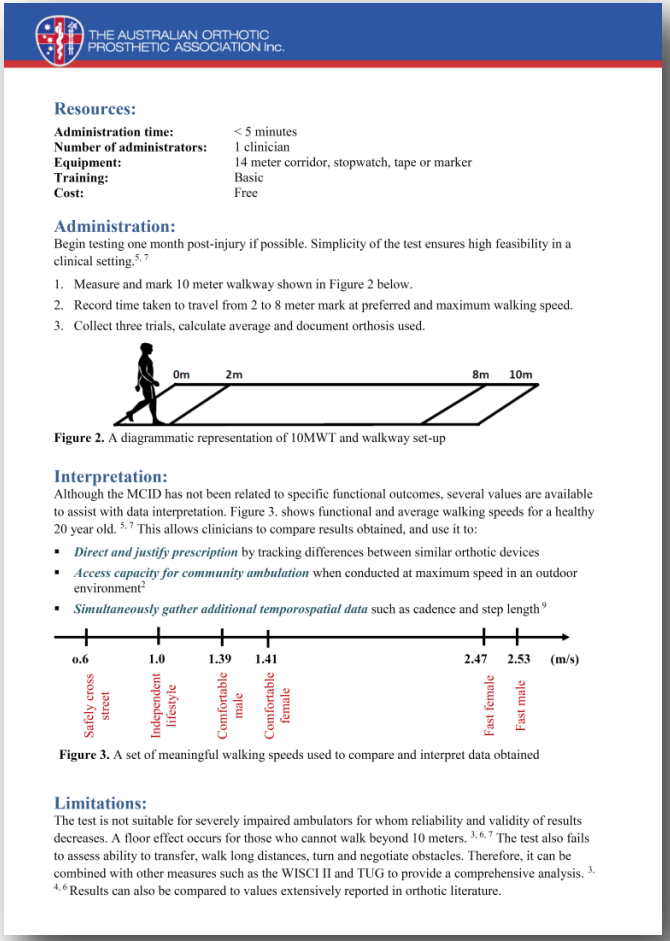
- Online Learning Center
  - Basic principles
  - Terminology
  - Types of measures
  - Review of available measures
  - Psychometric properties
  - Recommendations for use
- Access to measures
  - Lower limb measures
  - Upper limb measures



AAOP Online Learning Center (OLC)

Learning Materials

- "How-to" videos
  - Setup instructions
  - Administration instructions
  - Scoring instructions
- Quick reference guides
  - Intended uses
  - Psychometric properties
  - Required resources
  - Administration instructions
  - Interpretation information
  - Limitations



THE AUSTRALIAN ORTHOTIC PROSTHETIC ASSOCIATION Inc.

Resources:

Administration time:	< 5 minutes
Number of administrators:	1 clinician
Equipment:	14 meter corridor, stopwatch, tape or marker
Training:	Basic
Cost:	Free

Administration:

Begin testing one month post-injury if possible. Simplicity of the test ensures high feasibility in a clinical setting.[5, 7]

1. Measure and mark 10 meter walkway shown in Figure 2 below.
2. Record time taken to travel from 2 to 8 meter mark at preferred and maximum walking speed.
3. Collect three trials, calculate average and document orthosis used.

Figure 2. A diagrammatic representation of 10MWT and walkway set-up

Interpretation:

Although the MCID has not been related to specific functional outcomes, several values are available to assist with data interpretation. Figure 3. shows functional and average walking speeds for a healthy 20 year old. [5, 7] This allows clinicians to compare results obtained, and use it to:

- ***Direct and justify prescription*** by tracking differences between similar orthotic devices
- ***Access capacity for community ambulation*** when conducted at maximum speed in an outdoor environment[2]
- ***Simultaneously gather additional temporospatial data*** such as cadence and step length [9]

Figure 3. A set of meaningful walking speeds used to compare and interpret data obtained

