Cardiology Updates: Syncope and Stress Testing

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Disclosures

• NONE 😊
PART ONE: Let’s start with **SYNCOPE**

- Objectives:
  - Definition of Syncope
  - Brief review of causes and incidence
  - Review ACC 2017 Updated Guidelines
• **Abrupt, transient, complete** loss of consciousness associated with inability to maintain postural tone with rapid and spontaneous recovery.
  - CEREBRAL HYPOPERFUSION
• Should NOT be other non-syncope loss of consciousness such as: seizure, antecedent head trauma or apparent LOC (pseudosyncope)
Incidence

Framingham Heart Study followed 7814 men and women
• Followed for 17 years
• 11% reported syncopal episodes
• Similar in men and women*

3-5% of ER visits
1% of hospital admissions
COST

• A nationally representative sample of hospital discharges and reported charges was analyzed, and costs were estimated using Medicare cost-to-charge ratios.

• A conservative estimate of total annual costs for syncope-related hospitalizations was $2.4 billion (95% confidence interval [CI] $2.2 to $2.6 billion), with a mean cost of $5,400 (95% CI $5,100 to $5,600) per hospitalization. Efforts to safely decrease syncope-related admissions may result in substantial costs savings.
Etiologies of Syncope

- Neurally mediated- 35%
  - Vasovagal
  - Carotid hypersensitivity
  - Situational
    - Cough, post-micturition
- Orthostatic- 10%
  - Drug induced
  - Autonomic failure
    - Primary
    - Secondary
- Syncope mimics
  - Seizure, psychogenic (2-10%)
- Neurologic
  - CVA/TIA
- Unknown (25-40%)

- Cardiac Arrhythmia- 10%
  - Bradycardia
    - Sinus pause/arrest, AV block
    - AV block
  - Tachycardia
    - VT, SVT
    - Long QT syndrome

- Structural Cardiopulmonary – 5%
  - Aortic stenosis
  - HOCM
  - Pulmonary HTN
  - Aortic Dissection
Survival was worst for patients with a cardiovascular cause of syncope. P < 0.001 for the comparison between participants with and those without syncope. The category “Vasovagal and other causes” includes vasovagal, orthostatic, medication-induced, and other, infrequent cause of syncope.

Let’s Review the Guidelines
Most Important IB Recommendation

History and Physical Exam

History and Physical Exam

History and Physical Exam

History and Physical Exam
<table>
<thead>
<tr>
<th>More Often Associated With Cardiac Causes of Syncope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Older age (&gt;60 y)</td>
</tr>
<tr>
<td>Male sex</td>
</tr>
<tr>
<td>Presence of known ischemic heart disease, structural heart disease, previous arrhythmias, or reduced ventricular function</td>
</tr>
<tr>
<td>Brief prodrome, such as palpitations, or sudden loss of consciousness without prodrome</td>
</tr>
<tr>
<td>Syncope during exertion</td>
</tr>
<tr>
<td>Syncope in the supine position</td>
</tr>
<tr>
<td>Low number of syncope episodes (1 or 2)</td>
</tr>
<tr>
<td>Abnormal cardiac examination</td>
</tr>
<tr>
<td>Family history of inheritable conditions or premature SCD (&lt;50 y of age)</td>
</tr>
<tr>
<td>Presence of known congenital heart disease</td>
</tr>
<tr>
<td>More Often Associated With Noncardiac Causes of Syncope</td>
</tr>
<tr>
<td>Younger age</td>
</tr>
<tr>
<td>No known cardiac disease</td>
</tr>
<tr>
<td>Syncope only in the standing position</td>
</tr>
<tr>
<td>Positional change from supine or sitting to standing</td>
</tr>
<tr>
<td>Presence of prodrome: nausea, vomiting, feeling warmth</td>
</tr>
<tr>
<td>Presence of specific triggers: dehydration, pain, distressful stimulus, medical environment</td>
</tr>
<tr>
<td>Situational triggers: cough, laugh, micturition, defecation, deglutition</td>
</tr>
<tr>
<td>Frequent recurrence and prolonged history of syncope with similar characteristics</td>
</tr>
</tbody>
</table>

SCD indicates sudden cardiac death.
IB: Resting ECG is useful in initial evaluation.

