Clinical Decision making involved in developing exercise programs

Assessment of Exercise Tolerance

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Disclosures

- President and CEO of PT Cardiopulmonary Educators, a web-based education company providing continuing education and entry-level education for PTs
- Editor and author of *Essentials of Cardiopulmonary Physical Therapy*, an entry-level text for DPT programs, published by Elsevier
- Author of *PT Clinical Notes*, a manual for clinicians, published by FA Davis
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Learning Goals

- When developing an exercise program, determine the level of complexity the patient presents with
- Determine appropriate exercise tolerance test to choose to evaluate exercise performance of patient
- Assess responses to exercise test or activity as normal or abnormal
- Develop an initial aerobic exercise prescription for a complex patient seen in a variety of settings

Complex Patient Definition

- **Complex patients:** individuals who have multiple complex medical conditions, multiple detrimental social determinants of health, or a combination of both
- These factors contribute to preventable service utilization and poorer overall healthcare management that ultimately negatively impact the individual's health

Definitions of Complex Patients

- **IOM**
  - Heart disease, cancer, stroke, HIV/AIDS, congenital malformations, SCI, TBI
  - Mobility disorders, cognitive issues (psychotic issues, Alzheimer's disease, etc.), COPD, diabetes, etc.
- **CMS**
  - Diabetes, PVD, COPD, heart failure, cancer, renal failure, MI, etc.
- Does this sound familiar?

Are there any tools available to determine my patient's complexity? Frailty? Risk of Disease?

Charlson Comorbidity Index (cont.)

Charlson Comorbidity Index predicts the 10-year mortality for a patient who may have a range of comorbid conditions

Myocardial Infarction	
CVA or TIA	Yes +1
Dementia	Yes +1
Connective tissue disorder	Yes +1
Peptic ulcer	Yes +1
Liver disease: mild Liver disease: moderate–severe	Yes +1 Yes +3
Diabetes Uncomp end organ	Yes +1 Yes +2
Hemiplegia	Yes +2
Leukemia	Yes +2
Chronic kidney disease	Yes +2
Solid tumor localized	Yes +2

https://www.mdc

Charlson Comorbidity Index (cont.)

Charlson Comorbidity Index predicts the 10-year mortality for a patient who may have a range of comorbid conditions

Myocardial Infarction	
Solid tumor: metastatic	Yes +6
AIDS	Yes +6
Greater number: greater risk of morbidity and mortality at both 30 days and one year Max score: 33	

https://www.mdcalc.com/charlson-comorbidity-index-cci

Case Study: Charlson Comorbidity Score

- 67-year-old female
- History of connective tissue disorder, COPD, MI, HF, mild dementia, uncomplicated diabetes

- **Score**
  - **2:** age
  - **1:** connective tissue disorder
  - **1:** COPD
  - **1:** HF
  - **1:** mild dementia
  - **1:** uncomplicated diabetes
- **Total:** 7/33 or about 20% risk of death in 10 years

Frailty Scales

- The **Clinical Frailty Scale** (CFS) is a judgment-based **frailty** tool that evaluates specific domains including comorbidity, function, and cognition to generate a **frailty** score ranging from 1 (very fit) to 9 (terminally ill)
- It was scored on a scale from 1 (very fit) to 7 (severely frail) upon initial publication in 2005. In 2007, however, the CFS was modified to a 9-point scale to include very severely frail and terminally ill as separate entities, which initially had been lumped together. The 9-point scale provides a descriptor of a frailty stage. There is a visual chart to assist with the frailty classification. A person with a score of ≥5 is considered frail.

Clinical Frailty Scale

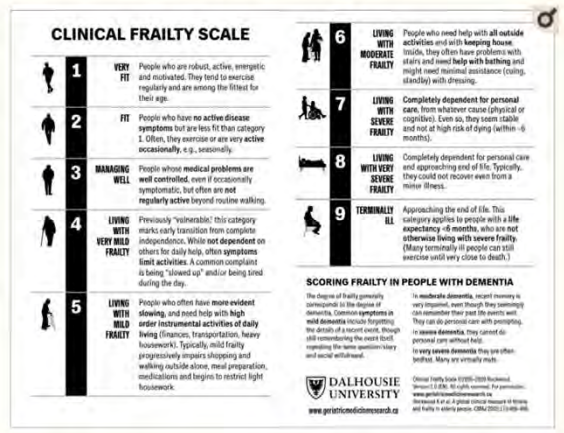


FIGURE 1

The Clinical Frailty Scale (CFS) version 2.0

Fried Frailty Criteria

Fried frailty criteria

- Fried and colleagues developed five criteria
  - Weight loss
  - Exhaustion
  - Low physical activity
  - Slowness
  - Weakness
- The stages of frailty, based on the Fried criteria, were defined as follows:
  - 0: person is robust or not frail
  - 1–2: person is at intermediate risk for adverse outcomes or is considered to be pre-frail
  - 3–5: person is frail

Determining a Phenotype of Frailty

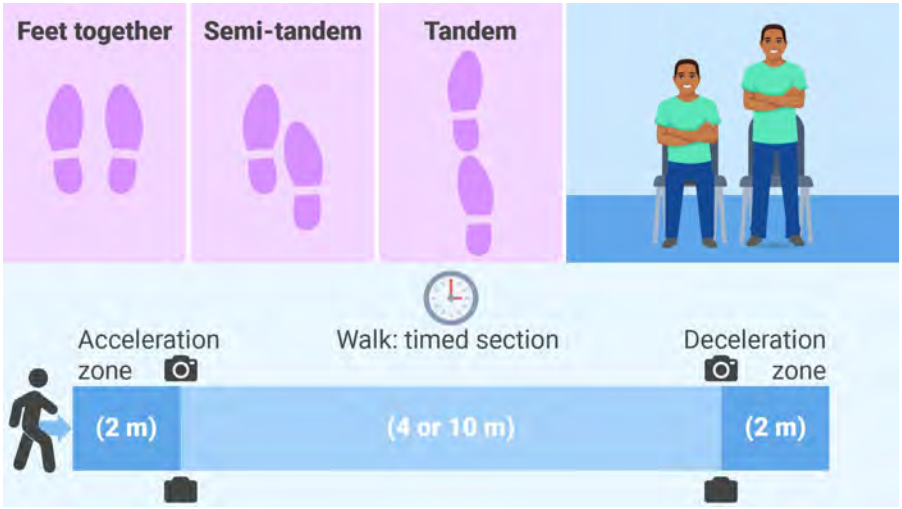
Fried Criteria

Characteristic of frailty	Cardiovascular measure
Shrinking: unintentional weight loss and/or muscle loss	>10 lbs. lost in one year
Weakness	Grip strength: lowest 20%
Poor endurance: exhaustion	Sel-report of exhaustion
Slowness	Gait speed: slowest based on norms for height, gender
Low activity	Kcals of energy expenditure: lowest 20% Males <383 kcals/week Females: <270 kcals/week

Short Physical Performance Battery

- Assessment of lower extremity function in older adults or in special populations
- Used as an assessment of frailty for individuals
  - Pre-surgery
  - Pre ventricular assist device
  - Pre heart or lung transplant
  - With heart failure, pre discharge/home health/other rehab settings

Short Physical Performance Battery



Scoring

- Minimum score = 0
- Maximum score = 12
- Score; > the lower extremity function
- Score <10 indicative of greater risk of all-cause mortality
- Score <10 indicates one or more mobility limitation
- MCID = 1.01
- In high-functioning older adults, there may be a ceiling effect

Perera et al., 2006

Summary

- Prior to performing an exercise test assessment or developing exercise prescription, one should be determining the patient's level of complexity
- Determining complexity of patient is based on
  - Medical record data from Institute of Medicine as well as CMS data on amount of payment for certain diagnoses
  - Highest complexity: mobility disorders, diabetes, cardiovascular diseases, COPD, Alzheimer's, etc.
- Charlson Comorbidity Scale can be used to rank comorbidities and thus determine complexity of patients
- Other scales can be used to discuss complexity level
  - Clinical Frailty Scale
  - Fried frailty criteria
  - SPPB

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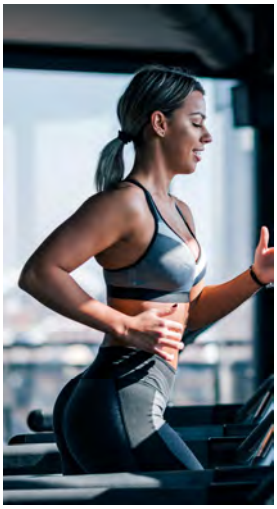
Why Assess Exercise Tolerance With a Specific Test?

Indications

- Atypical symptoms during exercise/activity
  - Chest/jaw tightness, pressure, indigestion, etc., that occur with activity and go away with rest
  - Perception of abnormal shortness of breath or dyspnea with activity
  - Perception of increased arrhythmias with activity or new onset of arrhythmias
- Assess for appropriateness for surgery if cardiac or pulmonary history
- Assess for exercise tolerance
- Assess response to medical interventions
- Assess for exercise prescription in individual with moderate to high risk of CAD or presence of multiple risk factors for CAD



Who should we NOT Test?

