

# **Can You Trust The Most Technologically Advanced Country In The World With The Best Healthcare System in the World With Your Health ???**

In 2007 & 2008, 87 billion people (1/3 of US population) had no health insurance

- In US, between 44,000 and 98,000 deaths per year attributed to misdiagnosis & errors
  - Citation: New England Journal of Medicine, April 2010
  - This exceeds the rate from motor vehicle accidents (43,458), breast cancer (42,297), or AIDS (16,516).
  - Get a second Opinion !
- Specimen analysis labs In the top 4 hospitals in this country reported:
  - 305,000 wrong (results) contributing to wrong diagnosis each day
    - 40% of these mistakes injured or harmed patients
- 1% of all pathology lab reports are erroneous and results in harm to patient
  - Delay in breast cancer diagnosis is the most prosecuted civil suit in U.S.
- 1 in 50 acute MI patients are sent home from the ER with wrong diagnosis
- Pediatricians admit to at least one diagnostic error per month
  - PEDIATRICS (doi:10.1542/peds.2009-3218)

Who's Ultimately Responsible for Your Medical Care ???

# Components of a Good Medical History and Physical Exam

## Medical History

- All previous diagnoses & examination findings, paying special attention to orthopedic and cardiorespiratory history
- Detailed description & history of current symptoms
- Recent illness, hospitalizations, and surgical procedures
- Current medications and drug allergies
- Family, work & exercise history
- Lifestyle history including exercise and eating habits, recreational drug and alcohol use, smoking and tobacco history

## Physical Exam

- Height, weight, body composition, temperature
- Ear, nose, mouth, neck (lymphatic), throat, & genitourinary exams
- **Supine, standing, & exercise HR's, BP's, ECG's**
- Palpation of the abdomen and cardiac apical impulse
- Auscultation of the heart & lungs
- Palpation & auscultation of carotid, abdominal & femoral arteries
- Palpation & inspection of extremities for edema and palpation of peripheral pulses
- Inspection for xanthoma & finger clubbing
- Neurological & eye exams (reflexes, ophthalmoscope)
- Review of recent blood panels (CMP, CBC), and urine tests
- US Screening for DVT's, Carotid Arteries, AAA (>60)
- Current recommended cancer screenings (colorectal, breast, prostate, skin, lung, oral)

## Validity of Medical Screening Tools

- **True Positive Test (TP)** - test is positive and condition is present
- **False Positive Test (FP)** - test is positive and condition is absent
- **True Negative Test (TN)** - test is negative and condition is absent
- **False Negative Test (FN)** - test is negative and condition is present

- **Sensitivity:** % of people with the condition that test positive

$$\frac{TP}{TP + FN}$$

- **Specificity:** % of people without the condition that test negative

$$\frac{TN}{TN + FP}$$

- **Predictive Value:** % of people with a positive test that have the condition

$$\frac{TP}{TP + FP}$$

### Sensitivity and specificity for GXT with 12- lead ECG

Sensitivity: approx. 67% Specificity: approx. 70% (AHA)

# Notes on Sensitivity & Specificity of Medical Tests

- **Sensitivity** is important when consequences of missing a diagnosis are high
  - **EXAMPLE: Mammography for early breast cancer detection.....**
    - traditional X-ray mammography is about 80% sensitive
    - MRI mammography about 94% sensitive
    - which test had you rather have???????
    - which one costs more...the MRI....who's going to pay?????

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- **Specificity** is important when the cost or risk associated with further diagnostic procedures or further medical intervention are very high
  - EXAMPLE: HIV testing.....
    - The drugs associated with treating HIV are very expensive
    - Imagine paying for and taking these drugs unnecessarily
- A very "specific" test may also be important from a psychological standpoint
  - **Imagine being told you are HIV positive when you're actually not**

# Notes on Sensitivity & Specificity of Medical Tests

- A good example of a test with sensitivity and specificity problems is the blood test used in prostate cancer screening: Prostate Specific Antigen (PSA)
  - Sensitivity: 73%
  - Specificity: 60%
  - Predictive Value: 31.5%
- Sensitivity is not all that good and specificity is terrible
- Questions have arisen regarding the efficacy of screening:
  - It has not been shown to ↓ morbidity or mortality
  - Are surgical procedures being performed (causing significant morbidity) on tumors that are likely to be clinically insignificant ?
- Major questions concerning the usefulness of this test may not be answered for another decade.