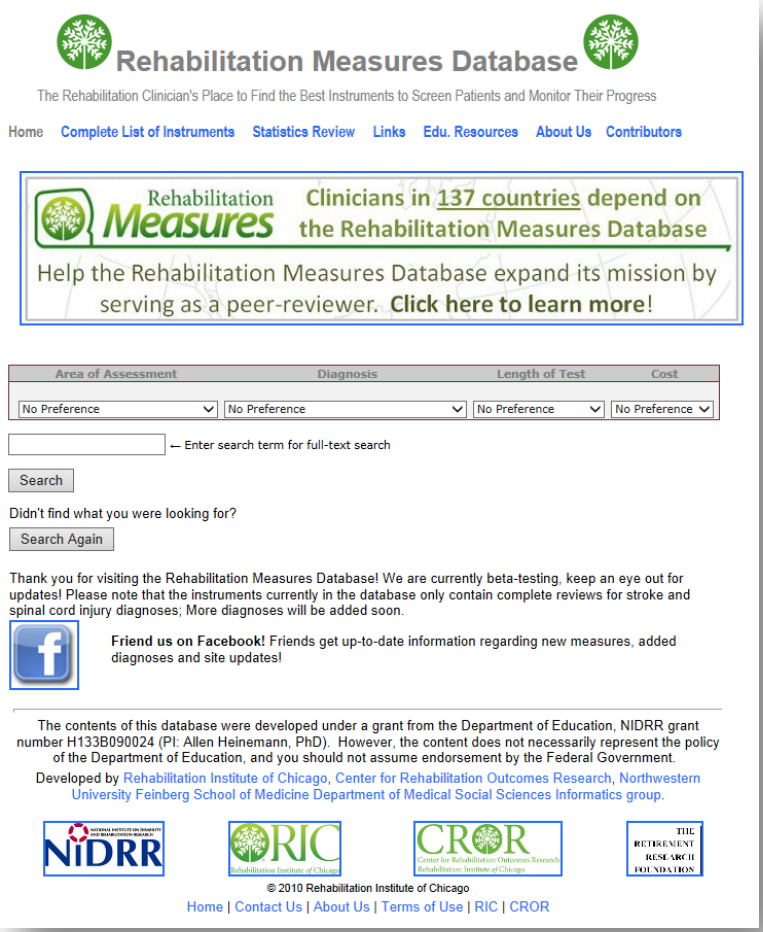
Limitations:

The test is not suitable for severely impaired ambulators for whom reliability and validity of results decreases. A floor effect occurs for those who cannot walk beyond 10 meters. [3, 6, 7] The test also fails to assess ability to transfer, walk long distances, turn and negotiate obstacles. Therefore, it can be combined with other measures such as the WISCI II and TUG to provide a comprehensive analysis. [3, 4, 6] Results can also be compared to values extensively reported in orthotic literature.

Australian Orthotic Prosthetic Association

Online Databases

- Outcome measure databases
  - Educational information
    - Terminology
    - Statistics
    - Psychometric properties
  - Online measure repositories
    - 100's of measures
  - Selection tools
    - Area of assessment
    - Population(s)
    - Time of test
    - Type of test
    - Cost
  - Compare and contrast
  - Usage recommendations

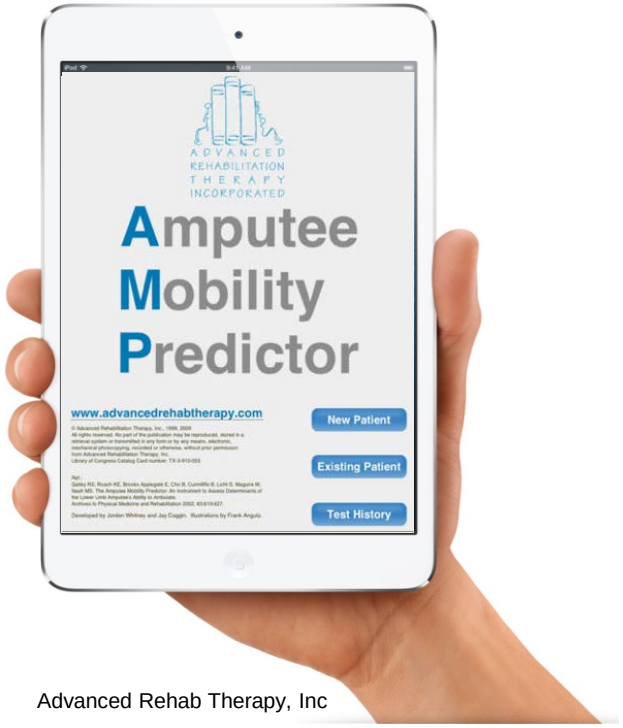


Rehabilitation Institute of Chicago

Measures

Collecting Measures

- Computerized outcome measures
  - Easy data entry
  - Patient/clinician instructions
  - Automatic scoring
  - Generated reports
  - Direct input into EMR
  - Saves time
  - Reduces paperwork



Advanced Rehab Therapy, Inc

Testing Measures

- Testing in O&P populations
  - Limb loss
  - Stroke
  - Cerebral palsy
  - Multiple sclerosis
- Testing psychometric properties
  - Reliability
  - Validity
  - Sensitivity
  - Responsiveness
  - Normative data
  - Translations

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AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation
journal homepage: www.archives-pmr.org
Archives of Physical Medicine and Rehabilitation 2013;94:2194-202

ORIGINAL ARTICLE

Validity and Reliability of the Berg Balance Scale for Community-Dwelling Persons With Lower-Limb Amputation

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Abstract

Objective: To evaluate the validity and reliability of the Berg Balance Scale (BBS) for use in people with lower-limb amputation.

Design: Cross-sectional study.

Setting: Research laboratory.

