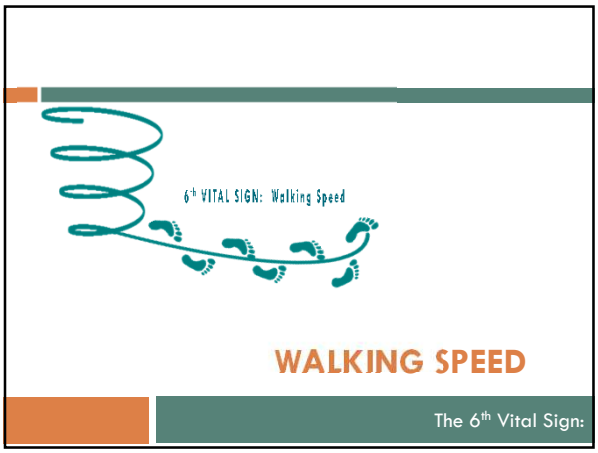
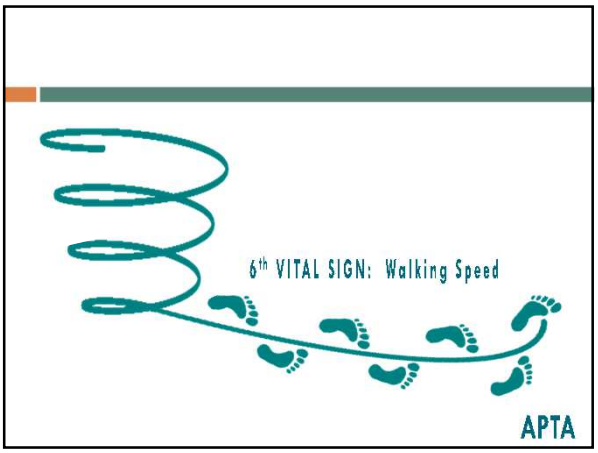
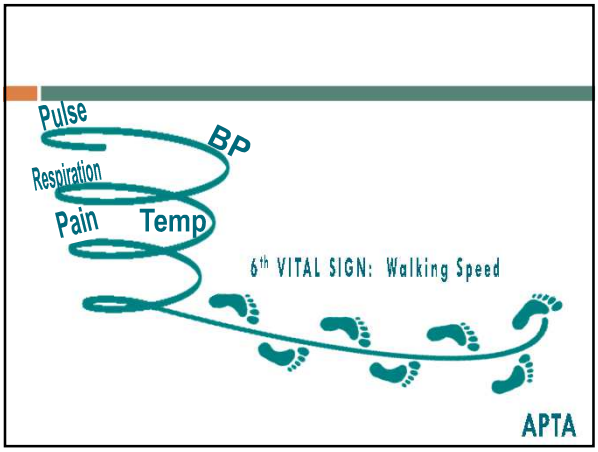






Key Questions

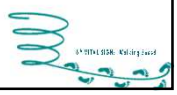
A primary physical therapy goal is to screen for mobility limitations

- What is our common metric or metrics for measuring walking recovery?
- Do we know if we make a difference?

Objective:
Demonstrate why WS should be the 6th Vital Sign

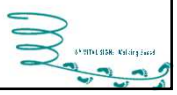
Walking Speed is Outstanding Indicator

- Predictive:
  - Walking speed is a powerful indicator of health & disease
- Evaluative:
  - Clinical evaluation of abnormal gait speed
- Simple, Feasible, & Understandable:
  - Normative data, understand abnormal data, understand meaningful change



Walking Speed is….

- "…almost the perfect measure" (Wade 1992)
  - Reliable (Richards 1995)
  - Valid (Steffen 2002)
  - Sensitive (van Iersel 2008)
  - Specific (Harada1995)
  - Correlates with
    - Functional ability (Perry1995)
    - Balance confidence (Mangione 2007)



Walking Speed: Predictive

- Future health status (Studenski 2003; Purser 2005)
- Functional decline (Brach 2002)
  - Hospitalization (Montero-Odasso 2005)
  - Discharge location (Salbach 2001; Rabadi 2005)
  - Mortality (Hardy 2007)
- Functional & Physiological changes (Perry1995)
  - Potential for rehabilitation (Goldie 1996)
  - Aids in prediction of:
    - Falls (Guimaraes 1980)
    - Fear of falling (Maki 1997)