# Notes on Sensitivity & Specificity of Medical Tests

- It would be desirable to have tests that were both sensitive and specific
  - Usually, there is a "trade-off" between sensitivity and specificity
    - Trade-off based on what constitutes a positive vs. a negative test
    - Criteria for + test given a "lower cutoff value" → fewer cases missed
      - (↑ sensitivity and ↓ specificity)
        - Example: reducing PSA values for biopsy from 4 to 2.5 ng/ml
        - More biopsies performed → fewer cases would be missed
        - More total biopsies would ↑ number of false positive tests
    - Criterion for + test given a "higher cutoff criteria" → more cases missed
      - (↓ sensitivity and ↑ specificity)
        - Example: increasing PSA values for biopsy from 4 to 10 ng/ml
        - Fewer people would have biopsies → more cases would be missed
        - Fewer total biopsies would be done → ↓ true negative tests

## Health Risk Continuum and Graded Exercise Testing

Consider two people, both of whom had a **positive GXT** (ST-segment depression)

Healthy

MI waiting to happen

Gender:	female
Family History:	negative
Age:	17
TC:	146
HDL-C	69
LDL-C	92
BP:	114 / 76
Smoking:	never
Peak $\dot{V}O_2$ :	52 ml O <sub>2</sub> / kg / min
Diabetes:	never
Exercise habits:	3x / week for 50 min.

Gender:	male
Family History:	father died of MI at 42
Age:	70
TC:	310
HDL-C	29
LDL-C	191
BP:	156 / 96
Smoking	150 pack years
Peak VO <sub>2</sub> :	22 ml O <sub>2</sub> / kg / min
Diabetes:	Type 1 since age 23
Exercise habits:	none

### ST- segments and Hemodynamics of GXT

- ST depression is up-sloping & shallow
- ST depression noted only at peak exercise
- ST depression resolved 15 sec after test
- BP 174 / 84 at peak exercise
- BP 118 / 72 10 min after test

(99.99% sure of a False + test)

### ST-segments and Hemodynamics of GXT

- ST depression is down-sloping & deep
- ST depression noted at low workload
- ST depression persists 8 min after test
- BP 246 / 112 at peak exercise
- BP 208 / 100 10 min after test

(99.99% sure of a True + test)

# Components of the Common Graded Exercise Test (GXT)

- **Pre-Test**

- 12-lead ECG in supine and exercise postures (make sure it is “clean”)
  - Blood pressure in supine and exercise postures

- **Exercise**

- 12-lead ECG during last minute of each stage or every 3 minutes
  - Blood pressure during last minute of each stage
  - Exertional and, if necessary, angina scales
  - Symptoms noted from 12-lead ECG, BP, scales, patient

- **Post- Test**

- IPE 12-lead ECG
  - IPE blood pressure
  - IPE exertion scale while at max exercise and, if necessary, angina scale