Participants: Individuals (N=30; age, 54±12y; 20 men) with unilateral transtibial (n=13), unilateral transfemoral (n=14), or bilateral (n=3) lower-limb amputation of dysvascular (n=7), traumatic (n=14), infectious (n=6), or congenital (n=3) origin.

Interventions: Not applicable.

Main Outcome Measures: BBS, 2-minute walk test, L test, Prosthesis Evaluation Questionnaire-Mobility Subscale, Activities-specific Balance Confidence Scale, and Frenchay Activities Index; self-reported descriptors were also collected, including frequency of prosthesis use, number of falls in 12 months before the visit, fear of falling, and daily mobility aid use.

Results: The BBS had high interrater reliability (intraclass correlation coefficient =.945) and internal consistency (α=.827). Relations between the BBS scores and those of other outcome measures were all statistically significant ($P \leq .001$). Significant group differences in BBS scores were observed for fear of falling (P=.008) and mobility aid use (P<.001), but not for multiple (≥2) falls in the previous 12 months (P=.381). BBS items involving reaching forward, turning 360°, tandem standing, and standing on 1 leg had relatively greater frequencies of lower scores across participants.

Conclusions: The BBS appears to be a valid and reliable clinical instrument for assessing balance in individuals with lower-limb amputation, but it may not be able to discriminate between individuals with greater or lesser fall risk. Limitations in prosthetic motion and control may be responsible for the challenges experienced on items of lower performance. Future studies would be useful to assess the responsiveness of the BBS to interventions aimed at improving balance in individuals with lower-limb amputation.

Archives of Physical Medicine and Rehabilitation 2013;94:2194-202

Revising Measures

Instructions for Participants
For each of the following, please indicate your level of confidence in doing the following activities without losing your balance or becoming unsteady by choosing one of the percentage points on the scale from 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 walking aid to do the activity or hold onto someone, rate your confidence as if you were using these supports. If you have any questions about answering any of the following, please ask the administrator.

Rating Scale
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

ABC Questions
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 something off the floor?

____ % 4. Reach for a small can off a shelf at eye level?

ABC based on Powel (1995)

Revising Measures

For each of the following, please indicate your level of confidence in doing the following activities without losing your balance or becoming unsteady. 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 walking aids to do the activity or hold onto someone, rate your confidence as if you were using these supports.

How confident are you that you will not lose your balance or become unsteady when you ….	**No confidence**	**Low confidence**	**Moderate confidence**	**High confidence**	**Complete confidence**
1. Walk around the house?	☐	☐	☐	☐	☐
2. Walk up or down stairs?	☐	☐	☐	☐	☐
3. Bend over and pick up something off the floor?	☐	☐	☐	☐	☐
4. Reach for a small can off a shelf at eye level?	☐	☐	☐	☐	☐

ABC based on Sakakibara (2011)

Creating New Measures

- Contemporary measures
  - Rigorous development standards
    - Conceptual framework
    - Input from stakeholders
    - Literature review
    - Focus groups
    - Item pooling
    - Cognitive interviews
    - Pilot testing
    - Large scale testing
    - Longitudinal testing
    - Translation

PROMIS®
Instrument Development and Psychometric Evaluation Scientific Standards*

The Patient-Reported Outcome Measurement Information System (PROMIS®), funded by the National Institutes of Health, aims to provide clinicians and researchers access to efficient, valid, and responsive self-reported measures of health, including symptoms, function and well-being. PROMIS instruments are grounded in modern measurement theory. They were developed using mixed qualitative and quantitative methods employed to inform one another in an iterative process.

This document describes a set of standards that serve as the scientific foundation and guidance for the development and evaluation of PROMIS item banks and instruments. A general summary of instrument development and validation standards is followed by an appendix that summarizes a maturity model for PROMIS item banks and instrument development and evaluation. The instrument maturity description document provides information concerning the readiness of measures derived from the PROMIS item banks for use in clinical research and practice (see Appendix 1). This is then followed by several appendices that outline specific practices in more detail. The practices outlined in this document were based on the experience of PROMIS investigators, the published literature, and several existing sets of scientific methodology documents. These scientific standards are operationalized by a series of guidelines that provide detailed guidance for item bank development and psychometric evaluation, as well as a summary of existing PROMIS practices. Reference citations are provided at the end of each individual guidance document.

Instrument development and psychometric evaluation is a process of accumulating evidence. Some standards, such as those related to translation and cross-cultural adaptation, reliability, validity, or interpretability, will pertain only to those item banks and instruments that have a relevant language translation or have accumulated data on reliability, validity, or information regarding interpretation. Similarly, guidelines regarding item banks and CAT instruments apply only to calibrated item banks; yet not every PROMIS product is a calibrated item bank.