Walking Speed: Predictive

- Example:
  - WS predicts the post hospital discharge location 78% of the time in acute stroke
    - the addition of cognition or initial FIM scores does not significantly strengthen the ability of defining if a patient will be discharged to home or to a skilled nursing facility (Rabadi 2005)

Admission Ambulation Velocity Predicts Length of Stay and Discharge Disposition Following Stroke in an Acute Rehabilitation Hospital

Meheroz H. Rabadi and Alan Blau

Neurorehabilitation and Neural Repair 19(1); 2005

Walking Speed

- Progression of WS has been linked to
  - clinical meaningful changes in **quality of life** (Schmid 2007)
  - in home & community walking behavior. (Bowden 2008)
- Due to its ease of use (Guralnik 2000) & psychometric properties, WS has been used as a **predictor & outcome measure** across multiple diagnoses.
  - Older adults (Studenski 2003) (Perera 2006)
  - Incomplete Spinal Cord Injury (Behrman 2005)
  - Frail Elderly (Purser 2005)
  - Hip Fracture (Palombaro 2006)
  - Pain & LBP (Lee 2007)
  - Children (Meyer-Heim 2007)
  - Stroke (Bowden 2008)
  - Parkinson's Disease (Rochester 2009)

Contributors to Walking Speed

1. Individual's health status (Lord 2005)
2. Motor control (Gerin-Lajoie 2006)
3. Muscle performance & Musculoskeletal condition (Buchner 1996; Ostchega 2004)
4. Sensory & perceptual function (teVelde 2003)
5. Endurance & habitual activity level (Langlois 1997)
6. Cognitive status (Persad 2008)
7. Motivation & mental health (Lemke 2000; Fredman 2006)
8. Characteristics of the environment in which one walks (Robinett 1988)

NIH Toolbox

Assessment of Neurological and Behavioral Function

- Chosen by a panel of experts at NIH as the standardized assessment to measure locomotion www.nihtoolbox.org

Motor Function and the NIH Toolbox

David Reuben, MD, University of California - LA
Email: dreuben@mednet.ucla.edu

Motor function, the ability to physically perform tasks, is integrally related to daily functioning and quality of life. Accordingly, assessment of motor function has been included as a major domain of the NIH Toolbox. To identify the components of motor function to be measured in the Toolbox, a Motor Domain Team was created consisting of David Reuben, MD, Domain Co-leader; W. Zev Rymer, MD, PhD, Domain Co-leader; Edward Wang, PhD, Domain Co-Manager; Jin-Shei Lai, PhD, OTR/L, Domain Co-Manager; and Inga Wang, PhD, Scientist.

The Motor Team began its work with literature reviews, a field survey of 147 researchers, in-depth interviews with 9 motor experts, and a national expert review of the process and early findings. Through this process, the team identified five subdomains that are critical for optimal functioning: locomotion, nonvestibular balance, dexterity, strength, and endurance.

The team then proceeded through a selection process to identify candidate instruments that would provide robust measurement in each of these areas. This process was guided by ground rules established by the National Institutes of Health. First, instruments were to be objective (performance-based) rather than self-report. Second, instruments needed to be applicable to all age groups from 3 years upward. (cont'd page 2)

Locomotion: is defined as an act of moving from one place to the other place, reflecting ambulation ability including walking distance, velocity, and quality of the gait under different environments and ground surfaces. To assess locomotion, the 20-foot walk test was selected.

Walking Speed as a Vital Sign

Vital sign is:	Walking speed is:
Summary indicator that can predict future events & reflect multiple underlying physiological processes , reflects overall health of organism (Studenski 2003, 2009)	A summary indicator capable of predicting future events as a result of multiple physiologic inputs will be demonstrated
In general, there are normal & abnormal **ranges**	**Ranges** of normal & abnormal values will be defined
Differential diagnosis of an abnormal vital sign is based on contributing systems e.g. causes of hypertension	A **differential diagnosis,** based on contributing systems, can be developed

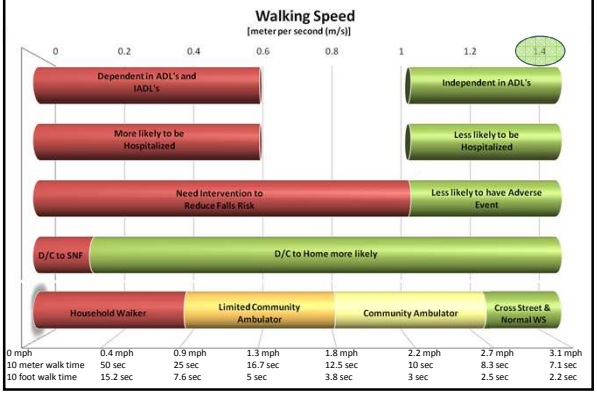
Walking Speed as a **Vital Sign**

General indicator that can predict future events & reflect various underlying physiological processes

