“Can I Stop Now?”
The Importance of Measuring & Progressing Endurance for Older Adults with CVP conditions

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• Presentation hashtags:
  – #APTACSM, #canIstopnow, #cvpPTendurance
Objectives

• Understand muscle physiological changes that occur due to aging and CVP disease and their impact on endurance.
• Understand the various endurance tests that may be used with a patient.
• Explain the administration of the endurance test.
• Give examples of appropriate, objective goals for endurance.
• Apply these concepts to common patient case scenarios for older adults and those with cardiovascular or pulmonary complications.
Overview

Changes in Endurance with CVP Conditions

Endurance Measures

Endurance Goal Writing

Aging & CVP Conditions

Endurance

Case Study

Image: www.presentermedia.com
Why Endurance?

Pamela Bartlo, PT, DPT, CCS
Definitions

- **Endurance**: basic definition: the time limit of a person’s ability to sustain a particular level of physical effort.\(^\text{11}\)

- **Fatigue**: basic definition: weariness or exhaustion from labor, exertion, or stress\(^\text{12}\).
Who should perform endurance assessments?

• PTs: can and should do baseline endurance assessment in their initial evaluation and then in sub-sequent re-evals

• PTAs: can and should note endurance throughout sessions even though they are not performing the endurance assessment.
What endurance assessments should be used?

• Discussed more fully later in the presentation.
Where should endurance be assessed and treated?

• Clinic, gym, home care setting, long-term care facility, school, or other PT setting.
• Can also be tested in environments specific to that patient
• Endurance interventions will occur anywhere the pt performs activity, but include those listed above.
When should endurance be assessed and treated?

• Assessment:
  – Initial evaluation period
  – Re-eval times
  – D/C from facility or PT care
  – Change in medical status occurs

• Intervention for endurance:
  – Should occur throughout the treatment sessions.
  – Great to do endurance specific interventions, but also incorporate it into other tasks/mobility
Why should endurance be assessed and treated?

- COMPREHENSIVE CARE
- Cardiovascular and respiratory systems contribute so much to function and QoL
- Skeletal muscle impact from conditions impacts demand on CVP systems too
- Metabolic costs
- Quantifiable
Changes in Endurance Due To Aging

Julie Skrzat, PT, DPT, PhD, CCS
The number of people aged > 60 years will rise from 900 million to 2 billion between 2015 - 2050.

There is little evidence that older people today are in better health than their parents.

The most common health problems in older age are non-communicable diseases.

When it comes to aging, there is no ‘typical’ older person.

Health in older age is not random.

Healthy Aging is achievable by every older person.
Mobility is fundamental to everyday life and central to an understanding of health and well-being among older populations. Impaired mobility is associated with a variety of adverse health outcomes. As the age of the U.S. population continues to increase, aging and public health professionals have a role to play in improving mobility for older adults. There are critical gaps in the assessment and measurement of mobility among older adults who live in the community, particularly those who have physical disabilities or cognitive impairments. By changing physical environments and creating unique integrated interventions across various disciplines, we can improve mobility for older adults.

Figure 1. U.S. population aged 65 years or older and diversity, 2010–2050

Source: U.S. Census Bureau, 2008.
Figure 2. Chronic conditions were the leading causes of death among U.S. adults aged 65 or older in 2007–2009.

Changes Due to Advanced Aging

Julie Skrzat, PT, DPT, PhD, CCS
Sarcopenia

Aging

Sarcopenia

Poor muscle function

Impaired physical performance

Low muscle mass

Low muscle strength
Sarcopenia

Figure 1.
The relationship between age and (A) muscle cross-sectional area and (B) the total number of muscle fibers. Reproduced with permission of Elsevier Science from Lexell J, Taylor CC, Sjostrom M. What is the cause of the ageing atrophy? Total number, size, and proportion of different fiber types studied in whole vastus lateralis muscle from 15- to 83-year-old men. J Neurol Sci. 1988;84:275–294.
PURPOSE
To examine the published scientific literature regarding the prevalence of sarcopenia in aging people, with different diagnostic criteria, using bioelectrical impedance analysis to assess muscle mass

SUBJECTS
- **INCLUSION**
  - Adults > 50 years old
  - Living at home, institutionalized, or hospitalized in which BIA was used to assess muscle mass
- **EXCLUSION**
  - Serious co-morbidities
  - Animal studies
  - Studies focused on genetics, biochemistry, biomarkers, endocrinology
  - Reports, editorials, review articles

WHAT IS SARCOPENIA’S PREVALENCE?
Fig. 1. Flow diagram for identification, screening, eligibility, and inclusion of articles in this systematic review.
Table 1
Prevalence of sarcopenia using only muscle mass criterion to define sarcopenia.