Contraindications to Exercise Testing

Absolute vs. relative contraindications exist

- **Absolute**
  - Aortic dissection (could progress or rupture)
  - Severe aortic stenosis (risk for sudden death)
  - Acute MI within 48 hours of onset of injury
  - Unstable angina prior to assessment and stabilization
  - Presence of life-threatening arrhythmias
  - Decompensated heart failure

Absolute Contraindications

Absolute vs. relative contraindications exist

- **Absolute** (cont.)
  - Pulmonary embolism without treatment
  - Pulmonary infarction (acute) without treatment
  - Acute myocarditis
  - Acute DVT without treatment
  - Acute endocarditis without treatment

Hemodynamic stability of patient

- Determine stability vs. instability by:

  Vital Signs Assessment:

  Assessment of blood pressure and heart rate and SpO2

  Can the patient tolerate the activity (rest or movement)? Determined by ability to maintain an adequate perfusion of blood to entire system. This ability is determined by CARDIAC OUTPUT

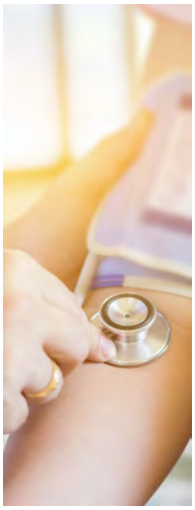
Other Thoughts About Whom You Should NOT Test

Individuals who do **not** demonstrate hemodynamic stability

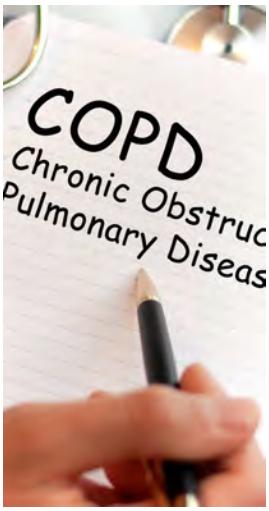
- HR elevated with low BP or low SpO2
- Symptomatic (dyspnea, chest pain, dizzy, extreme fatigue) at rest
- Demonstrate elevated risk for CAD, and your setting is not set up for critical life-threatening incidents (no AED, no O_2, no mock code, no 911 that has been tested)

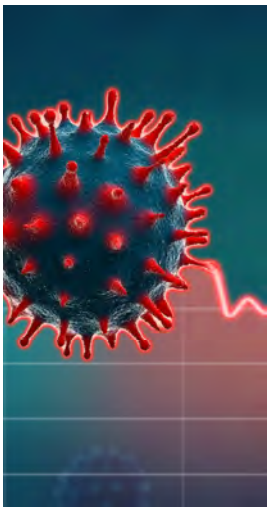
Risk Factor Assessment Prior to Testing






Why Risk Stratification?





Risk Stratification

Distinguish between risk of an adverse CV **response** and the **likelihood of detecting** CVD

- Likelihood of detecting CVD is from risk stratification
- Risk of adverse CV response during exercise or during testing: decreases with identification of history of physical activity and symptoms[1]

- If your patient already HAS Cardiovascular Disease you do NOT use this calculator
  - However, you might expect adverse CV responses during exercise or testing…therefore you SHOULD to an exercise test prior to developing an exercise program
  - You SHOULD assess responses to exercise to determine how HARD to work your patient.

1. Goodman et al., 2011

Framingham Risk Score for Hard Coronary Heart Disease

- Used for patients aged 30–79 years with no prior history of coronary heart disease
- Not for use in patients with intermittent claudication or diabetes
- Items in the calculator
  - Age
  - Sex
  - Smoker
  - Total cholesterol
  - HDL cholesterol
  - Systolic BP
  - BP treated with medications

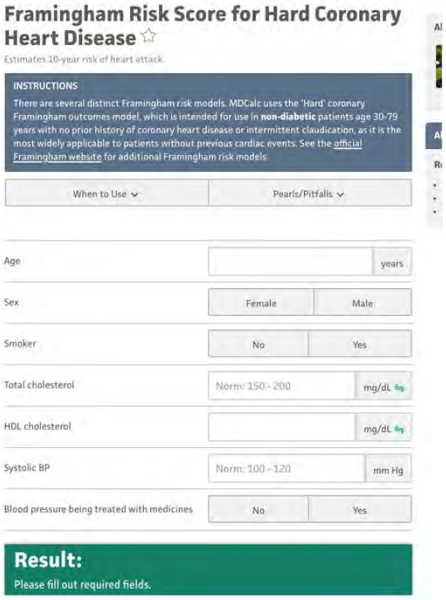
- https://www.mdcalc.com/framingham-risk-score-hard-coronary-heart-disease

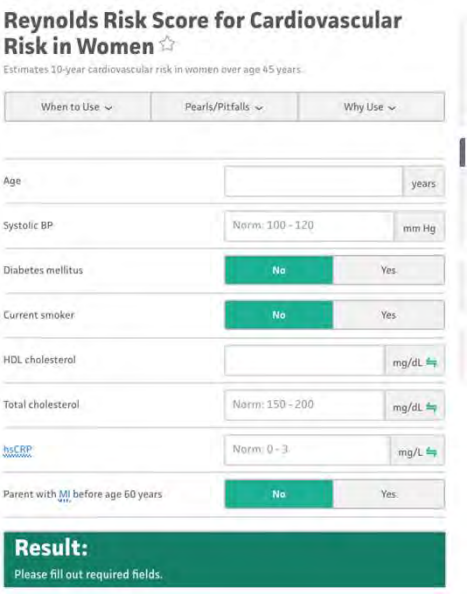
Framingham Risk Score

- One of a number of scoring systems to determine an individual's risk of developing cardiovascular disease
- Cardiovascular risk scoring systems give an estimate of the probability that a person **will develop** cardiovascular disease within a specified amount of time, usually 10 to 30 years
- **Low risk:** have 10% or less CHD risk at 10 years
- **Intermediate risk:** 10%–20%
- **High risk:** 20% or more

Example Using Framingham Risk Score

- 55-year-old male
- Former smoker
- Cholesterol: 220
- HDL: 35
- Systolic BP: 142
- BP treated with medications: yes
- Score: 26.8% = 10-year risk of MI or death for this patient





Reynolds Risk Score for Cardiovascular Risk in Women

If you are healthy and without diabetes, the Reynolds Risk Score is designed to predict your risk of having a future heart attack, stroke, or other major heart disease in the next 10 years

- Items in the calculator
  - Age
  - Diabetes
  - Current smoker
  - Systolic blood pressure (BP)
  - HDL cholesterol
  - Total cholesterol
  - Hs CRP
  - Family history of MI prior to age 60

- https://www.mdcalc.com/reynolds-risk-score-cardiovascular-risk-women

Example for Reynolds Risk Score

- 55-year-old female
- Systolic: 140
- HbA1c 6.8
- Not a current smoker
- HDL: 50
- Total cholesterol: 200
- hsCRP NL (2)
- No previous MI
- Total score: 5.0% risk

What Do We Do With the CAD Risk Score?

Determine if you should be testing patient in your clinic

- Depends on your setup, physician availability, ACLS certification, mock code results, etc.
- **High risk for CAD:** I would not test in the clinic
- **Moderate risk:** if I had cardiovascular and pulmonary skills and knowledge plus a good emergency system
- **Low risk:** I would definitely test in clinic

Other Options for Determining if Patient Should Be Tested or Be Exercising

- **ACSM clinical decision tree on participating in regular exercise**
  - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7059860/
- **PARQ readiness of physical activity**
  - https://www.acsm.org/docs/default-source/files-for-resource-library/par-q-acsm.pdf

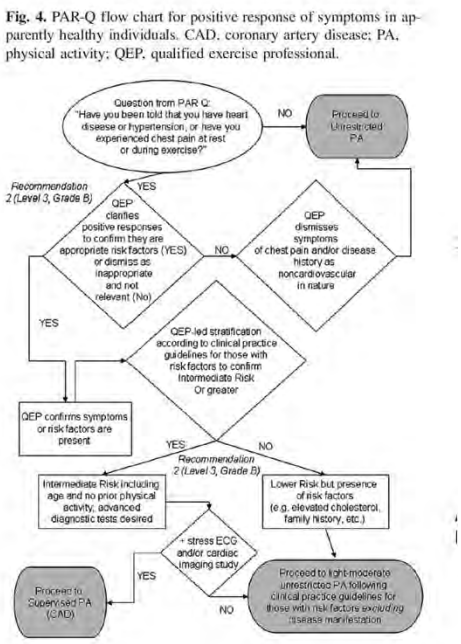
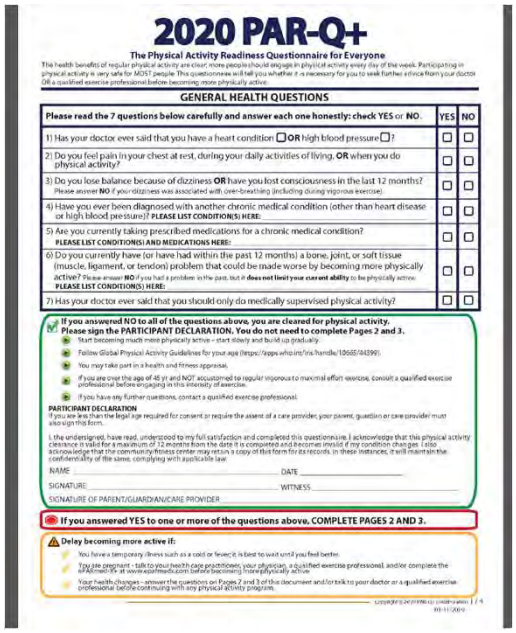


Fig. 4. PAR-Q flow chart for positive response of symptoms in apparently healthy individuals. CAD, coronary artery disease; PA, physical activity; QEP, qualified exercise professional.



2020 PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

GENERAL HEALTH QUESTIONS

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	YES	NO
1) Has your doctor ever said that you have a heart condition ☐ **OR** high blood pressure ☐?	☐	☐
2) Do you feel pain in your chest at rest, during your daily activities of living, **OR** when you do physical activity?	☐	☐
3) Do you lose balance because of dizziness **OR** have you lost consciousness in the last 12 months? Please answer **NO** if your dizziness was associated with over-breathing (including during vigorous exercise).	☐	☐
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? **PLEASE LIST CONDITION(S) HERE:**	☐	☐
5) Are you currently taking prescribed medications for a chronic medical condition? **PLEASE LIST CONDITION(S) AND MEDICATIONS HERE:**	☐	☐
6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer **NO** if you had a problem in the past, but it **does not limit your current ability** to be physically active. **PLEASE LIST CONDITION(S) HERE:**	☐	☐
7) Has your doctor ever said that you should only do medically supervised physical activity?	☐	☐

If you answered NO to all of the questions above, you are cleared for physical activity. Please sign the PARTICIPANT DECLARATION. You do not need to complete Pages 2 and 3.