List of Standards

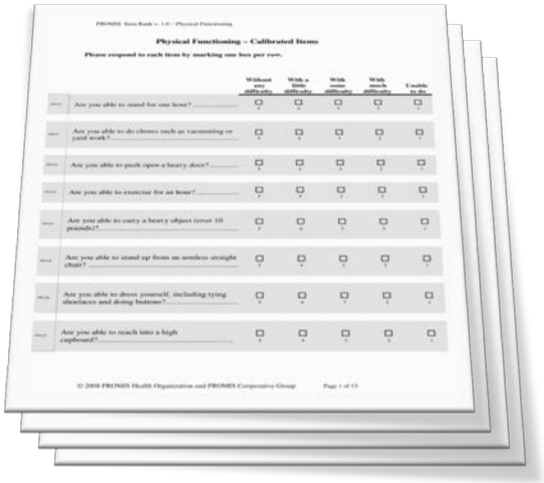
1. Defining Target Concept and Conceptual Model
2. Composing Individual Items
3. Constructing Item Pool
4. Determining of Item Bank Properties
5. Testing and Instrument Formats
6. Validity
7. Reliability
8. Interpretability
9. Language Translation and Cultural Adaptation

*We use the term "Standards" recognizing that "best practice" instrument development and psychometric evaluation often requires flexibility in choosing from among competing approaches or decision thresholds. This document is therefore more of a "Guidance" with minimum standards and ideal targets. We invite comments at Info@nihpromis.org

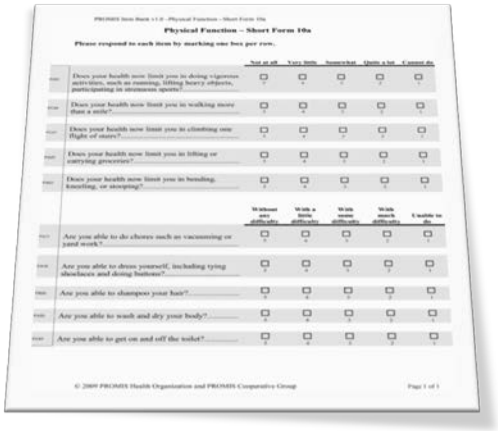
NIH Patient Reported Outcome Measurement Information System

Creating New Measures

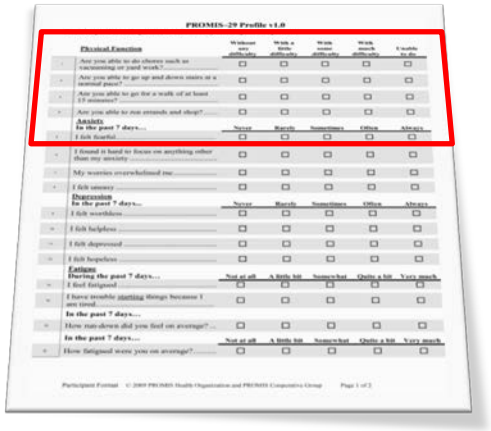
- Calibrated item banks
- Short forms
  - Standardized or custom
  - Same metric – scores have the same meaning