- **Recovery**

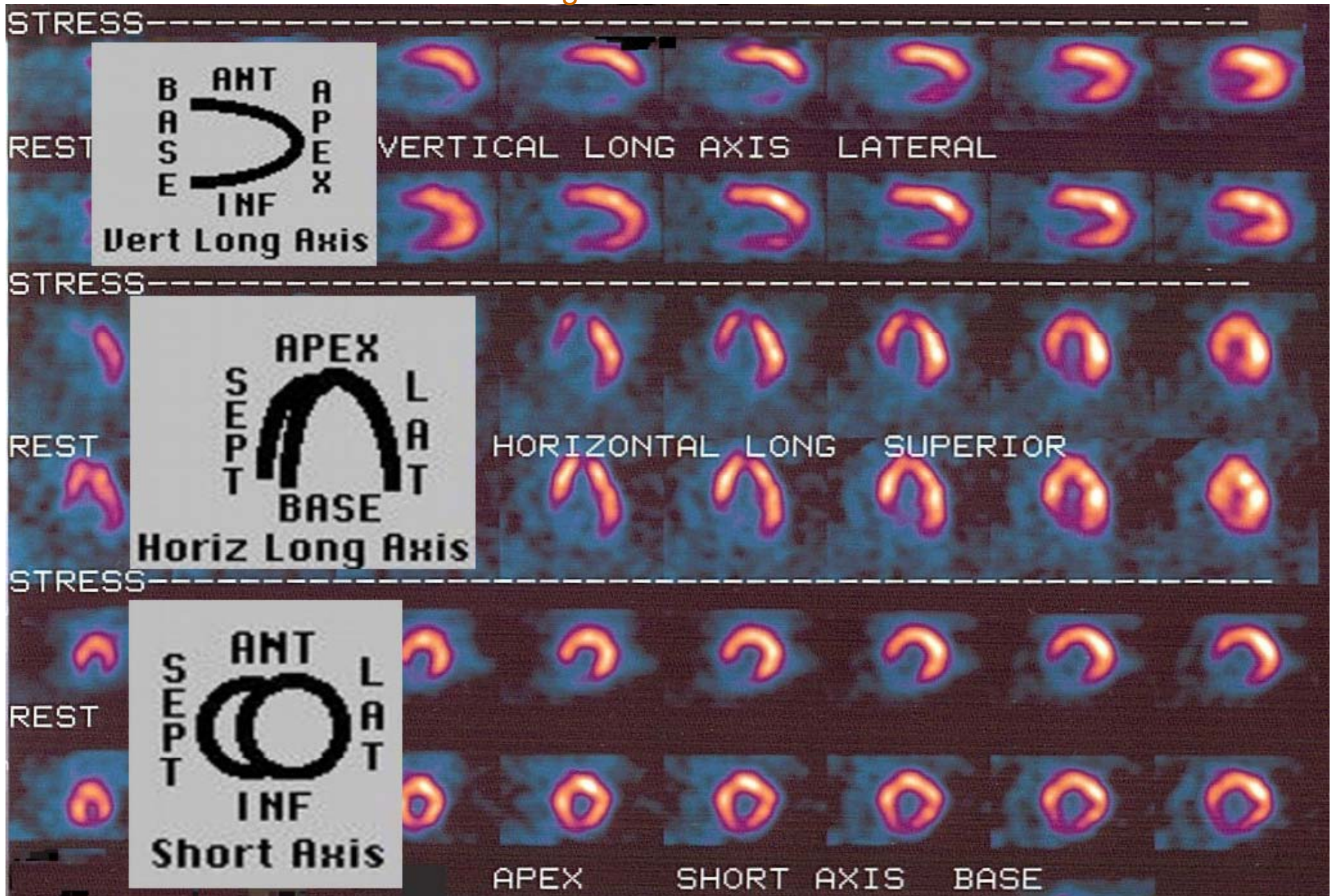
- 12-lead ECG every 1 - 2 minutes for at least 5 minutes
  - Blood pressure every 1 - 2 minutes until it returns to near pre-test level
  - Symptomatic rating scale assessments if symptoms persist



# Types of Cardiopulmonary Graded Exercise Tests (GXT's)

- Simple GXT with 12 lead ECG and BP assessments  
The kind we do here at A&M
- Pharmacologic GXT  
GXT using sympathomimetic drugs to ↑ HR & BP
- Metabolic GXT  
GXT with measurement of  $\dot{V}O_2$  and  $\dot{V}CO_2$
- Nuclear GXT  
GXT with injection of radioactive RBC attaching tracers  
Scintillation counter shows areas of under-perfusion
- GXT with echocardiography  
Detects wall motion abnormalities caused by ischemia

An example of inferioseptal ischemia. Note stress defects from 6 o'clock to 9 o'clock in the short axis view and horizontal long axis view that redistributes at rest.