- Start becoming much more physically active – start slowly and build up gradually.
- Follow Global Physical Activity Guidelines for your age (https://apps.who.int/iris/handle/10665/36399).
- You may take part in a health and fitness appraisal.
- If you are over the age of 45 yr. and NOT accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.
- If you have any further questions, contact a qualified exercise professional.

PARTICIPANT DECLARATION

If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that the community fitness center may retain a copy of this form for its records. In these instances, it will maintain the confidentiality of the same, complying with applicable law.

NAME _____ DATE _____

SIGNATURE _____ WITNESS _____

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER _____

If you answered YES to one or more of the questions above, COMPLETE PAGES 2 AND 3.

Delay becoming more active if:

- You have a temporary illness such as a cold or fever; it is best to wait until you feel better.
- You are pregnant – talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ at www.eparmedx.com before becoming more physically active.
- Your health changes – answer the questions on Pages 2 and 3 of this document and/or talk to your doctor or a qualified exercise professional before continuing with any physical activity programs.

What Are My Options for Exercise Testing?

- Treadmill/bicycle maximal vs. submaximal test
- 6-Minute Walk
- NuStep
- Shuttle walk
- Gait Speed
- 2-Minute Step Test
- TUG
- Simple exercise test: vital sign monitoring with activity
- Other tests for function/strength/balance

Test Termination Criteria

- Symptoms
- Abnormal HR responses, especially if too close to submax or max HR
- Abnormal BP responses, especially flat or drop in BP
- Abnormal SpO2 with exercise, especially HR below 90
- Palpation of new arrhythmias
- Change in gait
- Inability to keep up with workload

What Is Specificity of Exercise?

- The muscles that you use with your regular activities or your regular exercise will be trained due to use. The muscles you do not use will not develop training effects.
- Therefore, if goal is to improve walking performance, then walking should be the mode of exercise. If goal is to improve biking performance, then mode of exercise should be biking.

Summary

- Determine from patient's history if patient has any factors that would be a contraindication for exercise testing
- Determine risk stratification to determine if patient is a candidate for testing in your clinic
- Know the test termination criteria
- Use a test protocol that measures an individual's exercise tolerance based on the mode of activity/exercise the patient wishes to pursue (principle of specificity of exercise)

Poll Question

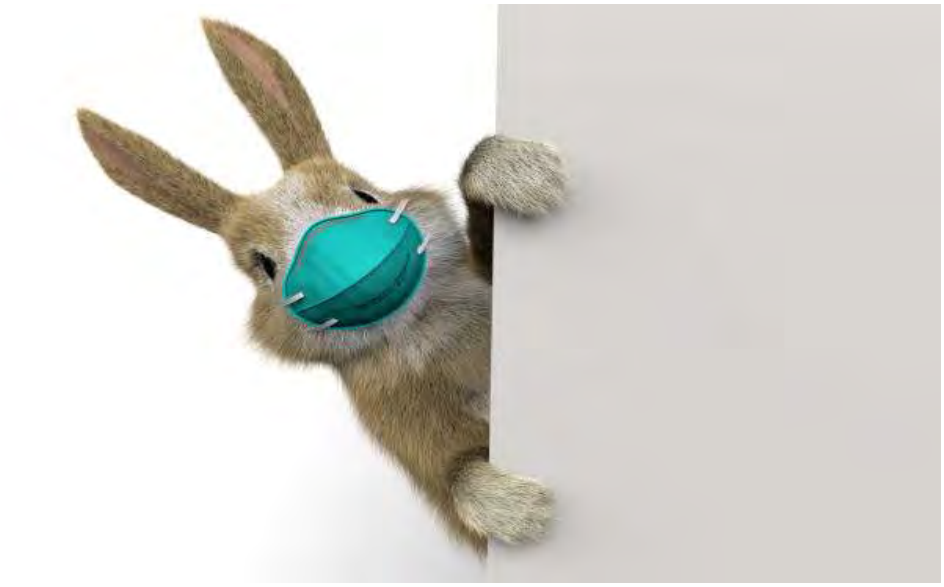
You decide your patient would benefit from a regular exercise program, but you have identified that the patient may be frail and may have risk factors for heart disease. Before performing the exercise test your next steps should be:

a) Evaluate for frailty, and if not frail, determine appropriate ex test and perform test

b) Evaluate for frailty, evaluate for risk for heart disease using a risk factor assessment tool, perform an exercise test to the patient's maximum no matter your clinic setting

c) Evaluate for frailty, evaluate for risk for heart disease using a risk factor assessment tool, and based upon their risk, determine a submaximal HR to use for termination of the test

d) Evaluate for risk for heart disease using the Framingham or Reynolds Risk score and determine a submaximal HR to use for termination of test as long as risk score is greater than 25%



Specific Exercise Tests, Including the Pros and Cons

Maximal vs. Submaximal TM or Bike Test

- Maximal TM or bike test: patient works to their predicted maximal HR based upon the HR formula used
- Submaximal TM or bike test: test terminated prior to achieving predicted max HR. Certain target HR set, such as 75% of predicted maximal or 85% of predicted maximal.
- Symptom-limited maximal test: exercise test terminated when patient reports symptoms of perceived maximal exertion or abnormal symptoms, such as chest pain, dyspnea, fatigue
- Typically, individuals are able to achieve higher HR with TM vs. bike

Great Article Published on Submaximal Exercise Testing

- Noonan, V., & Dean, E. (2000). Submaximal exercise testing: Clinical application and interpretation. *Physical Therapy*, *80*(8), 782–807.

6-Minute Walk Test (6MWT)

- Used to assess performance in a variety of cardiopulmonary diseases and to determine prognosis
- Test is influenced by frailty, deconditioning, and musculoskeletal strength and endurance
- There is a learning effect. Two tests are recommended. Often an increase of 26 meters on second test.
- The 6-Minute Walk Distance (6MWD) is the primary outcome of the 6MWT
- The lowest arterial oxygen saturation measured by pulse oximetry (SpO2) recorded during a 6MWT has emerged as an important marker of disease severity and prognosis; however, it may not be consistent with end-test SpO2. Continuous pulse oximetry is recommended during the 6MWT to ensure that the lowest SpO2 is recorded.

6-Minute Walk Test (6MWT) (cont.)

- A minimal important difference (MID) of 30 m exists for the 6MWD in adults with chronic respiratory disease
- A lower 6MWD is strongly associated with increased risk of hospitalization and mortality in people with chronic respiratory disease

Indications for 6-Minute Walk Test

Pretreatment and posttreatment comparisons

- Lung transplantation
- Lung resection
- Lung volume reduction surgery
- COPD
- Pulmonary rehabilitation
- Pulmonary hypertension
- Heart failure

Assessing functional status

- COPD
- Cystic fibrosis
- Heart failure
- PVD
- Fibromyalgia
- Older patients

Evidence of 6-Minute Walk

- Mean 6MWD was 524 meters (1,719 feet) for healthy males (≥60 years) and 475 meters (1,558 feet) for healthy females (≥60)[1]
  - 1 foot = .3048 meters
- **MCID:** 14–20 meters[2]
- **Prognosis**
  - <300 meters increased risk of morbidity and mortality in COPD and HF patients
  - <420 meters increased risk of morbidity and mortality in pulmonary hypertension

1. Bohannon, 2007
2. Bohannon & Crouch, 2016

Evidence and Description of Field Exercise Tests

- An official European Respiratory Society/American Thoracic Society technical standard: Field walking tests in chronic respiratory disease.
  - https://doi.org/10.1183/09031936.00150314

Video Examples of 6-Minute Walk Test

- American Thoracic Society
- https://www.youtube.com/watch?v=JD1AGVpftps

Using Recumbent Stepper for Testing

KM18
eh [2]25

Total Body Recumbent Stepper Exercise Test Protocol

- Exercise testing can be performed on all sorts of modalities
- The **key** is measuring responses to exercise: HR, BP, symptoms, SpO2, and sometimes ECG
- Truly **abnormal** responses should be referred for further diagnostic testing
- Recumbent stepper[1]

1. Billinger et al., 2012
2. https://www.youtube.com/watch?v=wZe9TJQVc1Q

Slide 54

KM18 Is this your image?
Kenzie Meek-Beck, 2/1/2021

eh [2]7 It was sent to me by a colleague...
ellen hillegass, 2/2/2021

eh [2]25 replaced with istock image
ellen hillegass, 2/2/2021

Total Body Recumbent Stepper Exercise Test Protocol (cont.)

- Published in *Physical Therapy* in 2008[1]
- Starts with 25 watts and stepping cadence of 80 steps/minute for two minutes
- Duration is two minutes per load
- Increase resistance based on patient's HR response
  - Load 2 is 40, then 55, then 70, then 85, then 100 watts

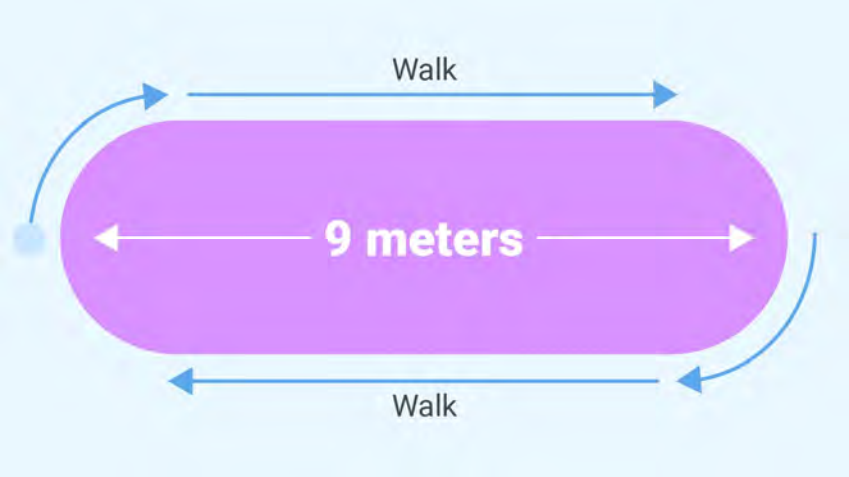
1. Billinger et al., 2008

Shuttle Walk Test

The Incremental Shuttle Walk Test (ISWT)