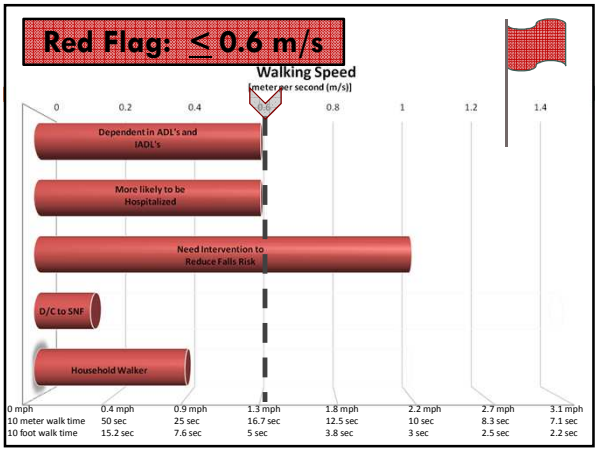
(Studenski 2003)

- WS cannot stand alone as the only predictor of functional abilities, just as blood pressure is not the only sign of heart disease
  - WS can be used as a functional "vital sign" to help determine outcomes such as:
    - functional status (Perry1995; Studenski 2003)
    - discharge location (Rabadi 2005)
    - need for rehabilitation (Montero-Odasso 2005)
    - speed necessary for function in the community (Perry 1995)

Evidence across studies…. Fritz S, Lusardi M, JGPT 32(2) 2009



Red Flag: ≤ 0.6 m/s



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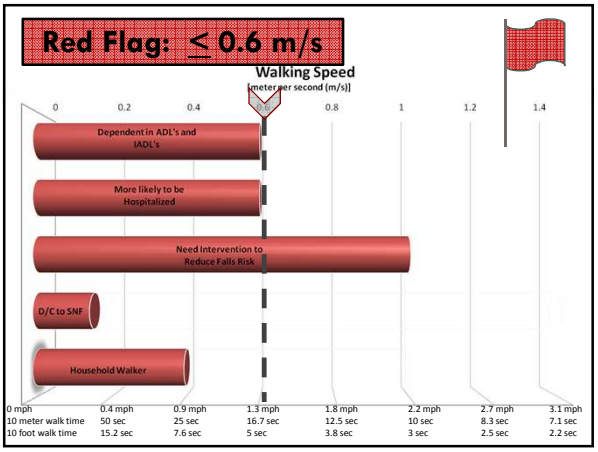

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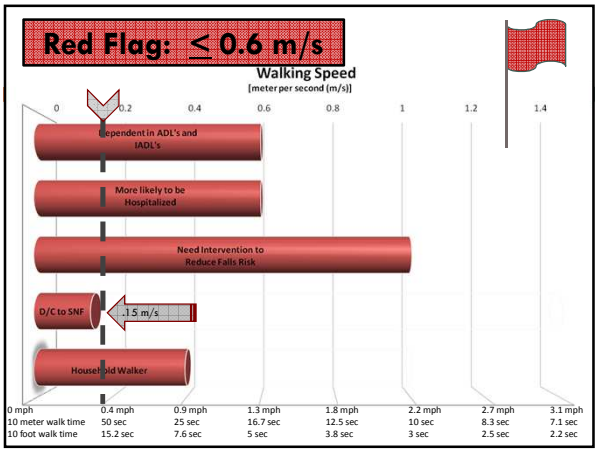
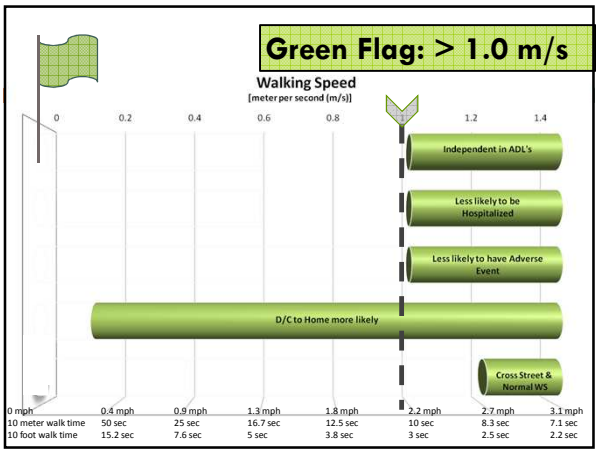
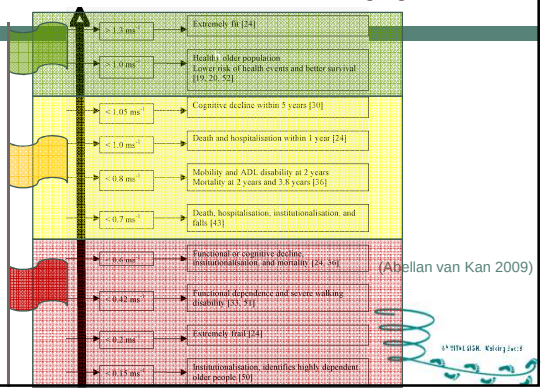