Physical Function **Item Bank**
124 items, 15 pages



Physical Function **Short Form**
10 items, 1 page

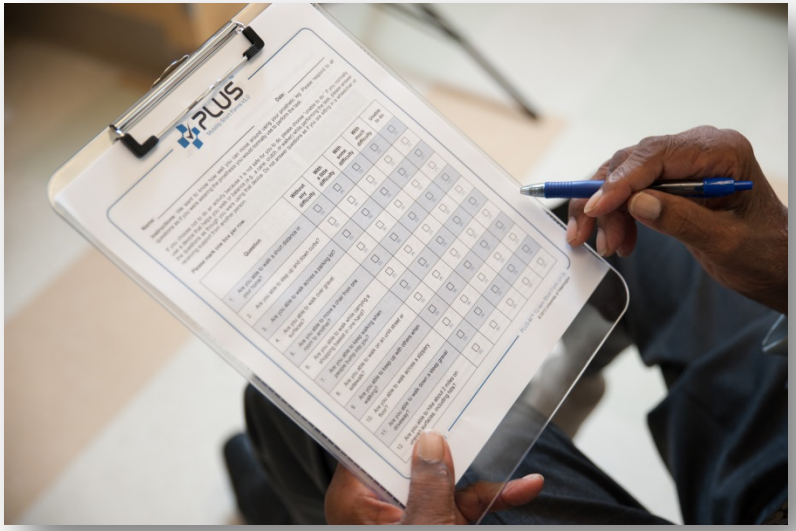


Physical Function **Profile**
4 items, ¼ page

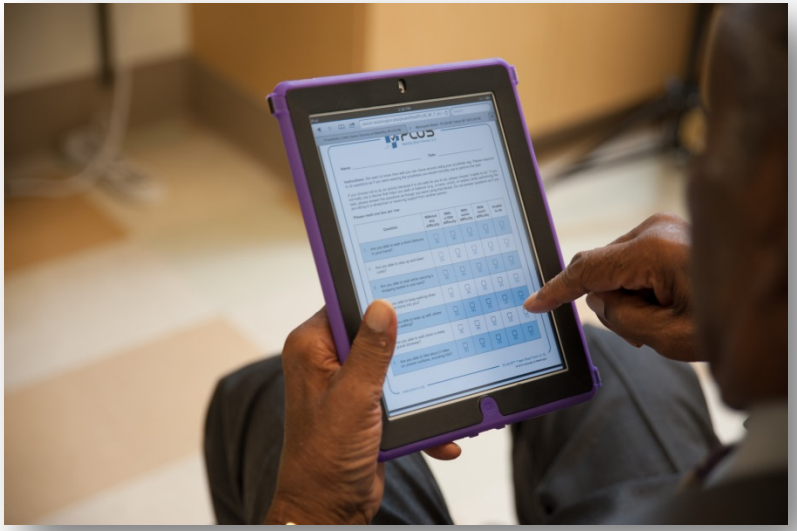
NIH Patient Reported Outcome Measurement Information System

Creating New Measures

- Flexible Administration Formats
  - Pen and paper forms
  - Computerized forms
  - Tablets and smartphones
  - Voice recognition



University of Washington



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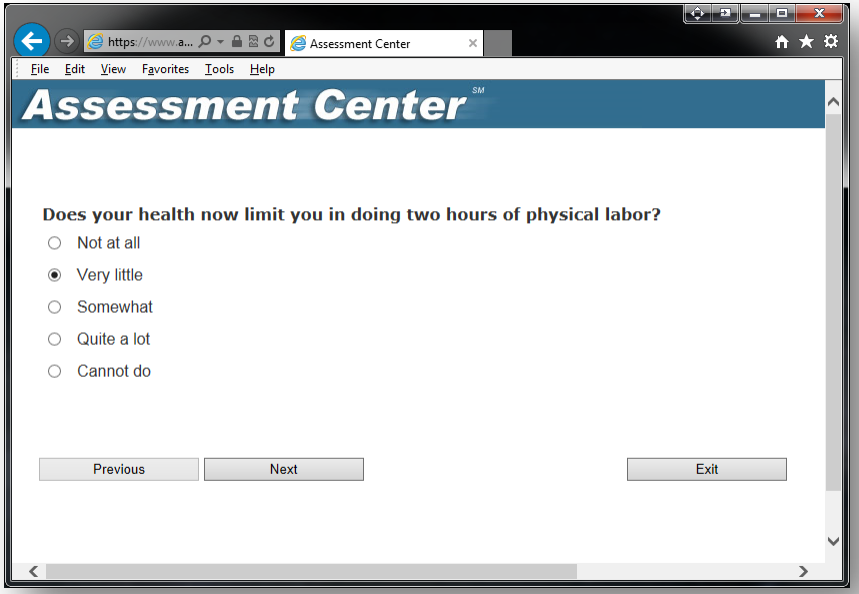
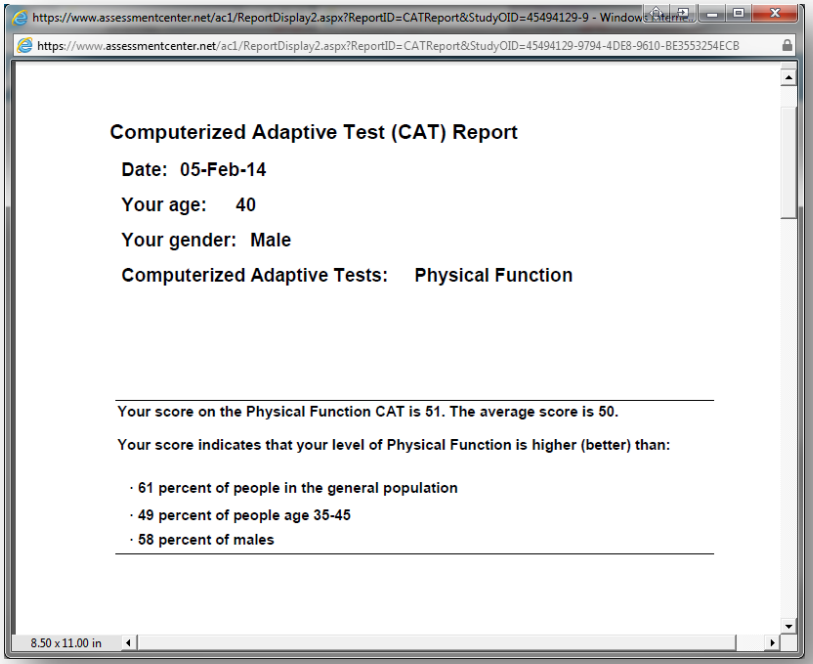
Creating New Measures

