

Graded Exercise Testing

Guidelines and Procedures

Indications for Testing:

- **Clinical Testing:** Post MI, CABGS, etc. and Diagnostic
 - Usually done in medical setting
- **Functional Testing**
 - Usually done in laboratory/research or or Health/Fitness facility

Guidelines for Exercise Testing

- Types of Tests
 - Maximal vs. Submaximal
 - Choice depends on clients age, risk stratification, reasons for doing the test
- Modes of Testing:
 - Treadmill
 - Bicycle Ergometer
 - Arm Ergometer

Types of Measurements:

- Direct or indirect measurement of VO_2 (evaluation of cardiovascular fitness)
- Heart Rate
- Blood Pressure
- RPE
- 12-Lead ECG (clinical testing)

Contraindications to Exercise Testing

- Absolute Contraindications:
 - A recent change in resting ECG
 - Unstable angina
 - Uncontrolled cardiac arrhythmias
 - Severe aortic stenosis
 - Uncontrolled heart failure
 - Acute pulmonary embolus, pulmonary infarction
 - Acute myocarditis or pericarditis
 - Suspected or known dissecting aneurysm
 - Acute infections

Contraindications to Exercise Testing:

- Relative Contraindications:
 - Left main coronary stenosis
 - Moderate stenotic valvular heart disease
 - Electrolyte abnormalities
 - Severe arterial hypertension (>200 SBP or >110 DBP at rest)
 - Tachyarrhythmias or bradyarrhythmias
 - Hypertrophic cardiomyopathy
 - Neuromuscular, musculoskeletal, or rheumatoid disorders
 - High degree AV block
 - Ventricular aneurysm, uncontrolled diabetes, chronic infectious disease

General Procedures:

- Review of medical hx, selection of type of test, informed consent obtained
- Measurement of resting data: heart rate and blood pressure
- Instructions given to client
- Start testing procedures using selected protocol, monitor HR, BP, and RPE at regular intervals
- Discontinue test when criteria is met (ACSM guidelines)
- Have client cool down at lower work load, continue monitoring HR and BP

Indications for Stopping an Exercise Test:

- Onset of Angina
- Drop in systolic BP of 20mmHg or more, or a failure of BP to rise with an increasing workload
- Excessive rise in BP: 260/115
- Signs of poor perfusion: lightheadedness, confusion, ataxia, pallor, cyanosis, nausea, or cold and clammy skin
- Failure of HR to increase with increased exercise intensity
- Noticeable change in heart rhythm
- Subject requests to stop
- Physical or verbal manifestations of severe fatigue
- Failure of the testing equipment

Maximal Exercise Test Protocols:

- Treadmill Protocols:
 - Bruce, Modified Bruce, Balke, Naughton, Wilson, Kattus, etc.
- Bicycle Ergometer Protocols:
 - Astrand, Fox

Submaximal Exercise Test Protocols:

- Multistage Treadmill: uses max. protocol with selected HR endpoint (usually 80-90% HR_{max})
- Single Stage Treadmill: uses constant speed for 3-6 minutes
- Bicycle Ergometer Protocols:
 - YMCA, Astrand-Ryhming, Fox, Lifecycle, AirDyne
- Other Protocols: Step test, Stairmaster, Rower Ergometer

How do you know when you reach the MAX?

- The graded exercise test measures maximum aerobic capacity (VO_2max) when the oxygen uptake plateaus....does not increase any more than 150 ml/min with a further increase in work load.

Other VO₂ max criteria:

- Failure of the heart rate to increase with increases in exercise intensity
- venous lactate concentration exceeding 8mM/L
- RQ (respiratory exchange ratio) greater than 1.15
- RPE greater than 17 (using the original Borg scale of 6-20)

Considerations for Max testing...

- Health status screening essential
- Fitness level important in selection of protocol
- Accurate measurements of HR, BP, etc. very important.
- Test termination criteria vital
- Cool-down procedures, with continual monitoring very important

Specific Procedures for MAX testing:

- Instruct client regarding test, obtain informed consent. (assuming that Med hx has been done)
- Select appropriate protocol.
- Measure resting HR and BP.
- Let client warm-up, familiarize with equipment.
- Monitor HR, BP, RPE and ECG (if done) during each stage.

Procedures, cont.

- Continuously monitor physical appearance and symptoms.
- Discontinue test when criteria is met for MAX test Or if any indications for stopping test occur.
- Have client cool down by exercising at a work rate that does not exceed the intensity of the first stage of the test.

Procedures, cont.