## Factors influencing follow-up testing decisions for a positive GXT

**GXT results (ST ↓ depth, arrhythmias, BP's, etc.)**

Age

Family history

Lipids status

Smoking status

Rest & exercise BP's

Other diseases

Lifestyle

**Non-invasive  
Nuclear Imaging**



**Sensitivity: approx. 87%**  
**Specificity: approx. 73%**

**Stress  
Echocardiography**



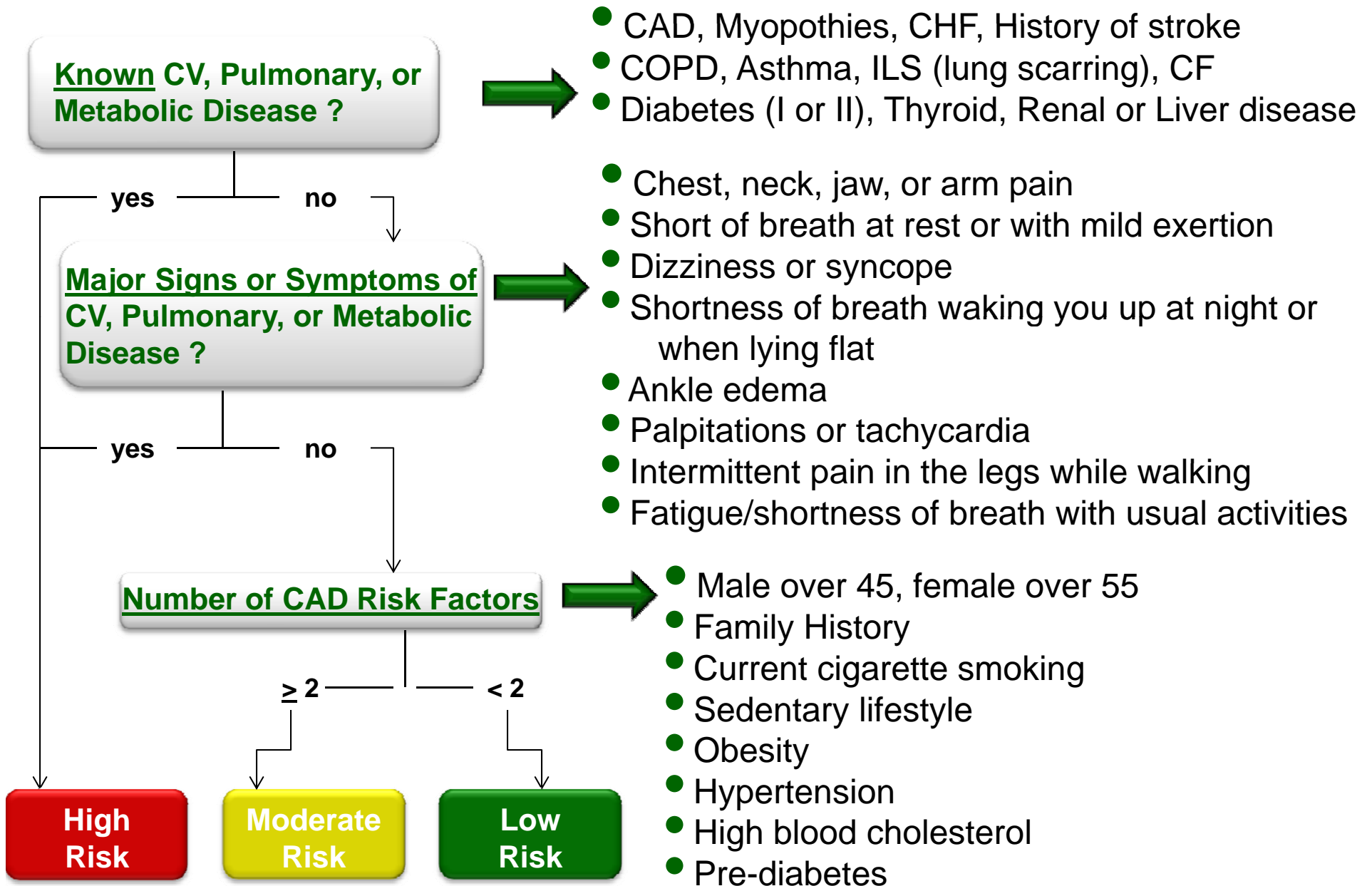
**Sensitivity: approx. 86%**  
**Specificity: approx. 81%**

**Coronary  
Angiography**  
(mortality: .15%)



**Sensitivity: approx. 97%**

# ACSM Risk Stratification



# ACSM GXT Physician Supervision Recommendations

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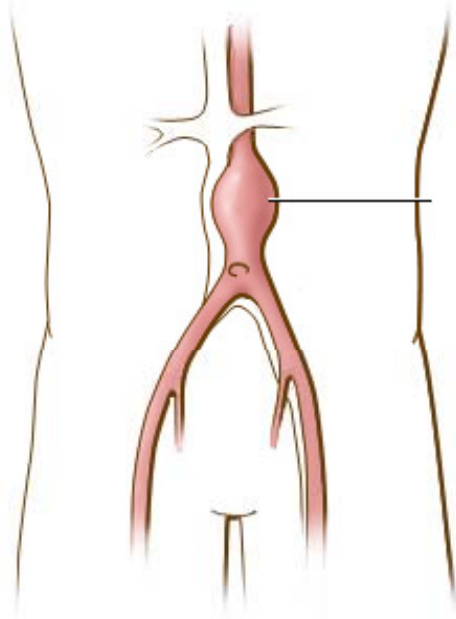
## M.D. Supervision recommended for Graded Exercise Testing

