Exercise Stress Testing

Indications

1. Diagnostic
   - Evaluation of chest pain or suspected CAD
   - Evaluation of patient with known CAD
   - Screening for ischemic heart dz in asymptomatic patient with CAD risk factors
     - Diabetes mellitus
     - Hyperlipidemia
     - Hypertension
   - Evaluation of cardiac rhythm disorders
     - Exercise induced arrhythmias
     - Response to therapy
   - Assessment of functional exercise capacity for patients with:
     - Valvular heart disease (except symptomatic aortic stenosis)
     - Heart transplant
     - ICD (implantable cardioverter/defibrillator)
     - Pulmonary hypertension
   - Generating an exercise prescription for men over 40 and women over 50 who plan to begin a vigorous exercise program
2. ACC/AHA Task Force Report on Exercise Stress Testing
   - http://www.acc.org/qualityandscience/clinical/guidelines/exercise/exercise_clean.pdf
3. American College of Sports Medicine Guidelines for Exercise Testing and Prescription
4. American Heart Association
   - http://www.americanheart.org/presenter.jhtml?identifier=4568

Contraindications

1. Absolute:
   - Acute myocardial infarction (within 2 days) or unstable angina
   - Uncontrolled cardiac arrhythmias
   - Symptomatic severe aortic stenosis
   - Uncontrolled symptomatic heart failure
   - Acute pulmonary embolus or pulmonary infarction
   - Acute myocarditis or pericarditis
   - Inflammatory cardiovascular disease
   - Acute aortic dissection
2. Relative
   - Systolic blood pressure >200mm Hg; diastolic blood pressure >110mm Hg
   - Electrolyte abnormalities (Ca, Mg, K)
   - Left main coronary artery stenosis
   - Moderate stenotic valvular heart disease
   - Hypertrophic cardiomyopathy
   - Mental or physical impairment leading to inability to exercise adequately
   - High degree AV block
   - Other cardiac conditions (WPW, SVT, MVP)

Materials

1. Treadmill with adjustable speed, grade and computer synchronized monitor that can record 12 lead EKG with continuous tracing
2. Adhesive disposable electrodes, cables, and belt
3. Blood pressure cuff (various cuff sizes)
4. Stethoscope
5. Razor, rubbing alcohol
6. Emergency equipment:
    - Defibrillator
    - Oxygen with nasal cannula, mask
    - Airway management equipment
        - Laryngoscope with blades, endotracheal tubes, suction
    - Emergency drug kit
        - IV fluids, tubing, available IV drugs to support ACLS protocols
7. At least a 10x10 space

Pre-Procedure

1. Pre-procedure patient preparation:
    - Avoid eating for 6-12 hours before procedure with small liquid meal preferred
    - Minimize alcohol consumption
    - Minimize over the counter medications
    - Avoid beta blockers, calcium channel blockers, digoxin use on day of test (consider substituting BP med with ACE inhibitor)
    - Wear clothing and shoes comfortable for walking and jogging
2. Obtain signed written informed consent prior to procedure
3. Assure patient-relatively safe procedure (risk of death 1:10,000)
4. Explain procedure to patient: timing of treadmill workload change, BP measurement increments, what symptoms to report during procedure
    - Chest pain
    - Leg cramps
    - Dizziness
5. Pre-procedure evaluation by physician including history, physical, review of recent labwork/ tests

Positioning

1. Standing with stability on treadmill, gently holding arm rails

Step-by-Step

1. Obtain resting blood pressure
2. Prepare patient for electrode placement
    - Wipe area for electrode placement with alcohol swab, shave if necessary
    - Place, electrodes then attach lead wires
        - V1- 4th intercostal space, right sternal border
        - V2- 4th intercostal space, left sternal border
        - V3- halfway between V2 and V4
        - V4- 5th intercostal space at midclavicular line
        - V5- anterior axillary line at same level as V4