- During recovery, continue measuring HR, BP, RPE, ECG for at least 4 minutes, or longer if there are any abnormal responses.
- Continue to monitor client's physical appearance.
- If a client has signs of discomfort or if emergency occurs, use a passive cool-down with client sitting or supine.

Emergency Procedures:

- Properly assess physical signs and symptoms.
- Use appropriate first aid or follow established emergency protocol. (Call 9-11, use CPR, etc.)
- Document everything...fill out accident or incident report. Be as detailed as possible.

Clinical Exercise Testing: Indications and Applications:

- Diagnostic Testing
 - Those with possibility of CAD, as determined by age, gender, symptoms, and/or multiple risk factors present
- Pre-discharge post MI
 - Usually sub-max, useful for med assessment and home activity recommendations
- Post-discharge after MI, CABGS, etc.
 - Usually about 3-4 weeks post, used to determine exercise prescription, med adjustment, prognosis
- Functional Testing
 - Used for activity counseling, exercise prescription, or disability assessment.
- Evaluation of disease severity and prognosis

Exercise Test Modalities

- Treadmill
 - Bruce protocol is most common, Balke easier for older or deconditioned
- Cycle Ergometer
 - usually smaller increases in workload per stage for deconditioned, VO₂max is usually lower.
- Arm Ergometer:
 - VO₂ is 20-30% lower than with TM testing

Exercise Protocols

- The protocol should consider the purpose of the test, the specific outcomes desired, and the individual being tested.
- The most common protocol used is the Bruce protocol
 - It has significant changes from one workload to another.
 - It is better suited for screening younger and/or physically active adults.

Bruce Protocol

- Stage 1: 1.7 mph 10% grade 1-3 min
- Stage 2: 2.5 mph 12% grade 4-6 min
- Stage 3: 3.4 mph 14% grade 7-9 min
- Stage 4: 4.2 mph 16% grade 10-12 min
- Stage 5: 5.0 mph 18% grade 13-15 min
- Stage 6: 5.5 mph 20% grade 16-18 min

Balke/Ware Protocol

- Speed: 3.3 mph (or 3mph)
- Incline: start at 0% grade, increase by 1% per minute after the first minute.
- Advantages: allows for a more gradual warm-up, is an uphill walking test, safer and easier for the unfit.
- Disadvantages: takes almost twice as long as Bruce protocol, too easy for fit individuals

Naughton Protocol

- Stage 1: 1.0 mph 0% grade 1-2 min.
- Stage 2: 2.0 mph 0% grade 3-4 min.
- Stage 3: 2.0 mph 3.5% grade 5-6 min.
- Stage 4: 2.0 mph 7.0% grade 7-8 min.
- Stage 5: 2.0 mph 10.5% grade 9-10 min.
- Stage 6: 2.0 mph 14% grade 11-12 min.
- Stage 7: 2.0 mph 17.5% grade 13-14 min.

Measurements during testing:

- Pre-test:: 12-lead ECG supine and standing, BP supine and standing. Optional post-hyperventilation 12-lead.
- Exercise: 12-lead ECG every stage or 3 min., BP during last minute of each stage, RPE at end of each stage, symptoms recorded if any
- Post-Test: 12-lead ECG immediately post ex, then every 1-2 min. for at least 5 min. BP immediately after exercise, then every 1-2 min. until stabilized. Symptoms recorded if any

Absolute Indications to terminate a Clinical GXT

- Acute Myocardial Infarction
- Moderate to severe angina
- Drop in SBP with increasing WL with signs and symptoms
- Serious arrhythmias (2nd or 3rd degree block, V-Tach, >PVC's, A-Fib)
- Signs of poor perfusion
- Unusual or severe shortness of breath
- CNS symptoms: ataxia, confusion, etc.
- Patient requests to stop
- Inability to monitor ECG

Relative Contraindications for termination of a CGXT:

- 2mm of horizontal or downsloping ST segment depression or 2mm ST-segment elevation
- Chest pain that is increasing
- Physical or verbal manifestations of severe fatigue or shortness of breath
- Wheezing
- Leg cramps or claudication
- Hypertensive responses: 260/115
- Less serious arrhythmias
- Exercise-induced Bundle Branch Block that cannot be distinguished from V-TACh

How to determine VO₂ and METS

- Formula for walking (speeds of from 1.9 to 3.7 mph)
 - $VO_2 = 0.1 (\text{speed}) + 1.8 (\text{speed}) (\text{grade}) + 3.5$
 - You must convert speed in mph to meters.min
 - $\text{Mph} \times 26.8 = \text{meters.min}$
 - You must convert grade to a fraction. Ie: 10% grade = .10
 - To determine METS, divide VO₂ by 3.5