<table>
<thead>
<tr>
<th>Author/year/reference</th>
<th>Country</th>
<th>Setting</th>
<th>N (M/F)</th>
<th>Mean age (years)</th>
<th>BIA trademark</th>
<th>Equation</th>
<th>Cut-off points</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tichet, 2008 [21]</td>
<td>France</td>
<td>C</td>
<td>T: 218 M: 112 F: 106</td>
<td>Impedimed, Brisbane, Australia</td>
<td>Janssen(^a)</td>
<td>SMI or MMI (\geq 2\ SDs below the gender-specific mean of a young adult reference population) M: &lt;34.4% F: &lt;26.6% MMI: M: 8.6 kg/m(^2) F: 6.2 kg/m(^2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chien, 2008 [22]</td>
<td>Taiwan</td>
<td>C</td>
<td>T: 302 M: 157 F: 145</td>
<td>Maltron Bioscan 920, Rayleigh, UK</td>
<td>Janssen(^a)</td>
<td>SMI (\geq 2\ SDs below the gender-specific mean of a young adult reference population) M: &lt; 8.87 kg/m(^2) F: &lt; 6.42 kg/m(^2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bahat, 2010 [23]</td>
<td>Turkey</td>
<td>N</td>
<td>M: 157</td>
<td>BC 532 model</td>
<td>BC 532 model equation(^b)</td>
<td>FFM (\geq 2\ SD below the mean value of the control group) M: 85.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masanés, 2012 [24]</td>
<td>Spain</td>
<td>C</td>
<td>T: 200 M: 110 F: 90</td>
<td>RJL Systems BIA 101 device</td>
<td>Janssen(^a)</td>
<td>SMI (\geq 2\ SDs below the gender-specific mean of a young adult reference population) M: &lt; 8.25 kg/m(^2) F: &lt; 6.68 kg/m(^2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norshafarina, 2013 [25]</td>
<td>Malaysia</td>
<td>C</td>
<td>T: 388 M: 155 F: 233</td>
<td>Maltron Bio-Scan 916 (Maltron International Ltd, UK)</td>
<td>Maltron Bio-Scan equation(^b)</td>
<td>SMI (\geq 2\ SD below the gender-specific mean of a young adult reference) M: &lt; 10.75 kg/m(^2) F: &lt; 6.75 kg/m(^2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Author/year/reference</th>
<th>Country</th>
<th>C/M/H/N</th>
<th>N (M/F)</th>
<th>Mean age (years)</th>
<th>BIA trademark</th>
<th>Equation</th>
<th>Sarcopenia criteria: muscle mass + function</th>
<th>Cutoff points</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volpato, 2013 [37]</td>
<td>Italy</td>
<td>C</td>
<td>T: 730</td>
<td>M: 345</td>
<td>Quantum/S Bioelectrical Body Composition</td>
<td>Janssen⁴</td>
<td>EWGSOP criteria</td>
<td>M: &lt;8.87 kg/m², F: &lt;6.42 kg/m²</td>
<td>T: 7.5%, 70-74 years: M: 1.2%, F: 2.6%; &gt;80 years: M: 17.4%, F: 31.6%</td>
</tr>
<tr>
<td>Legrand, 2013 [44]</td>
<td>Belgium</td>
<td>C</td>
<td>T: 288</td>
<td>M: 103</td>
<td>BODYSSTAT 15MDD device, Bodystat LTD</td>
<td>BODYSSTAT 15MDD device, Bodystat LTD equationb</td>
<td>EWGSOP criteria</td>
<td>M: &lt;8.87 kg/m², F: 6.42 kg/m²</td>
<td>T: 12.5%, M: 12.6%, F: 12.4%</td>
</tr>
<tr>
<td>Rubio-Macias, 2014 [45]</td>
<td>Spain</td>
<td>R</td>
<td>T: 166</td>
<td>M: 80</td>
<td>Maltron BioScan 916 Ltd, UK</td>
<td>Maltron BioScan 916 equationb</td>
<td>EWGSOP criteria</td>
<td>M: &lt;8.51 kg/m², F: &lt;5.75 kg/m²</td>
<td>T: 77.6%, M: 79.2%, F: 73.7%</td>
</tr>
</tbody>
</table>
DISCUSSION