- An externally paced maximal exercise test
- Speed of walking increases with each level that is controlled by a series of prerecorded signals
- Test is complete when participant cannot continue **or** when participant cannot keep up with the speed (pace required of level)
- Maximal duration of test is 20 minutes. Average performance is 168 meters (550 feet) in COPD (approximately 4 minutes), and 390 meters in cardiac rehabilitation patients (approximately 6–7 minutes)
- Little evidence of use with chronic respiratory disorders OTHER THAN COPD
- Learning effect on second test: difference of 20–25 meters; therefore, recommendation is to perform two tests and record best performance

Walking Track for ISWT



ISWT Procedure

- There are 12 levels of speed, beginning at 0.50 meters/second and ending at 2.37 meters/second
- The test is measured in meters, and no encouragement is provided
- The speed at which the patient should walk is directed by an audio signal. There is a triple bleep indicating the test has started, at which point the patient commences walking and the timer is started.
- The test is terminated when any of the following occurs:
  - The patient indicates that they are unable to continue
  - The operator determines that the patient is not fit to continue
  - The operator assesses that the patient was unable to sustain the speed and cover the distance to the cone prior to the beep sounding
- As with all beep-type tests, practice and motivation levels can influence the score attained

ISWT Shuttles

Level	Speed (meters/seconds)	Time per shuttle (seconds)	# of shuttles in level	Total distance
1	.50	20	3	30
2	.67	15	4	70
3	.84	12	5	120
4	1.01	10	6	180
5	1.18	8.57	7	250
6	1.35	7.50	8	330
7	1.52	6.67	9	420
8	1.69	6.00	10	520
9	1.86	5.46	11	630
10	2.03	5.00	12	750
11	2.20	4.62	13	880
12	2.37	4.29	14	1020

ISWT Recordings

Obtain the recordings from YouTube video below:
https://www.youtube.com/watch?v=69g77DVHb7w

Instructions

- The object of the progressive shuttle walking test is to walk as long as possible there and back along the 10-meter course, keeping to the speed indicated by the bleeps on the audio recording. You will hear these bleeps at regular intervals. You should walk at a steady pace, aiming to turn around the cone at one end of the course when you hear the first bleep, and at the other end when you hear the next. At first your walking speed will be very slow, but you will need to speed up at the end of each minute. Your aim should be to follow the set rhythm for as long as you can. Each single bleep signals the end of a shuttle, and each triple bleep signals an increase in walking speed. You should stop walking only when you become too breathless to maintain the required speed or can no longer keep up with the set pace.
- The test is maximal and progressive. In other words, it is easier at the start and harder at the end. The walking speed for the first minute is very slow. You have 20 seconds to complete each 10-meter shuttle, so don't go too fast. The test will start in 15 seconds, so get ready at the start now. Level 1 starts with a triple bleep after the 4-second countdown.

ISWT Evidence

- Lower ISWT predicts poor survival in COPD patients[1,2]
- Lower ISWT predicts rehospitalization in COPD patients[1,3]
- MCID 48 meters or 5 shuttles in COPD[4]
  - https://pubmed.ncbi.nlm.nih.gov/18390634
- MCID 70 meters in cardiac rehab patients[5]
- Comparisons between distance covered during the ISWT and peak oxygen consumption reported correlations ranging from 0.67 to 0.95 (P <.01)[6]
- Strong relationship between VO_2 or work rate on CPET and ISWT (r50.75–0.88)

1. Emter et al., 2007
2. Ringbaek et al., 2010
3. Williams
4. Singh
5. Houchen-Wouloff, 2015
6. Parreira

ISWT Evidence (cont.)

- **Equation:** peak VO_2 = 257 + (0.038 × ISWD × body mass) r = 0.90
- **Equation:** peak VO_2 = −16.1 − (22.4 × MWV)
  - r = 0.85
- **Equation:** peak VO_2 = −1142 + (1644 × MWV) r = 0.74

1. Parreira et al., 2014
2. Dourado et al., 2013

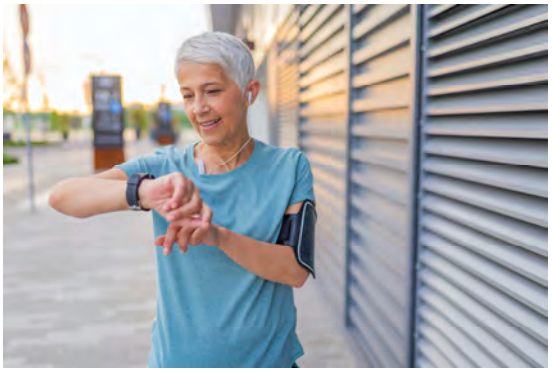
Gait Speed

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

2-Minute Step Test



2-Minute Step Test: Procedure

1. Take resting vital signs
2. Have patient/client stand next to a wall. Measure the height of the iliac crest and patella and mark on wall. Place a piece of tape on the wall half the distance between the two.
3. On the signal "go," the patient/client begins stepping (not running) in place, raising each knee to the mark on the wall for as many times as possible in the 2-minute period
4. Score by counting the number of times the right knee reaches the required height.
5. If the proper knee height cannot be maintained, ask the participant to slow down or to stop until they can regain the proper form, but keep the stopwatch running
6. At the end of the test, provide a cooldown, having the patient walk slowly for a minute
7. A person with impaired balance may use the back of a chair as a touch-hold for stability. Note this modification in your documentation.
8. Perform one trial
9. Take postexercise vital signs

Note: NO MCID established in any of articles using this test

2-Minute Norms: Males

Age % rank	60–64	65–69	70–74	75–79	80–84	85–89
95	135	139	133	135	126	114
75	115	116	110	109	103	91
55	104	104	98	95	90	78
35	93	92	86	80	78	66
15	79	77	71	63	62	50
5	67	67	67	47	48	36

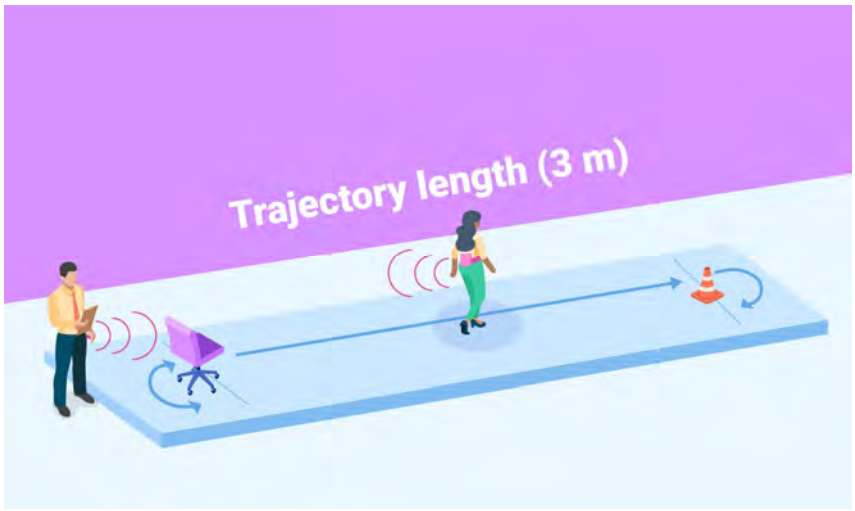
- Rikli, 2001

2-Minute Norms: Females

Age % rank	60–64	65–69	70–74	75–79	80–84	85–89
95	130	133	125	123	113	114
75	107	107	101	100	90	91
55	94	93	87	87	78	78
35	82	80	74	75	66	66
15	66	63	58	59	51	50
5	52	47	43	45	37	36

- Rikli RE 2001

Timed Up and Go (TUG)



- Holland et al., 2020

Timed Up and Go Normative Data

Age	Gender	Mean (seconds)	Normal Range
60–69	Male	8	4–12
60–69	Female	8	4–12
70–79	Male	9	5–13
70–79	Female	9	5–15
80–89	Male	10	8–12
80–89	Female	11	5–17
Score <14 seconds not a high risk for falls			
Score >13 seconds is a high risk for falls			

Simple Exercise Test: Vital Sign Monitoring With Activity

The simplest exercise test is to utilize vital sign monitoring with all new activities

- Measure and assess HR response with the specific activity
- Measure and assess BP response with the specific activity
- Measure and assess SpO2 response with the specific activity
- Measure and assess symptoms with the specific activity
- If available, measure and assess ECG rhythm response with the specific activity

Good References for "When Not Performing an Exercise Test"

- Foster, C., Porcari, J., Ault, S., Doro, K., Dubiel, J. T., Engen, M. R., Kolman, D., & Xiong, S. (2018). Exercise prescription when there is no exercise test: The Talk Test. *Kinesiology: International Journal of Fundamental and Applied Kinesiology, 50*, 33–48.
- Mytinger, M., Nelson, R. K., & Zuhl, M. (2020). Exercise prescription guidelines for cardiovascular disease patients in the absence of a baseline stress test. *Journal of Cardiovascular Development and Disease*, *7*(2), 15.

Summary

- Multiple exercise testing protocols exist and are appropriate for a variety of patients. The choice of the test should be based on the patient's mobility, musculoskeletal issues, and type of exercise they wish to perform regularly.
- It is important to understand the difference between maximal and submaximal or symptom-limited testing. Most patients are not tested maximally in the outpatient setting.
- Submaximal TM or bike test: test terminated prior to achieving predicted max HR. Certain target HR set, such as 75% of predicted maximal or 85% of predicted maximal.
- Options for testing include bike, treadmill, recumbent stepper, 2-Minute Step Test, 6-Minute Walk Test, Incremental Shuttle Walk Test, Gait Speed, and TUG

Poll Question

Based on a patient who is ambulatory with good balance and good cognition who has heart failure which would be the best choice for an exercise test according to the evidence of testing patients with heart failure?

a) Two-minute step test
b) Six-minute walk test
c) Incremental shuttle walk test
d) Submaximal treadmill test

Exercise Assessment: Assessing and Interpretation of Vital Signs

What Are the Normal Responses to Activity?