Yellow Flag: 0.6 – 1.0 m/s



Cut Points: Adverse Outcomes For Aging Adults



(Abellan van Kan 2009)

Community Function:

Example Task:

- Assess Traffic & Step off curb (1.5 sec)
- Cross Traffic Lanes (4 m/lane)
- Step up onto sidewalk (1.5 sec)

To safely cross:

- Critical speed = total distance / available time

Crossing the Street:

(10 sec signal) – (3 sec for curbs) = 7 sec
2 traffic lanes (8 m)
Critical speed: 1.14 m/sec

(15 sec signal) – (3 sec for curbs) = 12 sec
4 traffic lanes (16 m)
Critical speed: 1.33 m/sec

Considerations:

- Curb height / curb cuts
- Condition of road / type of surfaces
- Lighting
- Gradients
- Weather conditions
- Other pedestrians
- Distractions (Ipods, conversation)
- Additional Tasks (umbrellas, luggage, groceries…)
- Footwear
- Need to scan environment
- Use of assistive devices
- "Culture" of community

Finnis, 2008

Walking Speed and Function

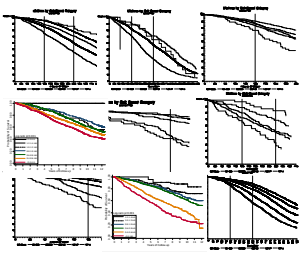
Walking speed		METS	Function
m/sec	mph		
.67	1.5	< 2	self care
.89	2.0	2.5	household activities
1.11	2.5	3.0	carry groceries, light yard work
1.33	3.0	3.5	climb several flights of stairs

N= 492 elders (Studenski ,2003)

Walking Speed Predicts…

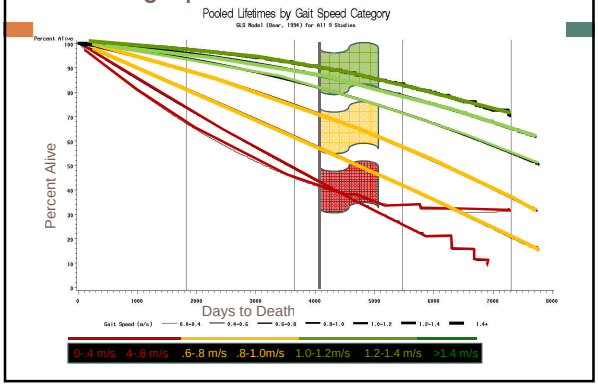
Walking Speed Predicts..
… How Long You Live

- Results pooled from nine participating studies that included 34,370 older adults