	<u>submax testing</u>	<u>max testing</u>
♂ < 45   ♀ < 55   +   no more than 1 ACSM risk marker	no	no
Older persons or those having 2 or more ACSM risk markers	no	yes
Signs, symptoms, of CV disease or known CV, pulmonary, or metabolic disease	yes	yes



# Absolute Contraindications to Graded Exercise Testing (ACSM)

- Recent significant ECG changes (ischemia)
- Recent MI (within 2 days)
- Symptomatic ventricular arrhythmia
- Symptomatic supraventricular arrhythmia
- Uncontrolled symptomatic heart failure
- Unstable angina
- Suspected or known dissecting aneurysm (see below)
- Acute myocarditis or pericarditis
- Thrombophlebitis or intracardiac thrombi
- Acute pulmonary embolus or infarction
- Acute systemic infection
- Symptomatic & severe aortic stenosis

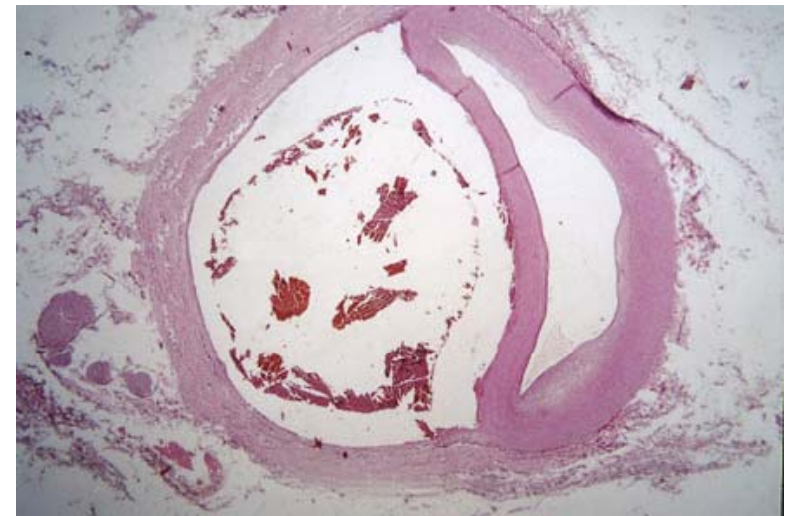


## Abdominal Aortic Aneurysm

Ruptured AAA mortality rate is 75% and is 15<sup>th</sup> leading cause of death of people > 60 years.

Stenting or surgery recommended for aneurysms greater than 5cm in diameter

## Cross-Section of Aneurysm



## Relative Contraindications to Graded Exercise Testing (ACSM)

- Resting SBP > 200 mmHg, DBP > 110 mmHg
- Left main coronary obstruction
- Moderate stenotic valvular heart disease
- Electrolyte abnormalities
- Hypertrophic cardiomyopathy/  
outflow tract obstruction
- Tachyarrhythmias or bradyarrhythmias
- Ventricular aneurysm
- High degree AV block
- Dangerous ventricular ectopy (not in ACSM guidelines – in Thaler)
  - Successive run of 3 or more PVC's (run of V-tach.)
  - PVC's compose > 30% of complexes
  - PVC's falling on a T-wave (R on T)
  - Multifocal PVC's
- Uncontrolled metabolic disease
  - Diabetes
  - Thyrotoxicosis (hyperthyroid)
  - Myxedema (hypothyroid)
- Chronic – active infectious disease
  - AIDS
  - Mononucleosis
  - Hepatitis
- Physical & mental limitations
  - Neuromuscular problems
  - Musculoskeletal problems
  - Rheumatoid arthritis

# Indications for Terminating a GXT (ACSM)

## Absolute

- $\downarrow$  SBP  $\geq$  10 mmHg + signs of ischemia
- Moderate to severe angina (3 on 4 point scale)
- $\uparrow$  CNS problems (ataxia, dizziness, syncope) (may reflect inadequate cerebral flow)
- Poor perfusion (cyanosis, pallor)
- Technical difficulties
- Sustained V-tach
- ST-segment elevation  $>$  1 mm
  - Without diagnostic Q-waves
    - may indicate arterial stenosis
  - With diagnostic Q-waves (old MI)
    - ventr. aneurysm or  $\downarrow$  wall motion