- Bradyarrhythmia with sinus pauses
- High grade AV conduction block
- Ventricular tachyarrhythmias
- Rare causes (but do not miss!)
  - Wolff-Parkinson White
  - Brugada Syndrome
  - Long-QT syndrome (LQTS)
  - Hypertrophic cardiomyopathy (HCM)
  - Arrhythmogenic right ventricular dysplasia (ARVC)
- Utility and prognostic value of obtaining ECG has been questioned
Example
Example
• IB: Evaluation and cause of short and long term morbidity and mortality is recommended.

<table>
<thead>
<tr>
<th>Short-Term Risk Factors (≤30 d)</th>
<th>Long-Term Risk Factors (&gt;30 d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>History: Outpatient Clinic or ED Evaluation</td>
<td>Male sex¹⁸⁴,⁹⁰</td>
</tr>
<tr>
<td>Male sex³⁴,⁸⁵,¹⁰¹,¹⁰²</td>
<td>Male sex¹⁸⁴,⁹⁰</td>
</tr>
<tr>
<td>Older age (&gt;60 y)⁸⁸</td>
<td>Older age⁶⁷,⁷⁴,⁷⁵,⁹⁰</td>
</tr>
<tr>
<td>No prodrome⁶⁸</td>
<td>Absence of nausea/vomiting preceding syncopal event⁹³</td>
</tr>
<tr>
<td>Palpitations preceding loss of consciousness⁶³</td>
<td>VA⁶⁸,⁹⁰</td>
</tr>
<tr>
<td>Exertional syncope⁸³</td>
<td>Cancer⁶⁸</td>
</tr>
<tr>
<td>Structural heart disease⁷⁰,⁸³,⁸⁸,¹⁰¹,¹⁰³</td>
<td>Structural heart disease⁵⁸,¹⁰³</td>
</tr>
<tr>
<td>HF⁷⁴,⁸³,⁸⁵,⁸⁸</td>
<td>HF⁵⁰</td>
</tr>
<tr>
<td>Cerebrovascular disease⁷⁰</td>
<td>Cerebrovascular disease⁵⁸</td>
</tr>
<tr>
<td>Family history of SCD⁷⁰</td>
<td>Diabetes mellitus¹⁰⁴</td>
</tr>
<tr>
<td>Trauma⁶⁸,¹⁰¹</td>
<td>High CHADS-2 score⁹⁵</td>
</tr>
<tr>
<td>Physical Examination or Laboratory Investigation</td>
<td></td>
</tr>
<tr>
<td>Evidence of bleeding⁸³</td>
<td>Abnormal ECG⁸⁴,⁹⁰,⁹³</td>
</tr>
<tr>
<td>Persistent abnormal vital signs⁷⁰</td>
<td>Lower GFR</td>
</tr>
<tr>
<td>Abnormal ECG⁶⁸,⁷²,⁷⁴,⁷⁵,¹⁰⁵</td>
<td></td>
</tr>
<tr>
<td>Positive troponin⁷⁵</td>
<td></td>
</tr>
</tbody>
</table>
IIB: Risk factor scores do exist.