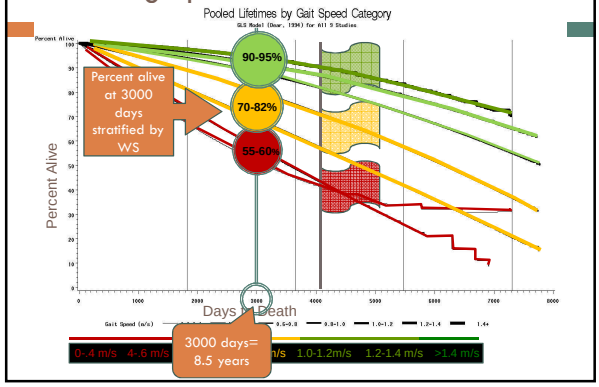


Studenski, 2009

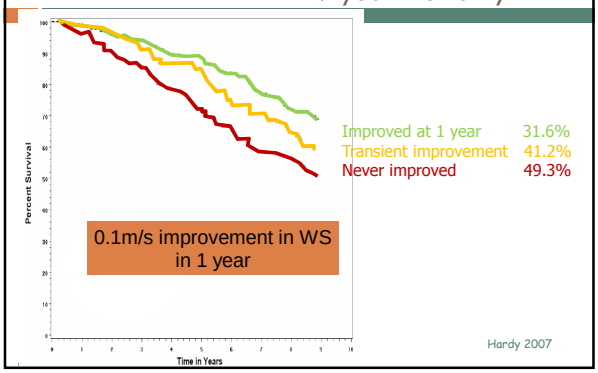
Walking Speed is Predictive



Walking Speed is Predictive



GAINS in Walking speed predicts…
…9 year mortality



GAINS in Walking speed predicts…
…9 year mortality

Walking Speed Predicts…
…Health Status and Hospital Costs

- **Differences of 0.10 m/sec at hospitalization**
  - Poorer health status (SF-36)
  - Poorer Physical Functioning
  - More disabilities
  - More rehab & med-surgical visits
  - Longer hospital stays
  - Higher inpatient costs

- **Improvements of 0.10 m/s at 1 year**
  - Improved health status, less ADL & IADL disability, better physical function
  - Fewer hospitalization days
  - 1 year cost reductions of ~$1,188 per 0.10 m/s improve

Purser 2005

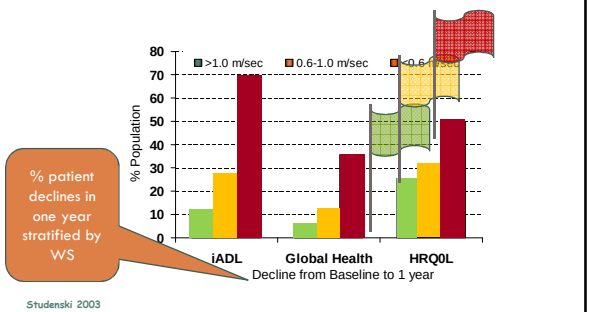
Walking Speed Predicts…
…6 month mortality

3.8 times more likely to die in 6 months if WS ≤ 0.65

	Patients n (%)		Adjusted OR
Overall	**309**		
Gait ≤ 0.65 m/s	**156 (50)**	**22 (14.1%)**	**3.8 (1.1, 13.1)**
Grip ≤ 25 kg	**155 (50)**	**20 (12.9%)**	**2.7 (0.7, 10.0)**
Stands ≤ 7 times	**172 (56)**	**21 (12.2%)**	**1.5 (0.5, 5.1)**
Fried Frail	**84 (27)**	**10 (11.9%)**	**1.9 (0.6, 6.1)**

Final models adjusted for age, gender, race, education, diabetes, CHF, number of comorbid conditions, creatinine, smoking, cognitive impairment, depression, systolic blood pressure, self-rated health, hematocrit, primary treatment regimen, & number of disabilities.

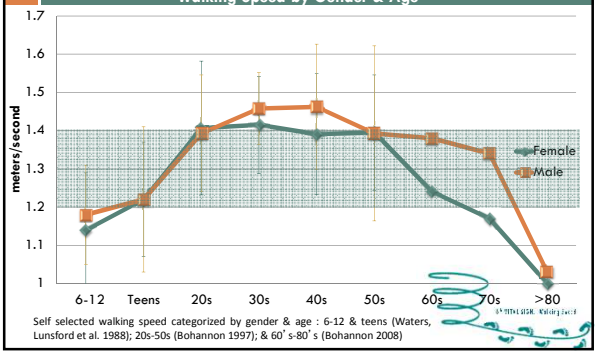
Walking Speed Predicts…
…1 year health outcomes