- Prevalence of sarcopenia varied widely due to factors.
  - Setting
    - Healthy older without functional disability do not really reflect the prevalence of sarcopenia.
  - **Convalescence and rehabilitation unit: higher prevalence**
  - Sex
    - It is not clear if aging men have a potentially higher risk of sarcopenia.
  - Ethnicity
    - European: BIA
    - Asian and Caucasian populations: anthropometric measurements (different)
  - Predictive factors
    - Malnutrition and immobilization
      - **PHYSICAL THERAPY**

- Despite the differences among studies reviewed, sarcopenia is highly prevalent in older people, but the groups most at risk are people in convalescence and rehabilitation units.
- BIA is an accessible instrument, easy to use, and has enough validity to detect people with low muscle mass.
PURPOSE
To describe measures of physical fitness in hospitalized frail older adults in relation to degree of frailty

SUBJECTS

- INCLUSION
  - Adults > 75 years old
  - Frail as determined by FRail Elderly Support Research (FRESH screening)
    - Included 5 questions relating to endurance, tiredness, falls, needing support while shopping, and ≥ 3 visits to the ER in the past 12 months
      - > 2/5: yes = frail
  - Inpatient

- EXCLUSION
  - In need of care at an organ-specific medical unit
Enrollment

Initial Measures

Results

1. Isodynamic hand grip strength
2. 5 time Sit to Stand
3. Timed Up and Go
4. 6 Minute Walk Test

- (+) FRESH
- Admitted to an emergency medical ward

WHO?32
MOST AT RISK?
PREVENTION?
EX. RX.
### Table 1. Study Characteristics of the Population

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>408</td>
</tr>
<tr>
<td>Gender female, n (%)</td>
<td>408</td>
</tr>
<tr>
<td>Frailty screening, median (min-max)</td>
<td>408</td>
</tr>
<tr>
<td>Charlson’s index, mean (SD)</td>
<td>408</td>
</tr>
<tr>
<td>Dementia, n (%)</td>
<td>408</td>
</tr>
<tr>
<td>Nutrition (MNA), mean (SD)</td>
<td>391</td>
</tr>
<tr>
<td>EQ5D-VAS, mean (SD)</td>
<td>373</td>
</tr>
<tr>
<td>Lived alone, n (%)</td>
<td>408</td>
</tr>
<tr>
<td>Nursing homes, n (%)</td>
<td>408</td>
</tr>
</tbody>
</table>

Abbreviations: EQ5D-VAS, Euro Qol-5 Dimensions—Visual Analogue Scale; MNA, Mini Nutritional assessment.
### Table 2. Physical Fitness in Relation to Degree of Frailty Based on the FRESH Screening*

<table>
<thead>
<tr>
<th>Variable</th>
<th>FRESH Screening 1 or 2 Yes</th>
<th>FRESH Screening 3 Yes</th>
<th>FRESH Screening 4 Yes</th>
<th>$p^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD), years</td>
<td>N</td>
<td>95% CI</td>
<td>N</td>
</tr>
<tr>
<td>Hand grip, mean (SD), kg</td>
<td></td>
<td>77</td>
<td>20.7 (8.6)</td>
<td>142</td>
</tr>
<tr>
<td>Low hand-grip, n (%)</td>
<td></td>
<td>77</td>
<td>57 (74.0)</td>
<td>142</td>
</tr>
<tr>
<td>Unable to perform test of hand-grip</td>
<td></td>
<td>80</td>
<td>3 (3.8)</td>
<td>160</td>
</tr>
<tr>
<td>strength, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TUG test, mean (SD), s</td>
<td></td>
<td>70</td>
<td>29.6 (30.1)</td>
<td>119</td>
</tr>
<tr>
<td>TUG test score $\geq$ 30 s, n (%)</td>
<td></td>
<td>70</td>
<td>18 (25.7)</td>
<td>119</td>
</tr>
<tr>
<td>Unable to perform TUG test, n (%)</td>
<td></td>
<td>81</td>
<td>11 (13.6)</td>
<td>159</td>
</tr>
<tr>
<td>6-MWT, mean (SD), m</td>
<td></td>
<td>62</td>
<td>200 (114)</td>
<td>103</td>
</tr>
<tr>
<td>6MWT $\leq$ 300 m, n (%)</td>
<td></td>
<td>62</td>
<td>46 (74.2)</td>
<td>103</td>
</tr>
<tr>
<td>Unable to perform 6-MWT, n (%)</td>
<td></td>
<td>77</td>
<td>15 (19.5)</td>
<td>153</td>
</tr>
<tr>
<td>5-STS, mean (SD), s</td>
<td></td>
<td>43</td>
<td>23.8 (12.4)</td>
<td>49</td>
</tr>
<tr>
<td>5-STS $&gt; 14$, 8 s, n (%)</td>
<td></td>
<td>43</td>
<td>33 (76.7)</td>
<td>49</td>
</tr>
<tr>
<td>Unable to perform 5-STS, n (%)</td>
<td></td>
<td>81</td>
<td>38 (46.9)</td>
<td>158</td>
</tr>
</tbody>
</table>