<table>
<thead>
<tr>
<th>Study/Reference</th>
<th>Year</th>
<th>Sample N</th>
<th>Events N (%)</th>
<th>Outcome Definition</th>
<th>ED Events*</th>
<th>Predictors</th>
<th>NPV (%)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martin⁹⁰</td>
<td>1997</td>
<td>252</td>
<td>104 (41%)</td>
<td>1-y death/arrhythmia</td>
<td>Yes</td>
<td>Abnormal ECG; &gt;45 y of age; VA; HF</td>
<td>93</td>
</tr>
<tr>
<td>Sarasin²⁴</td>
<td>2003</td>
<td>175</td>
<td>30 (17%)</td>
<td>Inpatient arrhythmia</td>
<td>Yes</td>
<td>Abnormal ECG; &gt;65 y of age; HF</td>
<td>98</td>
</tr>
<tr>
<td>OESIL⁵⁷</td>
<td>2003</td>
<td>270</td>
<td>31 (11%)</td>
<td>1-y death</td>
<td>N/A</td>
<td>Abnormal ECG; &gt;65 y of age; no prodrome; cardiac history</td>
<td>100</td>
</tr>
<tr>
<td>SFSR²²</td>
<td>2004</td>
<td>684</td>
<td>79 (12%)</td>
<td>7-d serious events⁵</td>
<td>Yes</td>
<td>Abnormal ECG; dyspnea; hematocrit; systolic BP &lt;90 mm Hg; HF</td>
<td>99</td>
</tr>
<tr>
<td>Boston Syncope</td>
<td>2007</td>
<td>293</td>
<td>68 (23%)</td>
<td>30-d serious event¹</td>
<td>Yes</td>
<td>Symptoms of acute coronary syndrome; worrisome cardiac history; family history of SCD; VHD; signs of conduction disease; volume depletion; persistent abnormal vital signs; primary central nervous event</td>
<td>100</td>
</tr>
<tr>
<td>Rule⁷⁰</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Del Rosso⁹⁰</td>
<td>2008</td>
<td>260</td>
<td>44 (17%)</td>
<td>Cardiac etiology</td>
<td>N/A</td>
<td>Abnormal ECG/cardiac history; palpitations; exertional; supine; precipitant (a low-risk factor); autonomic prodrome (low-risk factors)</td>
<td>99</td>
</tr>
<tr>
<td>STEPS⁴⁸</td>
<td>2008</td>
<td>676</td>
<td>41 (6%)</td>
<td>10-d serious events⁶</td>
<td>Yes</td>
<td>Abnormal ECG; trauma; no prodrome; male sex</td>
<td>99</td>
</tr>
<tr>
<td>Syncope Risk</td>
<td>2009</td>
<td>2584</td>
<td>173 (7%)</td>
<td>30-d serious events#</td>
<td>No</td>
<td>Abnormal ECG; &gt;90 y of age; male sex; positive troponin; history of arrhythmia; systolic BP &gt;160 mm Hg; near-syncope (a low-risk factor)</td>
<td>97</td>
</tr>
<tr>
<td>Score⁷⁵</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td>Abnormal ECG; B-natriuretic peptide; hemoglobin; O₂ Sat; fecal occult blood</td>
<td>98</td>
</tr>
</tbody>
</table>
• IIa: Transthoracic echocardiography can be useful in selected patients with syncope **if cardiovascular disease is suspected.**
  • Clues: Abnormal ECG; if suspect valvular disease, LV systolic dysfunction, HCM or other structural HD (based on PE).
  • Be aware of cost and necessity.
• On the other side: Class III recommendation: Routine cardiac imaging is NOT useful in evaluation of patients with syncope UNLESS cardiac etiology is suspected.

Cardiac Imaging
Special Scenarios: EXERTIONAL SYNCOPE

• IIA: Exercise stress testing can be useful to establish the cause of syncope in selected patients who experience syncope or presyncope during exertion.
• Structural lesions: HCM, AS, anomalous coronary arteries, PH
• Channelopathies: LQTS, Catecholaminergic polymorphic ventricular tachycardia

*Need to be completed with extreme caution and with experienced provider present.
Cardiac Monitoring

- I: Choice of specific cardiac monitor should be based on frequency and nature of events.
  - 24-48 hour Holter monitor
  - Event monitor (typically 2-4 weeks)
  - Loop recorder for more infrequent episodes
  - MCOT monitor (continuous ECG monitoring) for 2-4 weeks

- I: Continuous ECG monitoring is useful for hospitalized patients for syncope of suspected cardiac etiology.
Electrophysiology Testing

- **IIA:** EPS can be useful for evaluation of selected patients with syncope of suspected arrhythmic etiology.
  - Only helpful in patients who have **underlying cardiac disease**.
  - Most of literature old.
  - 40-50% of patients with or without structural heart disease.
If diagnosis unclear after initial evaluation, tilt table testing may be useful for VVS.

May be useful in patients with suspected delayed OH (> 3 minutes).

Reasonable to distinguish convulsive syncope from epilepsy in selected patients.

Reasonable to establish diagnosis of pseudosyncope.
NO BENEFIT (Class III)

• Routine laboratory testing
• Routine cardiac imaging
• Really any ROUTINE testing- should be based on overall clinical suspicion.
Neurologic Testing

• Class III: NO BENEFIT
  • **MRI and CT of the head** are NOT recommended in routine evaluation of patients with syncope in absence of focal neurological findings or head injury that support further evaluation.
    • MRI ordered in 11% and established diagnosis in 0.24%
    • CT ordered in 57% and established diagnosis in 1%
  • **Carotid artery imaging** is NOT recommended in the routine use in the absence of focal neurologic findings.
    • Ordered in 58% and established diagnosis in 0.5%.
  • **Routine use of EEGs** NOT recommended in absence of features suggesting seizure.
    • Ordered 52% of time and established diagnosis 0.7%.
Warrants further evaluation...