Heart Rate Responses

Increases with increasing workload

- Rise is nearly linear at sub max effort
- Increases ~8–12 bpm/met[1]
- Rise is greater during U/E vs. L/E work[2]
- Rise is greater during dynamic vs. static work[3]
- HR is **linearly** related to oxygen consumption
  - What does this mean?

1. ACSM, 2000
2. Aminoff et al, 1998; Hellerstein & Franklin, 1978
3. Akdur et al., 2002; Ielloamo et al., 1997; Lind & McNicol, 1967

HR Max Formulas

- 220 − age
- 207 − 0.7 × age over 40
- 211 − 0.64 × age healthy active
- Beta-blocking medication formula
  - 164 − 0.7 × age
- Age 60
  - 220 − age = 160
  - 207 − 7 × age = 207 − 42 = 165
  - 211 − 0.64 × age = 211 − 38.4 = 172.6
  - On beta blocker: 164 − 42 = 122

What Is the Normal HR Response?

- Getting up from sitting? Standing? Walking across room?
- Going up a flight of stairs?
- Doing arm exercise?
- Doing isometric exercise?
- Going from supine to sit to stand when patient has been on bed rest for day
- **Therefore, what would be abnormal? What do they mean?**

Beta-Blockers

Beta-Blockers (BBs): Indications

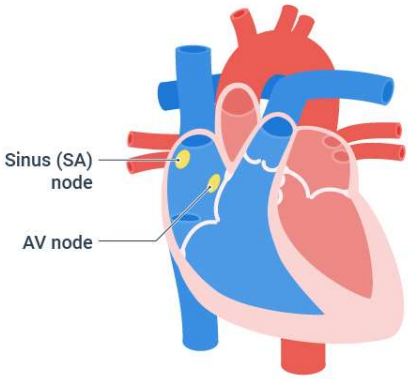
- Management of hypertension
- Management of angina (lower workload on heart, decrease myocardial O_2 consumption)
- Management post MI or CABG to lower workload on heart
- Research indicates BBs improve morbidity and mortality post MI or CABG

Beta-Blockers: Effects

- Lower HR
- Lowers systolic BP
- Decrease contractility of myocardium
  - Block stimulation of beta 1 and beta 2 adrenergic receptor sites
- Limit ventricular remodeling by decreasing early ventricular dilatation

Nerve Fibers to Heart

- **Sympathetic fibers**
  - Direct stimulation to SA node, AV node, and muscle
- **Parasympathetic fibers**
  - Vagal to SA node



Beta-Blockers: Side Effects

- Fatigue, weakness, drowsiness, impotence
- Insomnia, depression, memory loss, nightmares
- Bradycardia, hypotension, peripheral vasoconstriction
- Bronchospasm

Beta-Blocking Medications

Beta-blocking medications	
carteolol (Cartrol)	penbutolol (Levatol)
carvedilol (Coreg)	atenolol (Tenormin)
betaxolol (Kerlone)	metoprolol (Toprol)
labetalol (Normodyne)	bisoprolol (Zebeta)
nadolol (Corgard)	timolol (Blocadren)
pindolol (Visken)	esmolol (Brevibloc)
propranolol (Inderal)	nebivolol (Bystolic)
Sotalol (Betapace)	acebutolol (Sectral)

Blood Pressure Responses

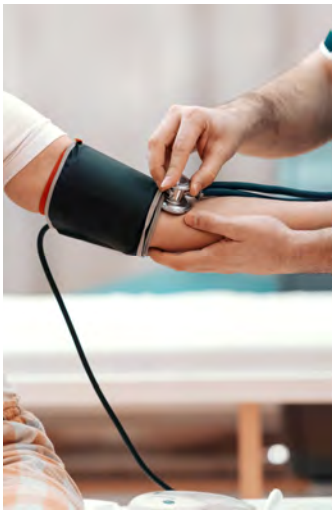
Systolic BP increasing with increasing workload

- Rises ~8–12 mmHg/met[1]
- Response is greater during U/E vs. L/E work[2]
- Also greater during static vs. dynamic work[3]
- Diastolic BP remains unchanged or decreases during aerobic activity[1]
- DBP increases during heavy resistance activity[4]

1. ACSM, 2000
2. Hellerstein & Franklin, 1978
3. Akdur et al., 2002; Iellamo et al. 1997; Sale et al., 1993; Lind & McNicol, 1967
4. Akdur et al., 2002; Ielloamo et al., 1997

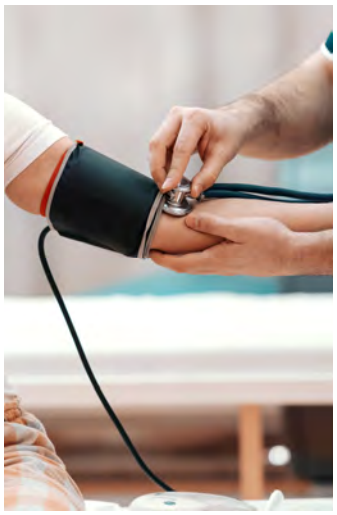
What Is Normal BP Response?

- **Getting up from sitting? Standing? Walking across room?**
  - Systolic? Diastolic?
- **Going up a flight of stairs?**
  - Systolic? Diastolic?
- **Doing arm exercise?**
  - Systolic? Diastolic?
- **Doing isometric exercise?**
  - Systolic? Diastolic?
- **Going from supine to sit to stand when patient has been on bed rest for days?**
  - Systolic? Diastolic?
- **What are abnormal responses? What do they mean?**



Hypotension

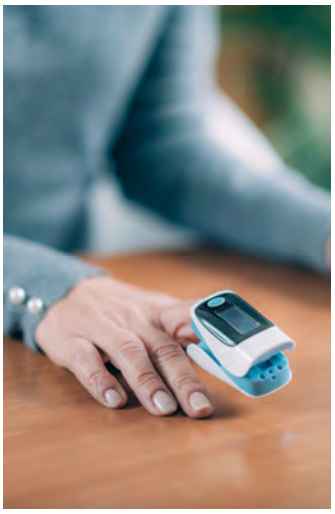
- **Orthostatic hypotension**
  - What is it?
  - What causes it?
  - What is treatment?
- **Exertional hypotension**
  - What is it?
  - What causes it?
  - What is treatment?



Oxygen Saturation (SpO2) Responses

Oxygen Saturation (SpO2)

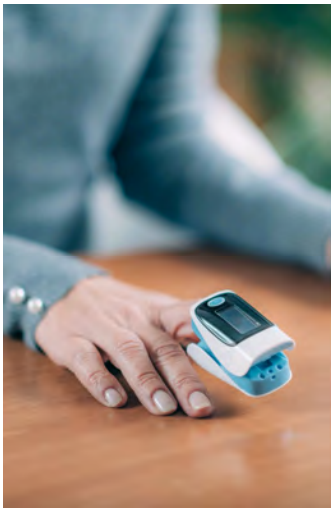
- Normal response: no change or minimal decrease
- Abnormal response: decrease with increasing activity (decrease of 4 percentage points, particularly if <90%, is clinically significant)[1]
- Severely abnormal: SpO2 drops below 88%



1. ACSM, 2000

What Is Normal SpO2 Response?

- Getting up from sitting? Standing? Walking across room?
- Going up a flight of stairs?
- Doing arm exercise?
- Doing isometric exercise?
- Going from supine to sit to stand when patient has been on bed rest for days?
- **Therefore, what would be abnormal? What do they mean?**



Respiratory Rate Responses

Respiratory Rate

- Normal = 12–20
- Should correspond with HR changes
- Will severely change with drop in SpO2
- Resting rate >24 may indicate clinical instability[1]

1. Halm et al., 2003
2. Halm et al., 2002

What Is Abnormal? When Should I Terminate Activity?

- **Abnormal HR responses**
  - Too rapid increase for the level of the activity
  - Extremely flat response and **not** on beta-blockers
  - Palpate new arrhythmias
- **Abnormal BP responses**
  - **Systolic BP**
    - Rapid rate of rise
    - Blunted
    - Exertional hypotension (>10 mmHg decrease) while exercise increasing[1]
  - **Diastolic BP**
    - Progressive rise (>10 mmHg)
    - Decrease (>10 mmHg)

1. ACSM, 2000

What Is Abnormal? When Should I Terminate Activity? (cont.)

- **Abnormal SpO2 responses**
  - Drop in SpO2 with any activity
- **If SpO2 drops…**
  - What should HR do?
  - What should RR do?
  - What if SpO2 drops and HR does not change, and RR does not change?
    - What should you do?
  - **What if SpO2 drops and HR DOES increase, and RR DOES increase?**
    - What should you do?

Case Examples of Vital Signs

VS Responses to Activity

Activity	HR	BP	SpO2	Symptoms
Supine	72	124/78	96	Tired
Sit	84	110/70	94	Tired
ADL sit	96	118/78	94	Tired
Stand	108	94/68	93	SOB, light-headed
Ambulation 6'	114	110/78	94	Fatigue

VS Responses to Activity (cont.)

Activity	HR	BP	SpO2	Symptoms
Supine	80 irregular	118/72	96	None
Sit	90 irregular	120/70	96	None
ADL sit	100 irregular	126/76	96	Tired
Stand	100 irregular	114/72	96	Tired
Ambulation	110 irregular	92/60	94	SOB, fatigue

VS Responses to Activity (cont.)