*Abbreviations: 5-STS, Five times sit to stand test; FRESH screening: Frail Elderly Support Research group screening instrument; 6-MWT, Six minute walk test; TUG, Timed Up and Go.

*aLow hand-grip strength: $W < 20$ kg, $M < 30$ kg.

*p value $\leq 0.05$ statistically significant.

$p = .05$.

$p = .01$.

$p = .001$. 
DISCUSSION

- Most tests were directed at individuals who were able to stand and walk.
  - Floor effect, especially 6MWT
- Hand grip test
  - 83% performed lower than cut offs, which predict all cause mortality
- 5 Sit to Stand
  - 97% performed more slowly than 14.8 seconds, indicating a high probability of poor prognosis
- Timed Up and Go
  - Mean time = 33.3 seconds, which is predictive of dependence on transfers and being dependent in ADLs (cut off = 30 seconds)
- 6 Minute Walk Test
  - 88.8% ambulated < 300 m, which indicates low endurance and an association with mortality in frail older adults with heart failure

Most hospitalized frail older adults performed far lower than previously described reference values, increasing risk of poor clinical outcomes.
PURPOSE
To examine the association between different doses and types of physical activity and development and progression of frailty in older adults

SUBJECTS (n = 2,964 analyzed)
- INCLUSION
  - Black and white men and women
  - Reports of no difficulty doing mobility-related tasks or ADLs
FRAILTY
- Determined at 3 time points: baseline, 3-, 5- years
- Described by the presence of functional limitations
  - Gait speed < 0.60 m/s or being able to rise from a chair once with arms folded

PHYSICAL ACTIVITY
- Standardized questionnaire
- Kilocalories / week expended in common exercise activities and lifestyle activities.
- Developed hierarchical doses with each PA
RESULTS

Table 2. Physical Activity Categories and Self-Reported Weekly Activity (N = 2,964)

<table>
<thead>
<tr>
<th>Volume</th>
<th>n (%)</th>
<th>Kcal/wk, median (IQR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low dose</td>
<td>1,880 (63.4)</td>
<td>338 (798)</td>
</tr>
<tr>
<td>Recommended dose</td>
<td>1,084 (36.6)</td>
<td>1,638 (1,734)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Intensity</th>
<th>n (%)</th>
<th>Kcal/wk, median (IQR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary dose</td>
<td>386 (13.0)</td>
<td>686 (463)</td>
</tr>
<tr>
<td>Light dose</td>
<td>1,374 (46.4)</td>
<td>3,757 (3,719)</td>
</tr>
<tr>
<td>Moderate dose</td>
<td>650 (21.9)</td>
<td>5,721 (4,706)</td>
</tr>
<tr>
<td>Vigorous dose</td>
<td>554 (18.7)</td>
<td>8,116 (6,495)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity types</th>
<th>n (%)</th>
<th>Kcal/wk, median (IQR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
<td>707 (23.9)</td>
<td>1,747 (1,126)</td>
</tr>
<tr>
<td>Lifestyle active</td>
<td>1,525 (51.1)</td>
<td>5,939 (4,779)</td>
</tr>
<tr>
<td>Exercise active</td>
<td>732 (24.7)</td>
<td>6,073 (5,517)</td>
</tr>
</tbody>
</table>