**Table 7. Examples of Serious Medical Conditions That Might Warrant Consideration of Further Evaluation and Therapy in a Hospital Setting**

<table>
<thead>
<tr>
<th>Cardiac Arrhythmic Conditions</th>
<th>Cardiac or Vascular Nonarrhythmic Conditions</th>
<th>Noncardiac Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustained or symptomatic VT</td>
<td>Cardiac Ischemia</td>
<td>Severe anemia/gastrointestinal bleeding</td>
</tr>
<tr>
<td>Symptomatic conduction system disease or Mobitz II or third-degree heart block</td>
<td>Severe aortic stenosis</td>
<td>Major traumatic injury due to syncope</td>
</tr>
<tr>
<td>Symptomatic bradycardia or sinus pauses not related to neurally mediated syncope</td>
<td>Cardiac tamponade</td>
<td>Persistent vital sign abnormalities</td>
</tr>
<tr>
<td>Symptomatic SVT</td>
<td>HCM</td>
<td></td>
</tr>
<tr>
<td>Pacemaker/ICD malfunction</td>
<td>Severe prosthetic valve dysfunction</td>
<td></td>
</tr>
<tr>
<td>Inheritable cardiovascular conditions predisposing to arrhythmias</td>
<td>Pulmonary embolism</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aortic dissection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acute HF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moderate-to-severe LV dysfunction</td>
<td></td>
</tr>
</tbody>
</table>

HCM indicates hypertrophic cardiomyopathy; HF, heart failure; ICD, implantable cardioverter-defibrillator; LV, left ventricular; SVT, supraventricular tachycardia; and VT, ventricular tachycardia.
OVERVIEW
Management Recommendations

• For structural or inheritable arrhythmic conditions, certainly would consult cardiology.
  • Decision making within need for ICD in parallel with management.
  • Varies disease state by disease state.
  • Refer to ACC/AHA guidelines for each disease state.

• EXAMPLE:
  • **Class I for LQTS**: BB therapy (and not ICD) is recommended in patients with syncope and LQTS (Same with CPVT).
    • VERSUS
  • **Class IIa for ARVC**: ICD implantation is reasonable for syncope in ARVC. (Class I if documented sustained arrhythmia).
VASOVAGAL SYNCOPE

- Education on diagnosis and prognosis (Class I)
  - Counter pressure maneuvers (Class IIa)
  - Salt and fluid intake (Class IIb)

- Options
- VVS recurs

- Options
- Midodrine (Class IIa)
- Fludrocortisone (Class IIb)
- Beta blocker (in patients ≥ 42 y) (Class IIb)
- Orthostatic training (Class IIb)
- Selected serotonin reuptake inhibitors (Class IIb)
- Dual-chamber pacemaker therapy (Class IIb)
Orthostatic hypotension
Within guidelines, there are specific recommendations on **driving restrictions** depending on cause.

Class I: Cardiovascular assessment by a care provider experienced in treating **athletes** with syncope is recommended prior to resuming competitive sports.
1. Be cost effective within your decision making regarding syncope work up.

2. **History and Physical** is everything. May require no further work up with a good thorough evaluation.

3. **Take a concerning history in** a young individual, particularly athlete, seriously.

4. A lot of resources are at your finger tips (risk calculators, reference of high risk features)- use them to your advantage when you are unsure.
PART TWO: STRESS TESTING
CASE ONE

• 58 yo active male with medically treated 65% mid cx stenosis on LHC 2011 noted some chest pain while exercising at the gym.

• Which stress test most appropriate?
  • Treadmill exercise
  • Treadmill + Stress ECHO
  • Treadmill + Nuclear myocardial perfusion scan
  • Pharmacological nuclear myocardial perfusion imaging
  • Dobutamine stress echocardiogram
  • Coronary angiography
CASE TWO

• 65 yo male with HTN, HLD with atypical chest pain at rest or with exertion. Has chronic AF with slow ventricular response with PPM and underlying LBBB.