Activity	HR	BP	SpO2	Symptoms
Supine	100	120/76	93	SOB
Sit	106	124/74	92	SOB
ADL sit	120	134/72	89	SOB increased
Stand	110	220/70	91	SOB
Ambulation 10'	10	132/80	88	Severe SOB

Official Guidelines from the Cardiovascular and Pulmonary Section

Supplemental Oxygen Utilization During Physical Therapy Interventions

Task Force on Supplemental Oxygen: Ellen Hillegass, PT, EdD, CCS, FAACVPR, FAPTA; Ann Fick, PT, DPT, MS, CCS; Amy Pawlik, PT, DPT, CCS; Rebecca Crouch, PT, DPT, CCS, FAACVPR; Christiane Perme, PT, CCS; Rohini Chandrashekar, PT, DPT, CCS; Susan Butler McNamara, PT, MMSc, CCS; Lawrence P. Cahalin, PT, PhD, CCS

Cardiopulmonary Physical Therapy Journal Vol 25 v No 2 v June 2014

Summary

- Always assess vital signs on initial evaluation and during any new activity
- Know normal VS responses to aerobic vs. anaerobic activity
- Determine if there is any intervention that can improve the VS to the activity (for example orthostatic hypotension)
- If abnormal response identified that cannot be improved with an intervention, consider discussing this problem with the medical team

Poll Question

Determine which of the following is an abnormal VS response to activity that requires discussion with the medical team rather than just a modification of program or exercise prescription

a) Rapid HR response, rapid BP response

b) Drop in SpO2 with a rise in HR and rise in RR

c) Rise in HR with activity in conjunction with a drop in BP with activity

d) Rapid HR rise with activity, flat BP response with activity

Exercise Prescription and Case Examples

How Do I Develop an Initial Exercise Prescription?

- Need to know how to develop an exercise prescription with and without an exercise test
- Need to consider the patient's goals
- Need to know how to build in progression

- As we have discussed performing an exercise test and assessing vital signs to exercise, we are now ready to develop the exercise program based upon these results.

Components of an Exercise Prescription

- Mode
- Intensity
- Frequency
- Duration

Mode of Exercise

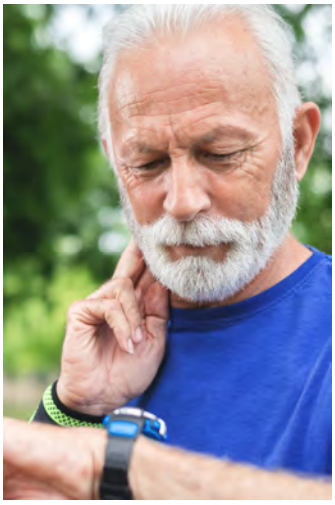



Intensity of Exercise

- Utilize a target heart rate
- Utilize a “perceived exertion”
- Time and distance prescription
- Pulmonary patients: use level of dyspnea

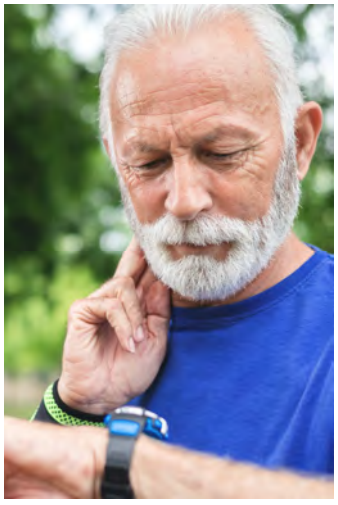
Target Heart Rate (THR)

- Karvonen Method of determining THR:
  - RHR + ___% (Max HR − RHR)
- Give a range for patient to work in
  - Usually use 60%–85% of max heart rate as a target heart rate range
  - 60%–85% may be "too hard" for beginners, very deconditioned individuals
- What max HR should you use for this formula?
  - If you do not actually perform an exercise test prior to developing exercise prescription, be conservative



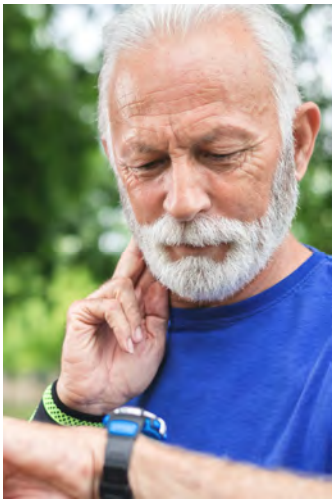
Target Heart Rate: Using the Formula

- RHR + ___% (max HR − RHR)
- 70-year-old deconditioned male with rest HR of 80, PMHR of 150
  - 80 + .6 (150−80) = 80 + 42 = 122
  - 80 + .85 (150 − 80) = 80 + 60 = 140
- Based on the formula, 70-year-old deconditioned male should have an **initial** target HR of 122–140?
  - Now consider if this is an appropriate target HR range for a deconditioned older individual



Target Heart Rate: Being Conservative

- RHR + __% (max HR − RHR)
- Use 40%–60%
  - 80 + .4 (150 − 80) = 108
  - 80 + .6 (150 − 80) = 122



Intensity of Exercise (cont.)

- Light-intensity exercise, 30% to <40% HRR or VO_2R, to <3 METs, 9–11 RPE, an intensity that causes slight increased in HR and breathing
- Moderate-intensity exercise, 40% to <60% HHR or VO_2R, to <6 METs, 12–13 RPE, and intensity that causes noticeable increases in HR and breathing
- Vigorous-intensity exercise ≥60 HHR or VO_2R, ≥14 RPE, an intensity that causes substantial increases in HR and breathing

- Patients who need adjustments in Intensity
  - CVD, cardiac, peripheral, vascular, or cerebrovascular disease
  - Metabolic disease, types 1 and 2 diabetes mellitus
  - Signs and symptoms, and rest or during activity; includes pain, discomfort in the chest, neck, jaw, arms, or other areas that may result from ischemia; shortness of breath at rest or with mild exertion; dizziness or syncope; orthopnea or paroxysmal nocturnal dyspnea; ankle edema; palpitations

Intensity

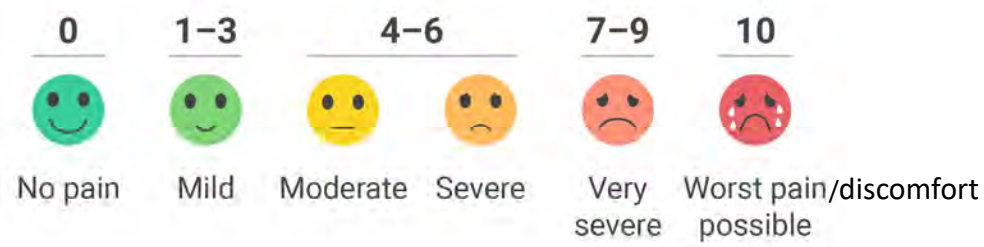
- Use a perceived exertion of <13, or somewhat hard on the 6–20 scale, or 4–5 on 0–10 scale
- Use distance/time such as 2.0 mph for 30 minutes
  - Instead of 2.0 mph, prescription could be 1.0 mile in 30 minutes
  - Walk 1.8 mph on treadmill in clinic for 10 minutes
    - Measure 0.3 miles at home, walk in 10 minutes

Intensity (cont.)

Level of dyspnea: one that has been determined from exercise test where SpO2 value is low for patient

- Often use no < 88 SpO2

Pain Scale…can use this for Dyspnea or Exertion



/discomfort

Duration of Exercise

- Increase duration until patient achieves 30 minutes continuously
- Interval training can be used initially with severely deconditioned individuals. Start with moderate-intensity intervals, not high-intensity intervals.
- Increase duration to >30 minutes for individuals with goal of weight reduction

Frequency of Exercise

- 3–6 times/week is optimal if individual exercising 20–30 minutes duration
- **Every day** and multiple times/day if only exercising 2–5 minutes at a time
- 2 times/week can be used to **maintain** conditioning
- 7 times per week is too much and may increase risk of injury
- For older patients, use day of rest between each day of exercise

HIGH INTENSITY INTERVAL TRAINING (HIIT)

- NOT recommended unless patients are defined as "stable
  - Heart failure: evidence is strong for benefit of HIIT in chronic stable HF
  - Other evidence for various populations when patients are stable
  - HIIT is defined as 80-95% of MAX HR for short intervals of 3-4 minutes at a time. Patients must be progressed into these intervals after they have demonstrated ability to tolerate moderate intensity activity.
  - Patients can REST in between intervals OR they can decrease down to moderate intensity in between intervals.

Physical Activity and Public Health in Older Adults Guidelines

- Describe amounts and types of PA that promote health and prevent disease
- For all adults 65+ and adults 50–64 with clinically significant chronic conditions or functional limitations that affect movement ability, fitness, or PA

- Nelson et al., 2007

Physical Activity and Public Health in Older Adults

- Moderate-intensity aerobic PA for minimum of 30 min on 5 days/week, or vigorous-intensity PA for minimum of 20 min on 3 days/week
  - Moderate: level 5 or 6 on 10 scale, or produces notable ↑ in HR or breathing
  - Vigorous: 7 or 8 on 10 scale
  - This is in addition to daily activities
- Perform activities that maintain or Increase muscle strength and endurance for min of 2 days/week
  - 8–10 exercises performed on two or more nonconsecutive days, working major muscle groups
  - To maximize strength development, use a resistance weight that allows 10–15 reps
  - Level of effort should be mod to vigorous
  - Includes progressive weight training and weight-bearing calisthenics

Physical Activity and Public Health in Older Adults (cont.)