        - V6- directly lateral to V5 at midaxillary line
        - Limb electrodes-right leg, left leg, left arm
3. Obtain resting supine ECG
4. Have patient stand, begin monitoring ECG
5. **Target Heart Rate**
    - (220-age) x 0.85
    - Heart rate max: 220-age
6. Begin exercise testing using preselected protocol
    - Bruce Protocol - most commonly used, most studied
7. **Bruce Protocol**
    - Each stage is 3 minutes
    - Stage I
        - Speed: 1.7 mph
        - Grade: 10%
        - METS: 4
    - Stage II
        - Speed: 2.5 mph
        - Grade: 12%
        - METS: 6.6
    - Stage III
        - Speed: 3.4 mph
        - Grade: 14%
        - METS: 10
    - Stage IV
        - Speed: 4.2 mph
        - Grade: 16%
        - METS: 14.2
    - Stage V
        - Speed: 5 mph
        - Grade: 18%
        - METS: 17.2
    - Stage VI
        - Speed: 5.5 mph
        - Grade: 20%
        - METS: 20.5
8. Monitor and record patient's:
    - Pulse rate
    - Symptoms
    - Perceived exertion level (1-10)
9. Record 12-lead ECG and BP at the end of each stage
    - Stop if abnormal
10. Indications for stopping
    - Marked ECG changes
        - $\geq$ 1mm of horizontal or downsloping ST segment depression
        - Up-sloping ST segment depression $\geq$1.5mm and 0.08 seconds from J point, or
        - $\geq$ 1mm ST segment elevation
    - Drop in SBP > 10mm or in first few minutes drop below resting SBP
    - Elevated blood pressure

        - SBP >250, or
        - DBP >115mm
    - Progressive worsening angina
    - Poor sense of well being or signs of poor perfusion including:
        - Dizziness, dyspnea, cyanosis, pallor, nausea, or vomiting.
    - Drop in heart rate
    - Complex arrhythmia
        - PVCs - at least 3 in a row or atrial arrhythmia with cardiovascular compromise
    - Appearance of LBBB
    - Equipment failure
    - When maximal effort attained
        - Maximal effort is indicated by maximal perceived exertion and inability to continue at that workload
    - Patient wants to stop due to disability, overwhelmed
11. Record ECG and heart rate 1 minute after test is completed or terminated
12. Keep patient monitored for up to 8 minutes during recovery phase
13. Reevaluate cardiac and pulmonary systems with physical exam

Post-Procedure

1. Discuss with patient-test is not 100% accurate
2. If symptoms persist need further evaluation
3. Report should contain:
    - ST changes or other ECG changes
    - Symptoms during test
    - Reason for ending test
    - Estimation of exercise capacity in METS
    - Blood pressure response
    - Presence and frequency of arrhythmias

Pearls

1. Stress testing is 70% sensitive and 80% specific for CAD in men, lower for women
2. Goals of treadmill stress test
    - Achieve Target Heart Rate (220-age) x 0.85 (minimal HR for acceptable test)
        - Achieve heart rate max (if possible)
        - Evaluate the CV system under stress
        - Evaluate for functional capacity
            - Fitness level:
                - Poor, METS 1.0-3.9
                - Low, METS 4-6.9
                - Average, METS 7-10.9
                - Good, METS 11-13.9
                - High, METS 14-16
3. Treadmill test for exercise medicine
    - Concept of "FITT" for exercise prescription
        - Frequency
            - Begin 3x weekly then advance to most days of the week

- Intensity
  - Begin aerobic workout at 60-80% of max HR; build up to 85-90% with goal to maintain level of exercise for 15-45 minutes per session
- Type
  - Exercise modality- machines, running, biking, walking
- Time
  - At least 30 minutes with 5 minute cool up and down; build to 60 minutes
- Graduate at 4-6 week intervals

Interpretation of Treadmill Stress Test

1. Uninterpretable test
   - Failure to obtain at least 85% of age predicted maximal heart rate
2. Positive test-suggests myocardial ischemia
   - Marked ECG changes
     - $\geq$ 1mm of horizontal or downsloping ST segment depression,
     - Upsloping ST segment depression $\geq$1.5mm and 0.08 seconds from J point, or
     - $\geq$ 1mm ST segment elevation)
   - Drop in SBP >10mm or a drop in first few minutes below resting SBP or hypotension during exercise
   - Symptoms:
     - Exercise induced chest pain typical of angina
   - Frequent high grade ventricular arrhythmia/ectopy
   - Appearance of S3, S4 or heart murmur during exercise
3. Negative test
   - None of above findings
   - Non-significant findings include:
     - Fatigue, dyspnea, diaphoresis, flushing
     - Incremental increase in BP / HR
     - ECG changes:
       - Shortening of PR and QT, J point depression, T wave and P wave peaking

Complications

1. Hypotension
2. CHF exacerbation
3. Severe cardiac arrhythmia
4. Cardiac arrest
5. Acute MI
6. Acute CNS event
   - Syncope or stroke
7. Death

Follow-Up

1. Abnormal treadmill stress test
   - Consider further workup or referral to cardiology

References

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Author: Andra Prum, DO, *University of Nevada Las Vegas FMRP*

Editor: Carol Scott, MD, *University of Nevada Reno FPRP*