• Which stress test is most appropriate?
  • Treadmill exercise
  • Treadmill + Stress ECHO
  • Treadmill + Nuclear myocardial perfusion scan
  • Pharmacological nuclear myocardial perfusion imaging
  • Dobutamine stress echocardiogram
  • Coronary angiography
CASE THREE

• 75 yo female with DM, HTN, advanced COPD on home O2 recently seen for worsening SOB for 2-3 weeks.

• Which stress test most appropriate?
  • Treadmill exercise
  • Treadmill + Stress ECHO
  • Treadmill + Nuclear myocardial perfusion scan
  • Pharmacological nuclear myocardial perfusion imaging
  • Dobutamine stress echocardiogram
  • Coronary angiography
Bayes’ Theorem

• The probability of a new event, or ‘true’ positive stress test, depends on the pre-test risk of the patient which have been derived from empiric data.
Stress Testing = Intermediate Risk Patients

CHEST PAIN FEATURES:
- Typical:
  - Substernal
  - Exertional
  - Relieved by rest or nitroglycerin

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Sex</th>
<th>Typical/Definite Angina Pectoris</th>
<th>Atypical/Probable Angina Pectoris</th>
<th>Nonanginal Chest Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤39</td>
<td>Men</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>40–49</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>50–59</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td>≥60</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
</tr>
</tbody>
</table>

*High*: >90% pre-test probability. *Intermediate*: between 10% and 90% pre-test probability. *Low*: between 5% and 10% pre-test probability. *Very low*: <5% pre-test probability. *Modified from the ACC/AHA 2002 Guideline Update for Exercise Testing (30a).*
Within decision making, **THINK:**

**STRESS**
- EXERCISE- if able, gold standard
- VASODILATOR
  - Ragadenosone (Lexiscan)
  - Adenosine
  - (Persantine)
- Beta-agonist
  - Dobutamine

**TEST**
- ECG
- ECHOCARDIOGRAM
- SPECT nuclear imaging
- PET imaging
- Cardiac MRI
Patient CAN exercise

Exercise

1. Treadmill
2. Treadmill + ECHO
3. Treadmill + SPECT Nuclear stress test
   IMAGING

Patient can NOT exercise

Pharmacological

Vasodilator
- Regadenosone
- Adenosine

Beta-agonist
- Dobutamine

4. SPECT Nuclear stress test
5. PET Nuclear stress test
6. Dob ECHO

7. Cardiac MRI
Stress Testing Sensitivity and Specificity

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Dobutamine</th>
<th>Adenosine or regadenoson</th>
<th>Dipyridamole</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECG(^a)</td>
<td>68/77(^b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuclear (SPECT)</td>
<td>87/64</td>
<td>82/75</td>
<td>90/75(^b)</td>
</tr>
<tr>
<td>Echocardiography</td>
<td>85/77</td>
<td>80/84(^b)</td>
<td>72/91</td>
</tr>
</tbody>
</table>

\(^a\)ECG is usually a part of all stress test protocols.
\(^b\)Usual preference.
Clinical factors impacting stress test modality

- Local availability and expertise
- Ability to exercise
- Resting ECG abnormalities
- Patient’s body habitus
  - Limited acoustic windows for echocardiography
- History of prior coronary revascularization
- Radiation exposure
- Need for concomitant assessment of hemodynamics or valvular disease
**Basic Algorithm**

Can the patient **exercise**?

**YES**
- **EXERCISE ECG**

**NO**
- **ECG uninterpretable or history of prior revascularization?**
  - **YES**
    - **ADD IMAGING**
  - **NO**
    - **EXERCISE ECG**

**ECG uninterpretable:**
- WPW
- Ventricular paced rhythm
- LBBB
- > 1 mm ST depression at rest
- Digoxin with ST changes
- LVH with ST-T wave abnormalities

**History of tachyarrhythmia, severe HTN**

**Avoid Dobutamine**

**Active wheezing, history of advanced conduction disease**

**Avoid regadenoson/adenosine**

**IMAGING Preference:**
- LBBB or RV pacing -> SPECT imaging may be preferred
- Marked obesity -> PET vs. cMRI (if can fit) if available
- Myocardial viability -> PET or cMRI
Treadmill Exercise Stress Test