Prevalent reported activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifestyle</td>
<td></td>
</tr>
<tr>
<td>Light housework</td>
<td>2,645 (89.2)</td>
</tr>
<tr>
<td>Grocery shopping</td>
<td>2,388 (80.6)</td>
</tr>
<tr>
<td>Climbing stairs</td>
<td>2,111 (71.2)</td>
</tr>
<tr>
<td>Doing laundry</td>
<td>2,013 (67.9)</td>
</tr>
<tr>
<td>Heavy chores</td>
<td>1,291 (43.6)</td>
</tr>
<tr>
<td>Volunteer work</td>
<td>1,150 (38.8)</td>
</tr>
<tr>
<td>Outdoor chores</td>
<td>936 (31.6)</td>
</tr>
<tr>
<td>Other walking</td>
<td>854 (28.8)</td>
</tr>
<tr>
<td>Exercise</td>
<td></td>
</tr>
<tr>
<td>Walking for exercise</td>
<td>1,189 (40.1)</td>
</tr>
<tr>
<td>Strengthening exercises</td>
<td>148 (5.0)</td>
</tr>
</tbody>
</table>
DISCUSSION

- Individuals who regularly engage in exercise activities at baseline were less likely to develop frailty for a 5 year period compared with those who were sedentary.
  - Presence of multiple diagnoses considerably attenuated the beneficial association of regular involvement in exercise activities on subsequent frailty.

- Neither volume nor intensity of lifestyle activity or structured exercise was related to progression of frailty, only the categorization of someone as participating in structured exercise or not.
  - < 20% of individuals who were regularly exercise active participated in strengthening.

This study provided concurrent comparisons of differing weekly doses of volume, intensity, and types of PA and their association with frailty in an initially high-functioning group of older adults.
PURPOSE
To qualify the dose-response relationship between different training regimens and the induced VO2max improvements

SUBJECTS (41 controlled trials included)

- **INCLUSION**
  - Controlled clinical trials
  - Mean ages of subjects > 60 y/o with aerobic exercise training as the only intervention, with treatment lasting a minimum of 2 weeks
  - Components of the training regimen reported in quantifiable terms
  - Presence of non-exercise control group
  - A measure of changes in VO2max
  - Published in the English-language after 1980
## RESULTS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[Range]</td>
</tr>
<tr>
<td>Frequency (days / wk)</td>
<td>3.25 ± 0.66</td>
</tr>
<tr>
<td></td>
<td>[1-4.9]</td>
</tr>
<tr>
<td>Intensity (% HRR)</td>
<td>63.24 ± 11.36</td>
</tr>
<tr>
<td></td>
<td>[35-80]</td>
</tr>
<tr>
<td>Time (minutes)</td>
<td>38.12 ± 10.01</td>
</tr>
<tr>
<td></td>
<td>[20-60]</td>
</tr>
<tr>
<td>Type</td>
<td>Walking, jogging, running, cycling, stair-climbing, aerobic dancing, outdoor aerobic performance, aerobic games</td>
</tr>
<tr>
<td>Duration (weeks)</td>
<td>22.72 ± 12.10</td>
</tr>
<tr>
<td></td>
<td>[8 – 52]</td>
</tr>
</tbody>
</table>
DISCUSSION

In general, a VO2max would be induced by aerobic training ~ 70% HRR, 45 minute duration, and 3.5 days /wk x 36 weeks.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Elicitation of VO2max</th>
<th>VO2max Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (days / wk)</td>
<td>6 – 7 days biweekly</td>
<td>4 – 5 days / wk adds NO greater CRF benefits</td>
</tr>
<tr>
<td>Intensity (% HRR)</td>
<td>35 – 50% HRR</td>
<td>70 – 73% HRR</td>
</tr>
<tr>
<td>Time (minutes)</td>
<td>40 – 50 minutes</td>
<td>45 minutes</td>
</tr>
<tr>
<td>Type</td>
<td>AEROBIC</td>
<td></td>
</tr>
<tr>
<td>Duration (weeks)</td>
<td>20 – 24 weeks</td>
<td>32 – 36 weeks</td>
</tr>
</tbody>
</table>

Quantitative dose response relationship between aerobic training regimens & VO2 max adaptations

In healthy, sedentary older adults…
Changes in Endurance Due To CVP Conditions

Pamela Bartlo, PT, DPT, CCS
Respiratory Muscle Strength

- Decreases seen with MI$^{19}$, CHF$^{28}$, COPD$^{46}$, Cardiothoracic surgeries$^{22,40}$
- Impairments in ventilation and overall gas exchange due to respiratory muscle strength
Central Aerobic Capacity

- $\text{VO}_2$ max decreases with almost all cardiopulmonary complications.
- Most evidence not quantifying how much it decreases, but plenty showing improvements after rehab.
- Improvements in pts with CABG, $^{15}$ CHF $^{10,18}$
Central Aerobic Capacity Cont’d