- Computerized adaptive testing (CAT)
  - Simplified testing
  - Automatically generated reports
  - Example: PROMIS-PF - 124 bank items, ~4 CAT items required



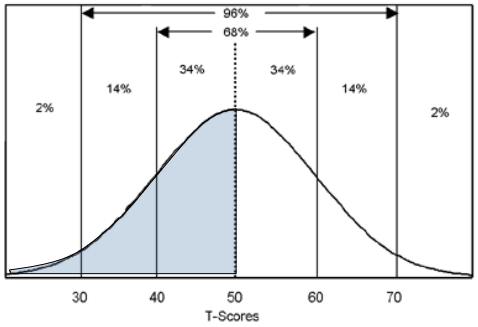
PROMIS Assessment Center

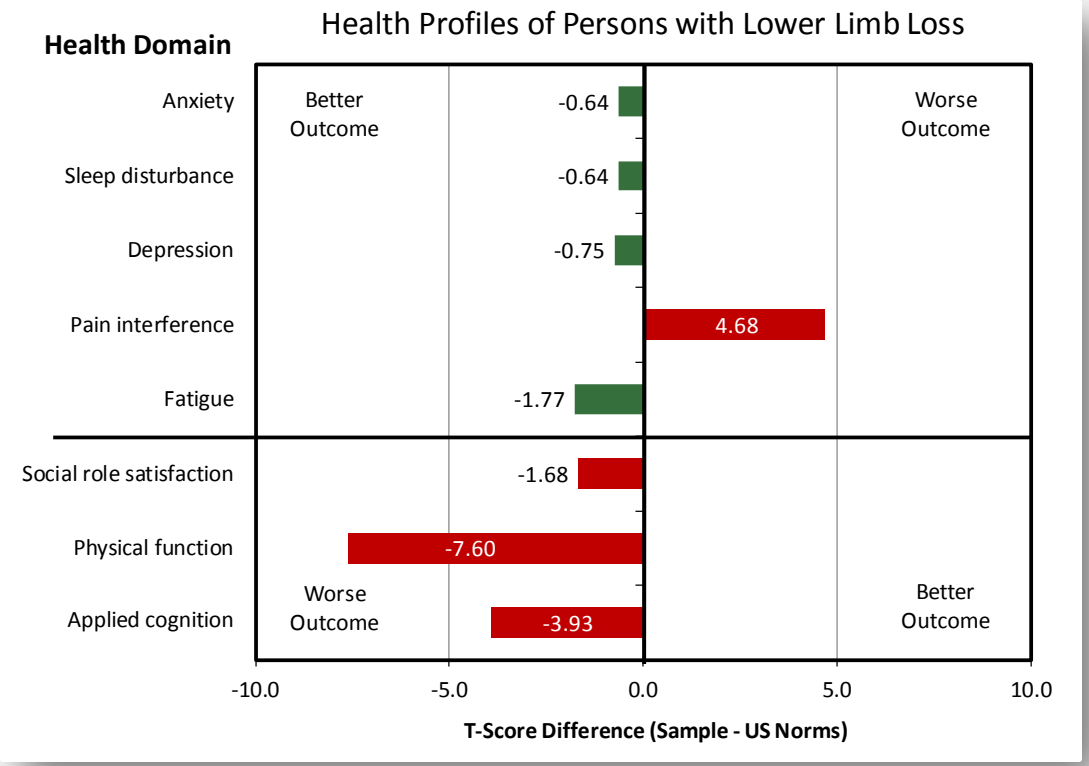


PROMIS Assessment Center

Creating New Measures

- New terminology
  - T-scores
  - Standard error
  - Minimal clinically important difference
- New kinds of data
  - Profiles





Creating New Measures

- Normative data
  - Facilitates interpretation
  - Compare patients

Table 5 – PLUS-M™ T-scores and percentiles (total sample)

PLUS-M T-Score	Transfemoral Dysvascular (n=120)	Transtibial Dysvascular (n=367)	Transfemoral Trauma (n=266)	Transtibial Trauma (n=338)	Total Sample (n=1091)
Mean	42.9	47.4	50.5	55.9	50.3
25th Percentile	37.2	41.7	45.1	49.5	43.7
50th Percentile (median)	42.6	47.2	50.1	55.4	50.0
75th Percentile	49.7	53.3	55.3	61.8	56.3
Standard Deviation (SD)	9.0	8.9	8.1	9.3	9.8
Range (min – max)	17.5 – 67.0	21.9 - 73.6	25.7 - 76.6	31.8 - 76.6	17.5 - 76.6

Table 6 – PLUS-M™ T-scores and percentiles (males)