## Relative

- $\downarrow$  SBP  $\geq$  10 mmHg
- Shift in the ECG axis
- Horizontal or down-sloping ST-segment depression  $>$  2mm
- Multifocal PVC's or 3 PVC's in a row
- PSVT, heart blocks, bradyarrhythmias (especially wide QRS complex rhythms)
- Fatigue, shortness of breath, leg cramps, wheezing, claudication
- Wide complex tachycardia
- Any  $\uparrow$  in chest pain
- SBP  $>$  250 mmHg, DBP  $>$  115 mmHg



## Differences in Physiological Responses to Exercise in Those with CAD

- Lower maximum oxygen consumption → Short time on treadmill
- Blunted (slow to rise) cardiac output response → Blunted ↑ in BP
  - Blunted heart rate response
  - Blunted stroke volume response
- Blunted increase / decrease in ejection fraction → Blunted ↑ in BP
- $AVO_2$  difference widens earlier in exercise and is less than normal
- Lower rate of circulatory adjustment to workload
  - HR & BP take longer to increase and stay high longer after exercise

Hossack, Bruce, et al. Am J Cardiol 52, 1983

# Test Results Warranting Medical Referral

- **Significant ST-segment changes from baseline**
  - Horizontal-to-downsloping ST segment depression  $\geq 1$  mm (ischemia)
  - ST segment elevation in a normal ECG (very probable ischemia)
  - ST segment elevation in leads with MI Q-wave (wall motion abnormalities)
- **Significant ventricular or supraventricular ectopy or rhythm**
  - Not necessarily associated with absence or presence of CAD
- **Any chest or arm pain induced or increased with exercise**
- **Failure to increase or significant drop in HR or SBP during exercise**
  - Normal: 10 beats / MET    10 mmHg / MET
  - Maximal SBP of  $< 140$  mmHg suggests poor prognosis
- **Hypertensive response to exercise (SBP  $> 225$  mmHg)**
- **Exercise induced 2<sup>nd</sup> or 3<sup>rd</sup> degree AV block**
- **Exercise induced BBB**

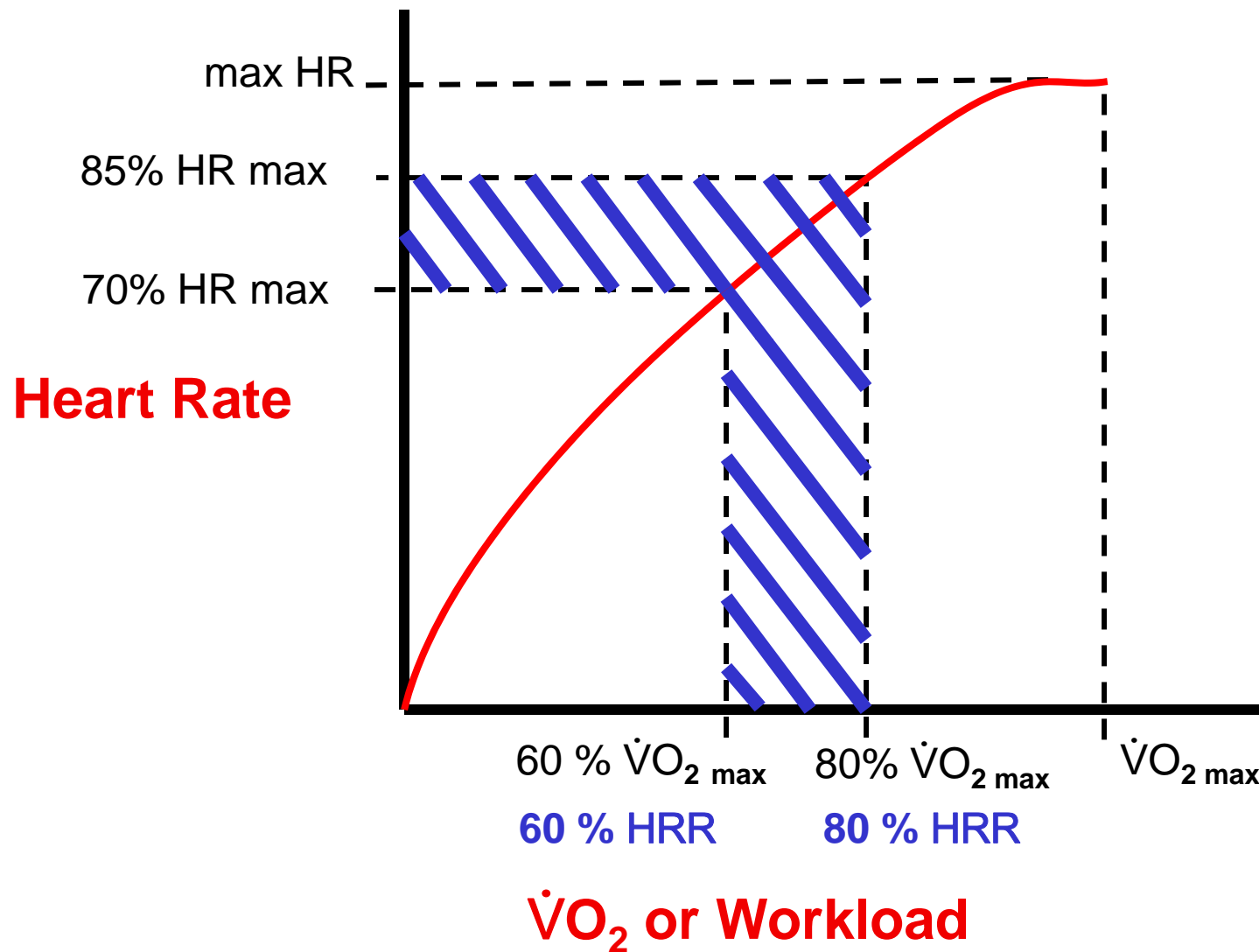
# ACSM Exercise Participation Recommendation