• Obviously COPD a bit different as tough to improve VO$_2$ max really.
• Interesting study found VO$_2$ max similar between CHF and COPD, but that breathing reserve and percent predicted oxygen uptake efficiency slope discriminated most between them.$^4$
Peripheral Strength

- Decreases found with almost all cardiac and pulmonary conditions.
- Some due to disuse or decreased activity (i.e. post surgical, chronic condition).
- Some due to peripheral circulatory changes. (i.e. PAD/PVD, CHF)
- Some due to lack of pulmonary delivery of \( \text{O}_2 \) to keep up with demand of muscle fibers so wasting occurs. (i.e. COPD, Asthma, CHF)
Peripheral Strength Cont’d

• Impact on pulmonary disorders.
• Way too many studies to list here. A few encompassing studies
  – UE strength with COPD.\textsuperscript{29}
  – Endurance ex were shown to be even better than resistance ex for people with COPD.\textsuperscript{27}
  – Balance of ventilator ability with demand.\textsuperscript{46}
Peripheral Strength Cont’d

• Impact on Cardiac disorders
• Standard use in all cardiac rehab programs along continuum of care
• Two studies specifically with people with CHF showed that increasing peripheral strength and muscle mass had big impacts on function.\(^{10,18}\)
Peripheral Circulation

- Blockage can decrease $O_2$ delivery
- Cardiomyopathy, CHF, other central dysfunction leads to decreased $O_2$ delivery
- Pulmonary conditions can lead to decreased $O_2$ uptake out of the blood
Endurance Measures:
Standardized & Non-standardized

Pamela Bartlo, PT, DPT, CCS
Standardized Endurance Assessments

Standardized Tools Used to Assess Endurance for Various Patient Populations
Disclaimer

• This section is not meant to be an exhaustive list of tests that can be used.
• It is meant to provide you with the most common assessment tools used and a discussion of their validity and reliability.
Safety Considerations

• General safety recommendations
  • have emergency procedures in place
  • select appropriate exercise protocol
  • perform pre-exercise clinical assessment and testing
  • determine variables to be monitored
  • perform post-exercise eval and monitoring
Indications to Stop Any Exercise Test

- Onset of angina or angina-like symptoms
- Drop in SBP > 10 mmHg from rest
- Excessive rise in BP: SBP > 250 mmHg or DBP > 115 mmHg
- SOB, wheezing, LE cramps, or claudication
- Signs of poor perfusion: light-headedness, confusion, ataxia, pallor, cyanosis, nausea, or cold and clammy skin
- Failure of HR to rise with increased exercise intensity
- Noticeable change in heart rhythm
- Subject asks to stop
- Failure of testing equipment

Taken from ACSM Guidelines for Exercise Testing and Prescription 10th ed.
Maximal Graded Exercise Tests (Cardiac patients)

• Strong reliability and validity in regards to endurance via aerobic capacity if pt reaches peak values
• Safe and feasible
  – Provided that…

• Disadvantage: Not very practical in clinic setting
Modes of GXT

- Treadmill
- LE cycle ergometry
- UE cycle ergometry
- Recumbent Stepper – not very common
- Body weight supported treadmill
- For SCI, there is some research using w/c propulsion on treadmill\textsuperscript{31}
Typically use Max HR as 220-age and then give a % of target HR that the pt achieved. The goal is usually to achieve 85% of age predicted max HR.

Gulati et al.: showed target really should be

HR = 206 - 0.88(age)

- 25% (N=1366) achieved more than 100% of age predicted max HR
- 7% (N=336) failed to achieve 85% of max HR

* Also saw a negative correlation between age and peak HR achieved on maximum stress test.
6 MWT - Six Minute Walk Test

- Cardiovascular and Pulmonary patient populations that routinely use this test:
  - Pulmonary hypertension
  - Cystic fibrosis
  - COPD
  - Asthma
  - CHF, s/p MI
  - s/p CABG, valve repair/replacement
  - pre- and post-transplant patients
6 MWT Cont’d

• A sub-maximal test
• Done as a standard test with pulmonary patients, but can also be done with cardiac patients or any other medical patient
• Simple, easy, cheap test
• A good predictor of functional aerobic capacity
6 MWT Cont’d

- Can also correlate to max oxygen consumption (VO$_2$ max), exercise tolerance, and survival rates among cardiac and pulmonary patients

- *Validity and reliability of the 6-minute walk test in a cardiac rehabilitation population* $^{20}$