PLUS-M T-Score	Transfemoral Dysvascular (n=86)	Transtibial Dysvascular (n=261)	Transfemoral Trauma (n=183)	Transtibial Trauma (n=238)	Total Sample (n=768)
Mean	43.9	48.5	51.3	57.3	51.4
25th Percentile	37.6	42.7	45.7	50.8	44.9
50th Percentile (median)	44.6	48.0	50.9	57.0	51.2
75th Percentile	49.8	54.6	56.0	63.5	57.6
Standard Deviation (SD)	8.4	8.7	8.1	9.3	9.8
Range (min – max)	24.1 – 67.0	21.9 - 73.6	25.7 - 76.6	31.8 - 76.6	21.9 - 76.6

Table 8 – PLUS-M™ T-scores and percentiles (persons under 35 years old)

PLUS-M T-Score	Transfemoral Dysvascular (n=4)	Transtibial Dysvascular (n=5)	Transfemoral Trauma (n=43)	Transtibial Trauma (n=55)	Total Sample (n=107)
Mean	53.7	50.6	52.8	59.4	56.1
25th Percentile	48.8	44.8	47.4	52.6	48.1
50th Percentile (median)	50.7	44.9	52.9	58.1	54.9
75th Percentile	55.6	47.5	57.5	67.4	62.2
Standard Deviation (SD)	9.2	12.9	7.4	10.0	9.6
Range (min – max)	46.3 – 67.0	42.2 - 73.5	38.4 - 76.6	36.1 - 76.6	36.1 - 76.6

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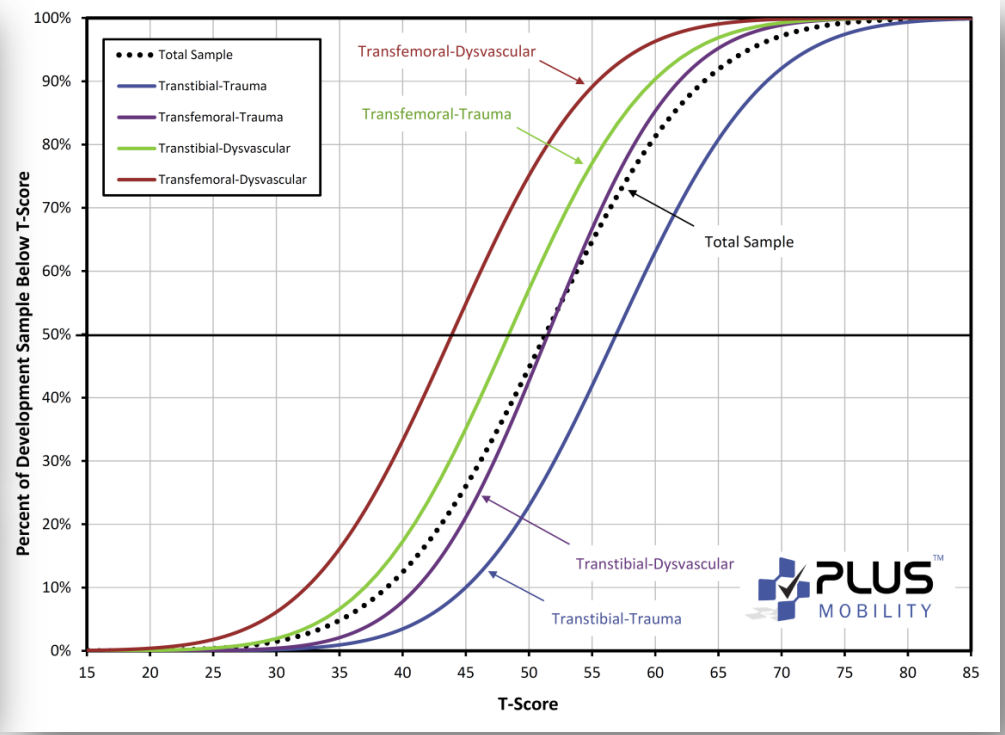

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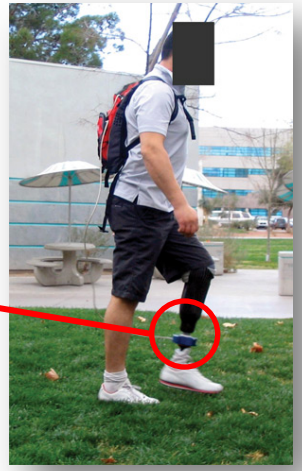
Technologies

Portable Instruments

- Load cells / strain gages
  - Socket reaction forces
  - Alignment
  - Forces on implants
  - Rollover kinetics
  - Activity classification
  - Symmetry (bilateral)
- GPS sensors
  - Location
  - Community activity
  - Access