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## Physical & GXT Recommended Prior to Exercise Participation

	<u>moderate exercise</u>	<u>vigorous exercise</u>
♂ < 45   ♀ < 55   +   no more than 1 ACSM risk marker	no	no
Older persons or those having 2 or more ACSM risk markers	no	yes
Signs, symptoms, of CV disease or known CV, pulmonary, or metabolic disease	yes	yes

# $\dot{V}O_2$ – Heart Rate Relationship for Exercise Rx



# Endurance Exercise Rx for Healthy People: ACSM Guidelines

## FREQUENCY:

- 3 to 7 sessions per week

## INTENSITY:

- 70% - 85% of peak HR (60% - 80% of peak  $\dot{V}O_2$ ) for young healthy people
- 57% - 67% of peak HR (30% - 45% of peak  $\dot{V}O_2$ ) initially for sedentary people

### Heart Rate Reserve Method for Calculating THR based on peak $\dot{V}O_2$ (Karvonen Formula)

$$\text{THR} = [\text{Intensity \%} \times (\text{MHR} - \text{RHR})] + \text{RHR}$$

▶  $\text{MHR} = \text{peak HR determined from GXT}$      $220 - \text{age}$      $206.9 - .67(\text{age})$

▶  $\text{Intensity \%} = 60 + \text{Functional capacity in METS}$

### Reserve Method can also be used with SBP or $\dot{V}O_2$

$$\text{Target } \dot{V}O_2 = [\text{Intensity \%} \times (\text{M}\dot{V}O_2 - \text{R}\dot{V}O_2)] + \text{R}\dot{V}O_2$$

- RPE: 12 – 16 on Borg Scale (5 to 8 on a 10 point scale)
- While exercising, a conversation should be possible

## DURATION: 20 – 60 minutes per session, average 30 – 40 minutes

Goals for health:        - get at least 150 minutes/week - expend at least 350 kcal 3 days/week (1050 kcal/wk)

For weight loss:        - 60 minutes per session - 300 minutes/week - expend > 2000 kcal/week

**Remember:** overuse injuries increase dramatically with a duration > 45 min.

# Progression Rate for Exercise Rx: ACSM Guidelines

## Focus of Exercise Rx: ADHERENCE

- **Initial Conditioning Stage**
  - May lasts up to 4 weeks for previously sedentary individuals
    - 3 days / week
    - 40% - 50 % HRR (slightly higher if subject is active)
    - 15 minutes (even less if client has been very sedentary)
- **Improvement / Progression Stage**
  - Lasts 4 to 5 months
  - ↑ duration and frequency before intensity
    - 3 - 5 days / week
    - ↑ intensity to 70% - 85% HRR (after ↑ freq. & duration)
    - ↑ duration to at least 30 minutes
- **Maintenance Stage**
  - Review goals (consider re-testing for more accurate Rx)
    - 3 -5 days / week
    - 70% - 85 % HRR
    - Minimum of 30 minutes

# Exercise Rx for Impaired and Sedentary People: ACSM Guidelines

## Frequency and Duration

- Functional Capacity < 3 METS: 3 sessions of 5 minutes (daily)
- Functional Capacity 3 – 5 METS: 1 – 2 sessions (daily)
- Functional Capacity > 5 METS: normal parameters