- *Practical interpretation of 6-minute walk data using healthy adult reference equations* $^{41}$
6 MWT Procedures

- Should have a walkway at least 30 meters (98’ 5”)
- Patient should walk at self-selected speed.
  – Can vary speed t/o test.
- Walk as far as they can in 6 minutes.
- Can use assistive device or oxygen.
- Can rest as needed either standing or sitting.
- Can use supervision or be independent.
- * If assistance is needed, you can provide it, but you are now doing a modified 6 MWT for individual performance only

ATS Guidelines for Administration of 6 MWT, 2002
6 MWT Normal Values \(^{42}\)

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>N</th>
<th>X</th>
<th>SD</th>
<th>CI (95%)</th>
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<td>471</td>
<td>75</td>
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<td>73</td>
<td>356–478</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>15</td>
<td>392</td>
<td>85</td>
<td>345–440</td>
</tr>
</tbody>
</table>

X - mean distance walked in meters, SD – standard deviation, CI – confidence interval

Reprinted from Steffan et al., 2002

1 meter = 3’ 3”

- Ambulation distances of <300m (~1000ft) predicts poorer prognosis for long-term survival and increased likelihood of death in patients with significant heart and lung diseases. (Bittner et al., 1993)
6MWT using Treadmill

• Laskin et al.\textsuperscript{33}
  – Good predictor of VO\textsubscript{2} max
  – As long as pt uses self selected speed, no significant difference from 6 MWT on floor
Step Tests

• Harvard Step Test – original step test 30 steps/min at height 50.8 cm (1’ 7”)
  – Too tough for many patient populations

• Height adjusted platform step test\textsuperscript{13}
  – Height adjusted based on femur length in at a certain hip angle
  – 26 steps/min done at that height for 3 min
  – Immediately post exercise, the subject will remain standing and a pulse will be taken (15 second count)
Step Tests for Patients with Pulmonary Conditions

- Astrand and Ryhming Step Test$^{35}$
  - Step height: Females 33cm (13in), Males 40cm (15.7in)
  - Rate: 22.5 steps/min (90 total steps-“up, up, down, down”) for 6 min
  - Take HR at end of each minute (use pulse ox or HR monitor) and average the last two readings
• Self paced step test\textsuperscript{39}
  – Step height: 7”
  – Rate: 20 steps at varying speeds: first pt instructed to go at slow speed, then at fast speed based on what the patient considered that to be
Timed Up and Go (TUG) Test

**Benefits**
- Simple, easy, cheap, quick
- Functional activities
- Fall risk assessment

**Disadvantages**
- Not really useful for endurance
Timed Up and Go (TUG) Test

• Procedure
  – Begin timing
  – Rise from standard chair
  – Walk to a spot/line 3 meters (~10ft) away from the chair
  – Turn around and return to the chair
  – Sit in chair
  – End timing

• Results
  – Low Risk
    • Score of < 14 sec & <3 RF
  – Moderate Risk
    • Score of < 14 sec & > 3 RF
    or >14 sec & < 3 RF
  – High Risk
    • Score of > 14 sec & > 3 RF
Timed Up and Go (TUG) Test

• Strong reliability and validity in relation to walking function
• No studies found to assess validity of TUG to endurance/physical fitness
• Good negative correlation with 6MWT
  – What does this mean?
• **NOT** recommended as an endurance test at this time. Need more research to see if it can really assess endurance
Other Tests

• 1 minute sit to stand: Shown to be a good tool to document endurance progress after Pulmonary Rehab\textsuperscript{43}

• Borel et al.: good paper looking at a variety of exercise testing and the validity, reliability, and feasibility for people with COPD.\textsuperscript{7}

• Interesting paper comparing 6 MWT and shuttle test just out of China, but unfortunately the full paper isn’t available in English yet.\textsuperscript{24}
Other Tests

• May be useful, but aren’t used as much with the cardiovascular and pulmonary patients

• **Recumbent stepper** - good test to use as using all extremities limits LE fatigue

• **Arm test** – good steady state ex test that uses UE only in case LEs are not able to be used or fatigue too quickly

• **Shuttle run** - Symptom limited test with incremental work loads
  - The original protocol
  - The modified version
  - Hassett et al. gives an equation to determine VO2 peak from shuttle run result
Sub-Maximal Tests

• Good reliability and validity
• Incremental sub-max tests
• Mossberg et al. showed that treadmill sub-max test less validity compared to 6MWT and 20 meter shuttle test
Non-Standardized Endurance Assessments

Clinical Tools or Tests Used to Assess Endurance for Various Patient Populations
Clinical Methods to Evaluate Endurance

• General Observation
  - Positioning / Postural Control
    - Is it requiring a lot of energy just to hold their head or trunk up?
  • Toleration to Therapy
    - How many rest breaks do they require?
Clinical Endurance Cont’d

• Breathing Pattern
  – High effort
  – Could it be easier?