University of Nevada, Las Vegas

Flinders University, Australia

University of Wisconsin-Madison

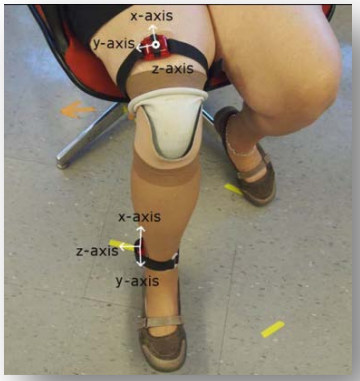
Portable Instruments

- Temperature / pressure sensors
  - Wear, compliance
- Accelerometers / gyroscopes
  - Activity, posture recognition

Maxim
iButton

University of Brescia

Actilife
Actigraph



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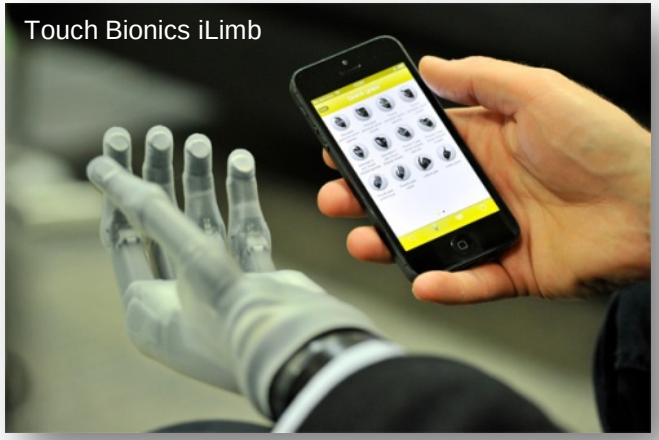
Xsens
MVN

King's College London

Device Sensors

- Smart Prosthetics/Orthotics
  - Integrated sensors
  - Computer communication
  - Patient smartphone applications
- Great potential for measurement
  - Troubleshooting
  - Repair/replacement
  - Warranty/servicing
  - Use/wear time
  - Activities
  - Stumbles/falls


Touch Bionics iLimb

Orthocare Innovations Magellan

Motion Capture Technologies

- Low-cost 2D and 3D systems
  - Inertial sensors
  - Portable walkways
  - Moiré tracking

ADPM, Inc.


CIR Systems, Inc.

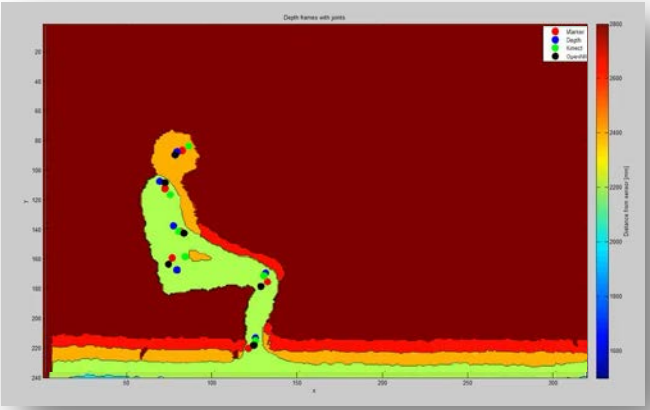

Metria Innovations, Inc.

Gaming Technologies

Nintendo Wii Balance Board

Microsoft Kinect

Touro College and A Step Ahead Prosthetics

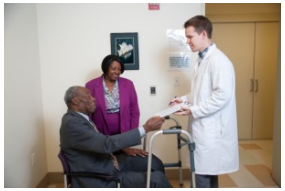
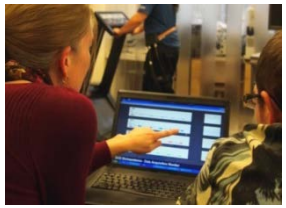


Marche Polytechnic University

The Future of Clinical Practice?

- Before visit
  - Integrated device sensor measures daily activities, stumbles, and falls
  - Periodic, brief health surveys administered by CAT (email, phone)
  - Valid and reliable measures selected for the patient
  - Practitioner and assistant review measures and take online training course
- During visit
  - Self-report surveys administered to patient on tablet computer
  - Measures automatically scored and data uploaded to patient file
  - Assistant downloads data from device and administers performance tests
  - Report generated with current scores, historical scores, and appropriate norms
  - Practitioner reviews report and meets with patient to discuss concerns
  - Revised treatment implemented to address identified issues
  - Practitioner programs portable instrument to collect data and attaches to device
- After visit
  - Instrument monitors patient outcomes and patient mails it back to clinic
  - Assistant downloads data and automated analysis confirms positive outcomes
  - Patient data recorded and system prepares automatic justification report
  - All of the above integrated with clinic-wide data to conduct QI activities



Final Thoughts

- Limited use of outcome measures
- Many barriers exist
- But so do facilitators
  - Academic standards have changed
  - Educational opportunities exist
  - Resources are available
  - Measures are being tested, revised, and developed
  - New technologies offer promise
- The culture is already changing
  - With it comes new challenges…and opportunities
  - Potential to elevate our industry and profession

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Thank You

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