- **Protocol:**
  - Follow Bruce Protocol and achieve 85% max predicted HR (220-age)
  - End Points: HR, BP, Exercise capacity, ECG symptoms
  - Hold BB 24 hours prior

- **Indications:**
  - Normal resting ECG
  - Least expensive; provides good measure of functional capacity
  - Prognostic value

- **Limitations:**
  - Non-diagnostic ECG: LBBB, paced, LVH, ST depression > 0.5 mm
  - Lower sensitivity and specificity.
  - Non-localizing (unless has ST elevation)
Treadmill Exercise ECG

Duke Treadmill Score:
- Exercise minutes- (ST deviation in mm x 5) – (angina index x 4)
- Score < -11 – HIGH RISK – 5 yr survival 75%
- Score -10 to 4+ - MODERATE RISK- 5 yr survival 75-95%
- Score > +5- LOW RISK- 5 yr survival 95%

Unfavorable: (5% mortality)
- Workload < 4 METS
- ST depression > 1 mm
- Failure to increased SBP > 120
- Exercise induced ST elevation
- Angina pectoris at low exercise work
- Sustained or symptomatic VT
Why obtain imaging?

- LBBB
- Paced rhythm
- Abnormal ST segments at baseline
- LVH with repolarization
- WPW
- Patients with prior revascularization
Stress Echocardiogram

**Advantages:**
- Direct visualization of walls, localize region of abnormality
- **Higher specificity** than perfusion imaging (3v disease, LM), higher sensitivity than treadmill
- NO radiation

**Disadvantages:**
- May be technically difficult with poor acoustic windows (could obtain ideal images at less than MPHR)
- **Less sensitive** than myocardial perfusion imaging (requires ischemia)
- Subjective interpretation
- False negative: more common in single vessel disease (particularly circumflex)
SPECT nuclear imaging

**Advantages:**
- Used in moderate to high pre-test probability
- Can risk stratify, look at perfusion and function, localize disease
- Higher sensitivity than stress echo

**Limitations**
- Expensive
- Decreased specificity particularly related to attenuation artifact
- Radiation exposure
- Cannot assess myocardium or valves

**High Risk Scan Findings:**
- Multiple reversible defects, large perfusion defect
- Transient dilatation of left ventricle
  - Depressed resting LVEF
- Increase RV radiotracer uptake
THE ISCHEMIC CASCADE

- Clinically apparent
- Clinically silent
- Normal function
- Degree of Ischemia

Axis:
- Sensitivity

Conditions:
- Angina
- ECG Abnormalities
- Systolic Dysfunction
- Diastolic Dysfunction
- Perfusion abnormalities

Tests:
- Exercise ECG
- STRESS ECHO
- Nuclear MPI
A word about cMRI within stress testing

• Stress Cardiac MRI
  • Better quality images
  • In general, cannot exercise (uses adenosine)
  • Provides structural, perfusion, viability associated with scar pattern (which could influence risk of SCD)
• Limitations: Availability, cost
CASE ONE

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  • Treadmill exercise
  • Treadmill + Stress ECHO
  • Treadmill + Nuclear myocardial perfusion scan
  • Pharmacological nuclear myocardial perfusion imaging
  • **Dobutamine stress echocardiogram**
  • Coronary angiography
Questions to consider when ordering...

- What is your pre-test probability of CAD?
- Reason for ordering stress test? Hold BB or not?
- Advantages and limitations of each stress modality?
- Ability to exercise?
- Normal or abnormal resting ECG?
- Contraindication to certain choice of agent/test (ie severe COPD on O2)?
- Cost/Availability
  - **Cost:** Exercise ECG < Stress echo < SPECT < cMRI/PET < LHC
Summary

• Appropriate for intermediate risk patients.
• If can exercise and has interpretable ECG, should get exercise ECG stress testing.
• If can exercise, do it! Provides **prognostic data**.
• Choice between Dobutamine echocardiogram vs. vasodilator SPECT imaging (part may be center dependent- availability, expertise).
• We will start seeing more cMRI and PET stress testing, particularly in those with difficult imaging, need for assessment of myocardial viability.
  • Keep in mind that stress cMRI is only available with vasodilator (adenosine) in Indianapolis (cannot get exercise data).
THANK YOU!

QUESTIONS!?
References