- Participation in muscle strengthening and aerobic activities above minimum results in higher level of physical fitness
- Perform activities that maintain or increase flexibility 2 days/week or more for at least 10 minutes
- Individuals with substantial risk of falls should perform exercises that improve balance
- When chronic conditions preclude performing minimum, individual should perform PA according to condition and abilities to prevent sedentary behavior

1. Nelson et al., 2007
2. Revised guidelines AHA 2018

Prescribing ADL Activities

- 1 MET = the energy (oxygen) used by the body as you sit quietly, perhaps while talking on the phone or reading a book = 3.5 ml O_2/kg/minute
- The harder your body works during the activity, the higher the MET
- Any activity that burns 3 to 6 METs is considered moderate-intensity physical activity
- Any activity that burns >6 METs is considered vigorous-intensity physical activity

Activities and MET Values

- Walking slowly
- Golf with powered cart
- Swimming, slow treading
- Gardening or pruning
- Bicycling, very light effort
- Dusting or vacuuming
- Conditioning exercise, light stretching, or warmup

- Walking briskly
- Golf, pulling or carrying clubs
- Swimming, recreational
- Mowing lawn, power motor
- Tennis, doubles
- Bicycling 5 to 9 mph, level terrain or with a few hills
- Scrubbing floors or washing windows
- Weight lifting, Nautilus machines, or free weights

MET and BMI Calculators

Here are some online MET and BMI calculators

- http://www.fedel.com/mets/
- http://nhlbisupport.com/bmi/

Safety Factors to Consider with Exercise Prescriptions

Musculoskeletal limitations

- Delayed-onset muscle soreness
- Previous musculoskeletal dysfunction
  - Stationary biking may aggravate low back problems
  - Footwear key component of any weight-bearing activity

Factors to Consider to Increase Compliance

- **What are the patient's goals???**
- Environment patient is exercising in
  - Heat/humidity vs. cold
- How exercise fits into patient's daily schedule
- Whether patient enjoys the activity
- Biking/elliptical training/treadmill can be boring; however, if done while watching a TV program, may increase compliance
- Work commitments, home/childcare commitments, etc.
- **Exercise with a buddy**

Environmental Factors to Consider

- Outdoor environment vs. indoor
- Seasonal changes
- Childcare responsibilities/needs
- Time of day
- Need to shower
- Other

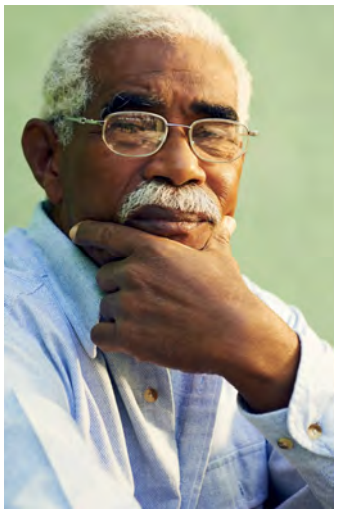
Flexibility

Strength Training

- Moderate- to high-intensity resistance training performed 2–3 times/week for 3–6 months
  - Improves muscle strength and endurance by 25%–100% (depending on initial level of strength and intensity)
- To achieve a balanced increase in both muscle strength and endurance, 8–12 reps is recommended for healthy pop. less than 60 yrs., and 10–15 reps for healthy pop. older than 60

Case Study

- 72-year-old male, four months post CABG surgery (uncomplicated), wishes to start strengthening program
- Exercise test was given by cardiologist at three months post bypass; results were normal
- What initial test would you use prior to providing strength prescription?
- Intensity?
- Frequency: times per week?
- Duration: reps/sets?



Answers

- What initial test would you use prior to providing strength prescription?
  - Has had aerobic exercise test; now do a multiple repetition strength test
- Intensity? Moderate: 5–6 out of 10
- Frequency: times per week? 3 times/week
- Duration: reps/sets? Start with multiple reps (3–5) for 2 sets

How to Develop Progression of Activity

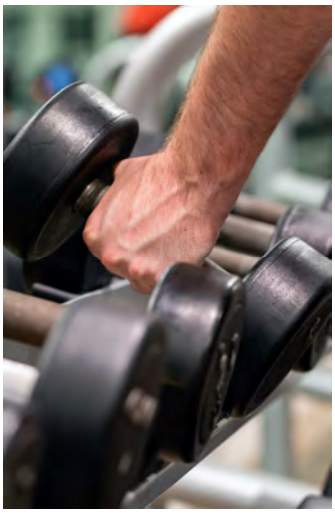
- Increase duration until patient achieves continuous exercise: 20–30 minutes
  - Use interval training to develop continuous
- Increase intensity once patient reaches 20–30 minutes of continuous exercise
- Increase no more than 10% each week
- Instruct patient in DOMS and how to treat DOMS if experienced
- Set up a progression of exercise for patient to follow when d/c from your services
- Have patient use a log for documenting exercise and symptoms

Progression for Case

- How do you build in progression?
- What are expected outcomes to monitor for this patient?

Benefits of Training for All Populations

- Lowers rate of rise of HR and BP with activity
- Faster return to baseline HR post exercise
- Decreased symptoms at lower workloads
- Higher max workload tolerated
- Benefits of training if work in the "training threshold zone"
- Decreased rest HR
- Decreased rest BP (if hypertensive)
- Decreased body fat (need diet management in addition to exercise training)



Overall Outcomes

- Improvement in vital signs with exercise
- Improvement in functional capacity/exercise tolerance
- Improvement in symptoms
- Improvement in strength
- Improvement in function
- **Add** time frame when developing objectives

Summary

- The most important component of an exercise prescription is the intensity. There are multiple ways to provide an intensity, but probably the easiest for individuals to understand is level of exertion or dyspnea rather than target HR.
- Intervals can be used, especially initially, but start with moderate-intensity intervals and build to high-intensity intervals
- Include an exercise prescription for muscle strengthening, and don't overlook the need to build in flexibility

Case Studies: Heart Failure and
Cerebrovascular Accident (CVA),COPD, ILD

Cardiovascular Case Study: Heart Failure

Case History

- A 68-year-old white male was recently discharged from hospital after being admitted with complaints of progressive weakness, shortness of breath, cough, and difficulty ambulating. His past medical history includes chronic hypertension with atherosclerotic vascular disease, coronary artery disease with ischemic cardiomyopathy, CABG x 2 one year ago, and chronic renal insufficiency. Patient reports he has paroxysmal nocturnal dyspnea (PND) and sleeps with two pillows. Patient was a smoker: 2 packs per day x 30 years.
- Medications include Coreg, NTG (nitrate) prn, Lasix (diuretic), and Altace (ACE inhibitor)
- Patient reports he has been walking at home around the house but still has shortness of breath with activity

Pretest Assessment

- Auscultation of heart and lung sounds
  - Concerned about history of cardiomyopathy and frequency of hospitalizations
- Assess any new signs/symptoms
- Assess resting vital signs: HR, BP, SpO2

Risk Assessment

- Pretest risk assessment
  - Framingham Risk Factor assessment: 19% 10-year risk of MI or mortality; classified as intermediate risk
  - Par-Q not needed as have MD referral already for patient to receive PT
  - Concern exists: individuals who do not perform an adequate preassessment of auscultation and vital signs and are not able to distinguish between normal and abnormal vital signs with activity should **not** perform exercise testing
- Don't forget to assess for **fragility**

Clinical Decision Regarding Test Choice

- Options
  - Submaximal treadmill stress test
  - Shuttle Walk Test
  - 6-Minute Walk Test
  - 2-Minute Step Test
- Chose 6-Minute Walk Test due to evidence on prognosis (morbidity and mortality) for HF patients
  - <300 meters or 984 feet demonstrates higher morbidity/mortality
  - Shuttle test mostly used for COPD, little data for HF
  - Patient could do more than 2-Minute Step Test, but probably not a candidate for submax treadmill test yet due to recent hospital discharge

Results of Exercise Test

Performed 6-Minute-Walk Test

- Frequent rests during test
- Walked 600 feet
- Rest HR: 60, Max HR: 90
- Max level of dyspnea 8/10
- Rest SpO2: 93/Ex SpO2: 89/patient is NOT on O_2 and no O_2 order exists
- Pre BP: 124/82, Post BP: 128/70

Exercise Prescription for Case

- Short bouts of walking daily, maybe multiple times per day
  - Mode: walk
  - Intensity: dyspnea of 5/10
  - Duration: 5–10 minutes continuously
  - Frequency 1–2 times/day
- Strengthening: sit-to-stands
  - Intensity: dyspnea of 5/10
  - 3–4 sit-to-stands 2–3 times/day
- Follow-up in 1–2 weeks to progress exercise prescription

Case Study: Cerebrovascular Accident

- 68-year-old male with long-standing history of hypertension, smoked two packs per day, elevated cholesterol, recent elevated HbA1c, works as a tax accountant and tends to work long days, especially during tax season
- Woke up in am with severe chest tightness, SOB. Contacted 911 and was transported to hospital, where he was determined to have a NON-STEMI and was transported to CCU for overnight stay and emergent four-vessel CABG surgery with sternotomy the next day.
- Patient returned from surgery, but five hours after returning to CCU, patient was demonstrating R sided weakness, and abnormal VS (elevated BP and HR). Patient was determined to have a mild L CVA.
- Patient was transferred to home with 12-hour nursing assistant care. After six weeks at home with home care PT, patient started outpatient PT/OT and was evaluated for ADLs and exercise tolerance.

Pretest Assessment

- Auscultation of heart and lung sounds
  - Concerned about history of bypass surgery and sternal precautions
  - Assess any new signs/symptoms
- Assess resting vital signs: HR, BP, SpO2
- Don't forget to test for **frailty**

Risk Assessment

- Framingham risk score: 28.6%
- Patient has already had bypass surgery and now a CVA
- Submaximal testing should be performed, not maximal

Clinical Decision Regarding Test Choice

- Options
  - Submaximal treadmill stress test
  - Shuttle Walk Test
  - 6-Minute Walk Test
  - 2-Minute Step Test
  - Recumbent stepper test
- Chose recumbent stepper test due to balance issues identified and poor exercise tolerance
- Billinger protocol used[1]

1. Billinger et al., 2008

Results of Exercise Test

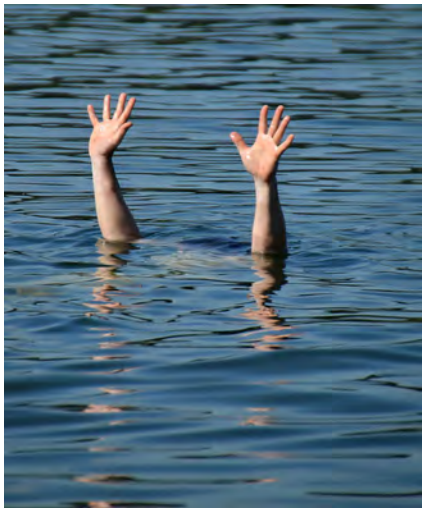
Each load is 2 minutes in duration, starting with 25 watts

- Patient performed 5 minutes 35 seconds on test, which was 55 watts workload
- Max HR: 110
  Submaximal HR goal: 114
- No symptoms
- Max BP: 160/90
- SpO2: 92
- RPE: 8/10

Exercise Prescription

- 2- to 5-minute intervals on the recumbent stepper
- Goal would be to progress to a walking program when balance improves and use of RLE is more functional

Are You Keeping Your Head Above Water?