• Functional mobility skills
  – Bed Mobility, Transfers, Ambulation, Stairs, W/C Propulsion, ADL’s

• Adaptive devices & equipment utilization
  – Looking at the quality & efficiency of their movement

• Environmental accessibility
  – Is their current way the most energy efficient?
Endurance Goal Writing

Julie Skrzat, PT, DPT, PhD, CCS
ICF Model

Health Condition (disorder or disease)

- Body Function & Structures
- Activity
- Participation

Environmental factors
Personal factors
Identified impairment

Determine its impact on function

Utilized an outcome measure to get baseline

Endurance

Documentation

Goal Writing

See previous 😊
Document S.M.A.R.T.

- **SMART**: Clear, concise, tangible. What, who, when, why, where?
- **MEASURABLE**: Time, money, volume. How much of how many?
- **ACHIEVABLE**: Goals should be challenging but not impossible
- **RELEVANT**: Goals should be consistent with other long term goals
- **TIME-BOUND**: Create a time frame. When to achieve the result?
Identified impairment

Determine its impact on function

Utilized an outcome measure to get baseline

Endurance

Goal Writing

Documentation

Functional or Educational?

Short term or long term?
Patient will perform 30 minutes of continuous aerobic training on the treadmill within 1 week.

Patient will be independent with heart rate assessment before and after aerobic training within 2 visits.
SHORT TERM:
Aimed at developing and learning strategies for healthier living and reducing CVP risk factors, particularly those that are most life-threatening

LONG TERM:
An extension of short-term goals and address the sustainability of health and fitness consistent with patients’ needs, wants, and capabilities for the rest of their lives
• Enhance pulmonary clearance.
• Maintain normal arousal.
• Prevent joint contractures.
• Reduce anxiety and stress.

• To increase aerobic capacity, muscle strength, and endurance consistent with overall health and well-being.
• To improve capacity to perform the activities of daily living and maintain gainful employment.

• To promote health and well-being in the patient's family and community
• To reduce direct and indirect health care costs over the short and long term

POST OP

LIFE LONG

CONTINUUM OF CARE

OUTPATIENT
Case Study:
Introduction → Aging → CVP

Julie Skrzat, PT, DPT, PhD, CCS
Case Study

- **Patient:** 71 year old female
- **Chief complaint:** 4 year history of shortness of breath
- **PMH:** Mitral regurgitation, mitral stenosis, pulmonary HTN, HTN, interstitial cystitis, remote smoking history, obesity, sleep apnea
- **Systems Review:** Denies chest pain, back pain, or syncope.

- **Function:**
  - Bed mobility: Independent.
  - Transfers: Independent.
  - Gait: Modified independent with a cane.
  - Stairs: Unable due to dyspnea.
  - Other: Unable to walk a city block due to dyspnea.
Case Study

- **Diagnostic testing:**
  - Cardiac Catheterization:
    - Normal coronary arteries and LV function
    - Exercise induced pulmonary HTN
  - Chest X-ray
    - Mild cardiomegaly
    - Suspect aneurysmal thoracic aorta in the aortic arch
  - EKG
    - Normal sinus rhythm, lengthened QT segment from previous EKG (3 months ago)
  - Transesophageal Echocardiogram:
    - EF 55 – 60%
    - Mild to moderate mitral stenosis

- **Vitals:**
  - Blood pressure: 109/64
  - Heart Rate: 76 bpm
  - BMI: 44 kg / m2
Based on medical diagnostic testing and physical presentation, what outcome measure would you use to assess endurance during a physical therapy evaluation?
Application to Case Study

Aging

Sarcopenia

Poor muscle function

Low muscle mass

Impaired physical performance

Low muscle strength

PT!
Clinical Decision Making #2

What outcome measure would you use to assess this patient’s endurance?
Clinical Decision Making #3

What exercise prescription would you prescribe for this patient?

F:
I:
T:
T:
Clinical Decision Making #4

Identify one endurance goal for this patient.
Discussion & Questions
Thank You!
References


References


References