% patient declines in one year stratified by WS

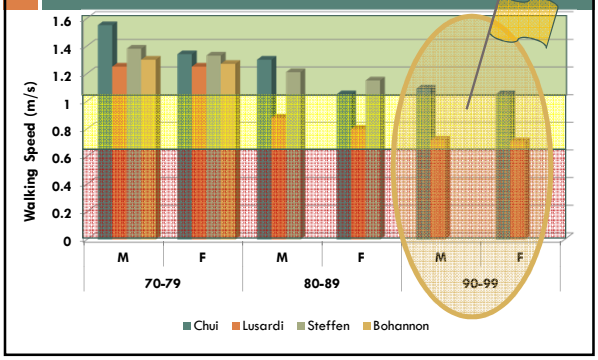
Studenski 2003

Walking Speed Varies By...
...Age, Gender, & Anthropometrics



Self selected walking speed categorized by gender & age : 6-12 & teens (Waters, Lunsford et al. 1988); 20s-50s (Bohannon 1997); & 60's-80's (Bohannon 2008)

Walking Speed Varies By...
...Age, Gender, & Anthropometrics



How to Measure Walking Speed

Feasibility of Use

Several standardized assessments reliably predict function & health related events:

- Yet, consistent use in PT & other clinical settings is not widely practiced (Duncan 2000)

Factors contributing to non-use of standardized assessments include:

- Insufficient time
- Inadequate equipment or space
- Lack of knowledge in interpreting the assessment (Cesari 2005)

Feasibility of Use

Feasibility

1. Is the test safe?
2. Is it cost effective?
3. How easy is the test to administer?
4. How easily are the results of the test graded & interpreted?

Walking Speed

1. Safe
2. Adds no significant cost to an assessment
3. Easy to Administer
   - Requires no special equipment
   - Requires little additional time
     - Administered in about 2 minutes (Studenski 2003)
4. Easy to calculate (distance/time)
   - Easy to interpret based on published norms
     - (Oberg 1993; Bohannon 1997; Steffen 2002; Lusardi 2003)

Assessment

- Walking speed can be quickly & accurately assessed in the majority of PT practice settings

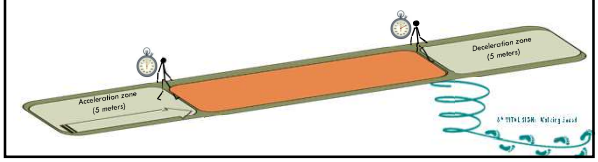
- home care
- subacute & acute rehabilitation facilities
- long term care facilities
- out-patient offices
- schools
- community wellness/ screening activities (Bohannon 2009)

Assessment

- Most normative values are based on measuring the middle 2/3^{rds} of a walkway (Bohannon 2008)
  - Timing 3 times provides a more accurate estimate than a single trial (Steffen 2002; Lusardi 2003; Bohannon 2009)
- However, measurements of WS are highly reliable regardless of:
  - the method for measurement
  - different patient populations (Bohannon 1997; Steffen 2002)

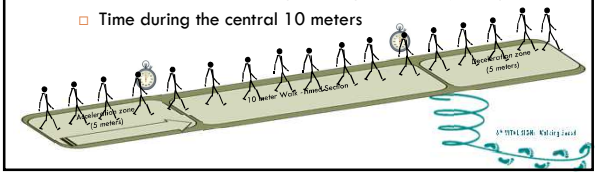
10 Meter Walk Test

- Reliable, inexpensive method (Perera 2006)
- 20 meter path
  - Central 10 meters being the timing area



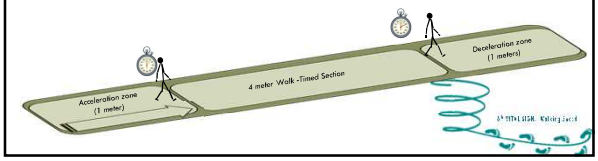
10 Meter Walk Test

- Reliable, inexpensive method (Perera 2006)
- 20 meter path
  - Central 10 meters being the timing area
- Start your patient at the beginning of the 20 meter line
  - Ask pt to walk "at a comfortable pace" to the end line
    - *"Walk at a comfortable pace as if you are walking in the park"*
  - Time during the central 10 meters



4 Meter Walk Test

- Reliable
  - Recommended as most feasible
- 6 meter path
  - Central 4 meters being the timing area



4 Meter Walk Test

Quick Gait Speed Test	
Meters/second	= 4/time to walk
3 seconds	1.3 m/s
4 seconds	1.0 m/s
5 seconds	0.8 m/s
6.7 seconds	0.6 m/s

Conversion	
Meters/second	Miles / hour
0.4	0.9
0.6	1.3
0.8	1.8
1.0	2.2
1.2	2.7
1.4	3.1