Case: Chronic Obstructive Pulmonary Disease

Case History

- 66-year-old male with history of smoking two packs per day x 40 years; quit three years ago. Patient worked in finance and lived in New York City. Recently retired to Florida due to chronic productive cough, shortness of breath, and frequent bouts of pneumonia.
- Patient has been active in retirement, golfs 5 times/week, walks dogs on beach, bikes occasionally in neighborhood. Patient wants to be able to perform activities without shortness of breath and wants to hike on trips out west to national parks.
  - PFTs show FEV1.0 55%, FEV1/FVC 62%, DLCO 60% , no oxygen requirements
  - Takes Spiriva 2 times/day, Xopenex in nebulizer 1 time/day. No cardiac history.

Pretest Assessment

- Auscultation of heart and lung sounds
  - Concerned about lung sounds; assume chronic bronchitis
- Assess any new signs/symptoms
- Assess resting vital signs: HR, BP, SpO2
- Don't forget to test for **frailty**

Risk Assessment

Pretest assessment

- Framingham Risk Factor assessment: 22%
  - Just above intermediate risk
- Par-Q not needed as have MD referral already for patient to receive PT
- Concern exists: individuals who do not perform an adequate preassessment of auscultation and vital signs and are not able to distinguish between normal and abnormal vital signs with activity should **not** perform exercise testing
- Concern also exists: should auscultate LUNGS pretest

Clinical Decision Regarding Test Choice

- Options
  - Submaximal treadmill stress test
  - Shuttle Walk Test
  - 6-Minute Walk Test
  - 2-Minute Step Test
- Chose Shuttle Walk Test due to lack of equipment of treadmill and the excellent evidence on Shuttle Walk. Plus, patient was highly functional and not sure 6-Minute Walk Test would push him as hard as Shuttle Walk, which is an incremental increase in workload test
  - Shuttle test mostly used for COPD
  - Patient could do more than 2-Minute Step Test

Results of Exercise Test

Performed Shuttle Walk Test

- Stopped due to inability to keep up with shuttles during level 7 at 370 meters (1,200 feet)
- Speed was 1.5 meters/second, which correlates with 3.35 mph
- Max HR achieved: 120 (78% predicted)
- SpO2 decreased to 86
- Max dyspnea at peak exercise 9/10
- BP post tests 160/94

ISWT Shuttles

Level	Speed (meters/second)	Time per shuttle (second)	Number of shuttles in level	Total distance
1	.50	20	3	30
2	.67	15	4	70
3	.84	12	5	120
4	1.01	10	6	180
5	1.18	8.57	7	250
6	1.35	7.50	8	330
7	1.52	6.67	9	420
8	1.69	6.00	10	520
9	1.86	5.46	11	630
10	2.03	5.00	12	750
11	2.20	4.62	13	880
12	2.37	4.29	14	1020

Exercise Prescription for Case

- Short bouts of walking daily, maybe multiple times per day
  - Mode: walk on level surface
  - Intensity: dyspnea of 5/10 or HR of 90–105. Recommended purchasing a pulse ox and keeping SpO2 >90 with exercise.
  - Duration: 20 minutes
  - Frequency 1 time/day, 5–7 times/week
- Strengthening: sit-to-stands (relationship with quad strength in COPD and prognosis/morbidity/mortality)
  - Intensity: dyspnea of 5/10
  - 6–10 sit-to-stands 2 times/day
- Follow-up in 1–2 weeks to progress exercise prescription

Case Study ILD

- 64-year-old female admitted with c/o DOE, fatigue, and weakness
- Currently working as a radiologist three days/week
- Former 10 pack/year smoker (quit 30 years ago)
- Medical history significant for idiopathic pulmonary fibrosis, Raynaud's syndrome, and osteopenia
- Current medications
  - Calcium carbonate
  - Cholecalciferol
  - Fluticasone
  - Magnesium gluconate
  - Esbriet

Case Study ILD (cont.)

- Uses home O_2
  - 2 L/minute resting
  - 8 L/minute with moderate exertion
- PFTs
- FEV1.= 56%
- FVC = 55%
- FEV1/FVC = 102
- DLCO = 24%

Case Study ILD (cont.)

- Patient diagnosed with pneumonia superimposed on chronic IPF
- Patient spent eight days in ICU, initially requiring BiPAP for respiratory support with wean to HFNC on day 3 following admission
- Oxygen requirements were gradually weaned with addition of antibiotics and steroids to treatment plan
- Patient discharged from hospital on day 14 with stable SpO2 >90% on preadmission resting oxygen requirements of 2 L/minute. However, patient is requiring 12 L/minute of supplemental oxygen with moderate activity.
- Patient was discharged home with mobility limited by fatigue and muscle weakness following lengthy hospital stay. Referral made for home health PT, and rolling walker acquired for safe discharge.

Pretest Assessment

- Auscultation of heart and lung sounds
  - Concerned about lung sounds: significant crackles in bases, but there should be normal heart sounds
  - Assess any new signs/symptoms
- Assess resting vital signs: HR, BP, SPO2
- Don't forget to test for **frailty**

Risk Assessment

- Reynolds risk score: low risk
- No identified contraindications to exercise testing

Clinical Decision Regarding Test Choice

- Options
  - Submaximal treadmill stress test
  - Shuttle Walk Test
  - 6-Minute Walk Test
  - 2-Minute Step Test
- Chose 6-Minute Walk Test due to lack of equipment of treadmill in the home and the excellent evidence on 6-Minute Walk Test for individuals with ILD. Plus, patient not as functional as prehospitalization, and Shuttle Walk Test might be too difficult for this patient immediately post hospitalization.
  - Patient could do more than 2-Minute Step Test

6-Minute Walk Test Results: Develop an Exercise Prescription

6-Minute Walk results: 50-foot track around interior of home. (200 feet). Used 12 L O_2 for walk.			Performed 4 laps	
Exercise duration	**Heart rate**	**SpO2**	**Dyspnea**	**Blood pressure**
Rest: 122/64	72	93	-	2
1 minute	101	87	-	6 sat for 1
2 minutes	107	90	-	4
3 minutes	113	82	-	8 sat for 1
4 minutes	116	89	-	4
5 minutes	105	82	-	8 sat for 1
6 minutes	108	83	-	6
Post exercise: 164/80	87	89	-	4

Exercise Prescription for Case

- Short bouts of walking daily, maybe multiple times per day
  - Mode: walk on level surface
  - Intensity: dyspnea of no more than 4/10 or HR of 90–10. Recommended purchasing a pulse ox and keeping SpO2 >90 with exercise.
  - Duration: 20 minutes in total
  - Frequency 1 time/day, 5–7 times/week
- Strengthening: sit-to-stands (relationship with quad strength in COPD and prognosis/morbidity/mortality)
  - Intensity: dyspnea of 5/10
  - 6–10 sit to stands 2 times/day
- Follow-up in 1–2 weeks to progress exercise prescription

Summary

- Individuals with heart failure need to be assessed for the severity of their heart failure as well as their frailty. These individuals would benefit from strengthening as well as aerobic exercise but may need interval exercise sessions before they can build up to 20-30 minutes of continuous exercise
- Individuals who suffer a CVA may benefit from modifications in exercise testing format (balance may affect ability to perform weight bearing exercise testing). However goal should always be to initiate weight bearing exercise programs when more stable.
- Individuals with pulmonary dysfunction often are limited by their oxygen supply during exercise. Patients who are currently not on oxygen even for exercise may be more limited in progressing exercise as you want them to exercise when their SpO2 is >88–90, so they will be discontinuing exercise when SpO2 drops below, and they are more symptomatic.
- Individuals with pulmonary dysfunction who are currently on oxygen may need to increase their oxygen delivery during exercise and need to learn about the benefits of titration of oxygen with all activities. Exercise prescription is dependent upon sufficient oxygen to perform the activities.

References

- **Citations from Bottom of Slides:**

  - Williams V, Hardinge M, Ryan S, Farmer A. Patients' experience of identifying and managing exacerbations in COPD: a qualitative study. *npj Prim Care Resp Med*. 2014;24(1):14062. doi:10.1038/npjpcrm.2014.62
  - Aminoff MJ, Eisen AA. AAEM minimonograph 19: somatosensory evoked potentials. *Muscle Nerve*. 1998;21(3):277-290. doi:10.1002/(sici)1097-4598(199803)21:3<277::aid-mus1>3.0.co;2-7
  - Franklin BA, Forgac MT, Hellerstein HK. Accuracy of predicted marathon time: relationship of training mileage to performance. *Res Q*. 1978;49(4):450-459.
  - Akdur H, Polat MG, Yigit Z, Arabaci Ü, Özyilmaz S, Gürses HN. Effects of long intubation period on respiratory functions following open heart surgery. *Jpn Heart J*. 2002;43(5):523-530. doi:10.1536/jhj.43.523
  - Lind AR, McNicol GW. Circulatory responses to sustained hand-grip contractions performed during other exercise, both rhythmic and static. *J Physiol*.
  - Halm EA, Fine MJ, Kapoor WN, Singer DE, Marrie TJ, Siu AL. Instability on hospital discharge and the risk of adverse outcomes in patients with pneumonia. *Arch Intern Med*. 2002;162(11):1278-1284. doi:10.1001/archinte.162.11.1278
  - Halm EA, Wang JJ, Boockvar K, et al. Effects of blood transfusion on clinical and functional outcomes in patients with hip fracture. *Transfusion*. 2003;43(10):1358-1365. doi:10.1046/j.1537-2995.2003.00527.x
  - Rikli, R. & Jones, C.J. (2001). Senior Fitness Test Manual. Champaign, IL: Human Kinetics
  - Acsm guidelines resources and downloads. Accessed March 15, 2021. https://www.acsm.org/blog-detail/acsm-certified-blog/2020/05/07/acsm-guidelines-resources-and-downloads

Whooooo has questions????