## Intensity

- 40% - 50% of peak  $\dot{V}O_2$  initially for sedentary people
- Progress by increasing duration and frequency before intensity
- Always below pain and symptom threshold

## Why Participate in Cardiac Rehabilitation....A.S. Leon & B. Franklin et al, 2005

- **Cardiac related death is about 26% lower in those who do cardiac rehab**
  - 21% fewer non-fatal heart attacks
  - 13% fewer bypass surgeries
  - 19% fewer angioplasties
    - At most, only about 20% of 2 million eligible candidates do cardiac rehab
- **Mechanisms by which cardiac rehab reduces morbidity & mortality**
  - Improved functional capacity along with reduced cardiac O<sub>2</sub> requirements
  - Improved blood vessel function
  - Improved coronary blood flow
  - Improved electrical stability of the heart muscle



## **Contraindications to Cardiac Rehabilitation**

- Unstable Angina
- SBP > 200 mm Hg or DBP > 110 mmHg
- Orthostatic BP drop of > 20 mmHg with symptoms
- Severe aortic stenosis
- Uncontrolled atrial or ventricular arrhythmias
- Uncontrolled sinus tachycardia
- Uncompensated heart failure
- 3<sup>rd</sup> degree AV block without pacemaker
- Active pericarditis or myocarditis
- Recent embolism
- Thrombophlebitis
- Resting ST – segment depression or elevation > 2 mm
- Uncontrolled diabetes (glucose > 400 mg / dl)
- Acute systemic illness or metabolic problems
- Orthopedic problems that would preclude exercise

# Exercise RX for Cardiac Patients: ACSM Guidelines

## Inpatient (Phase 1)

- Self care activities and ambulation as precursors
- Resting HR + 10 to 30 beats/min
- 2-4 session/day for 3 – 10 minutes per session
- Progress by ↑ bout duration and then ↓ number of bouts
- Borg Scale < 13
- ECG and hemodynamics should be constantly monitored
  
- Notes
  - Remember trauma to sternum and vein graft sites
    - Take care not to traumatize or re-injure these areas
  - Patient's functional capacity ( $\dot{V}O_2\text{max}$ ) is VERY LOW
    - Be patient and take great care when exercising them
  - Patient is usually told not lift more than 10 pounds for 3 weeks
  - Patient may be on a medication that limits HR (b-blockers, etc,)
    - Again, this makes functional capacity VERY LOW

# Exercise RX for Cardiac Patients: ACSM Guidelines

## Outpatient (Phase II)

- Functional capacity  $\leq$  5 METS: inpatient parameters
- Functional capacity  $>$  5 METS: low end of normal parameters
- Progress to a goal of 20 – 30 minutes 3 times / week
- Progress to a goal of burning a minimum of 1000 Kcal / week
- ECG monitor required for those with:
  - LV malfunction
  - Signs of ischemia
  - Arrhythmias
  - Low functional capacities

# Exercise Intensity Threshold Guidelines for Cardiac Rehabilitation

## Set intensity level below:

- Onset of angina (at least 10 beats per minute below)
- Plateau or decrease in SBP
- SBP of 240 or DBP of 110
- ST- segment depression of 1 mm
- Signs of left ventricular dysfunction (heart failure)
- Signs of increasing ventricular ectopy or ventricular arrhythmias
- Significant AV – block
- Significant supraventricular arrhythmias (tachycardia, A-fibrillation, etc.)

# Notes on Exercise Rx and Cardiac Rehab

## ● One Study Reported:

- No change in atherosclerotic lesions when expending **1533 Kcal / week**
  - 306 Kcal (about 30 – 40 minutes) 5 days / week
- Regression in atherosclerotic lesions when expending **2204 Kcal / week**
  - 441 Kcal (about 45 – 55 minutes) 5 days / week
- This translates into walking 15 – 25 miles per week at a fast pace

## ● Resistance training can and should be prescribed for cardiac patients

- Techniques to allow for breathing while lifting should be emphasized!!!
  - ↓ RPP for any given load lifted
- Single set programs performed at least 2 time / week are preferred
- Programs should included exercises to strengthen all muscle groups
  - May be specialized to occupation if necessary
  - Should always include muscles used for everyday living tasks
    - Standing, sitting, pushing downward, pulling,.....etc.
  - Balance training should be considered if patient is unstable
- Weight should allow for at least 10 – 15 repetitions per set