Instrumentation to Measure WS

6 minute walk

- Most widely used long walk
  - widely accepted for congestive heart failure & COPD
- Recommended cutoff is 350 meters
  - equivalent to gait speed of around 1.0 m/s
- Possible that endurance is incorporated into usual walking speed
  - individuals self select their personal optimal walking speed
    - which is adjusted for their aerobic capacity & their energy cost (Studenski 2009)

Efforts to clarify & standardize measures

- Task Force reported variations in technique (Abellan van Kan 2009)
  - Including starting conditions
  - Length of the walk
  - Incorporate other tasks or instructions
    - Example: the Timed Up & Go includes a chair rise & turn
  - Speed of requested walk (fast as possible)
    - Not yet known whether or how these modifications provide additional value to usual WS
- **Suggestion:**
  - **4 meter walk at self selected speed**

Test-retest reliability

Test-retest reliability coefficients reported in the literature range from:

0.929 (Evans 1997) to 0.97 (Stephens 1999)

- Variability related to:
  - Method used to measure
  - Distance measure
  - Diagnosis
  - Use of assistive device
  - Age
  - Anthropometrics (primary leg length)
  - Self-selected or fast WS

Change In WS

True change vs. measurement error

- Different populations have different MDC's (minimal detectable change scores)
- Most common is 0.1m/s

Change of 0.1 m/s is predictor

- Gain of 0.1 m/s is predictor for well-being in those without normal WS (Purser 2005; Hardy, Perera 2007)
- Decrease in 0.1 m/s is linked with:
  - poorer health status
  - more disability
  - longer hospital stays
  - increased medical costs (Purser 2005)

Use a change of 0.1m/s for patient goals

Interpretation: Walking Speed

Your patient , an 83 year old woman, is recovering from acute stroke

Initial Examination	Reassessment
WS 0.79 m/s	WS 1.02 m/s

IS THIS A MEANINGFUL CHANGE?

Mean difference:

$WS_{reasses} - WS_{inital} = 0.23$ m/s

WS MDC = 0.10 m/s

Assumptions:

For any individual, given their set of unique "resources"

Self-selected (comfortable) walking speed…

- Is most energy efficient
- minimizes metabolic cost per unit distance walked

Ability to increase walking speed…

- index of "functional reserve"
- allows individual to better meet demands of activity and environment

Take Home Points

Walking Speed IS THE Vital Sign for Function

Red / Yellow / Green

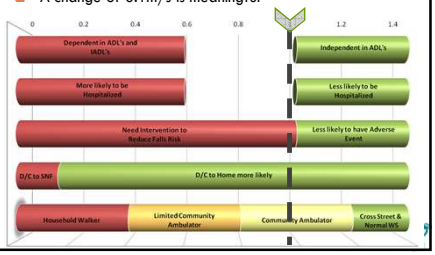
- < 0.6 m/s **DANGER**
- 0.6 to1.0 m/s **WARNING**
- > 1.0 m/s **FUNCTIONAL COMMUNITY AMBULATOR**

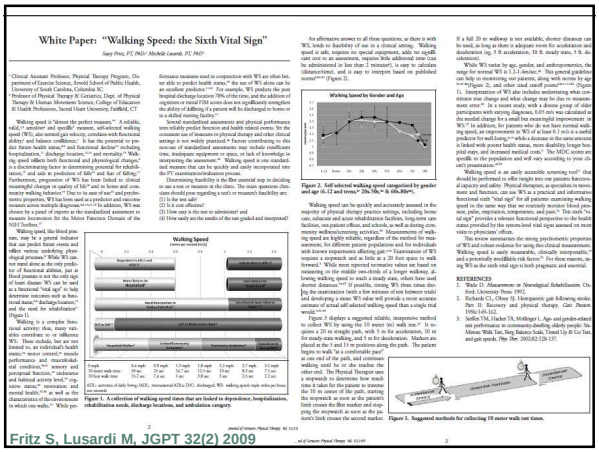
- 4 meter test is feasible in most settings
  - ALL PT's should test WS
  - on ALL patients
  - in ALL settings

Summary

Walking Speed as the 6th vital sign is pragmatic & essential

- WS has strong psychometric properties
  - Robust evidence for clinical use
  - Easily measurable, clinically interpretable & a potentially modifiable risk factor (Hardy2007 & Dickstein 2008)
  - A change of 0.1m/s is meaningful





White Paper: "Walking Speed: the Sixth Vital Sign"

Fritz S, Lusardi M, JGPT 32(2) 2009

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