EVIDENCE-BASED APPROACH TO PREOPERATIVE CARDIAC ASSESSMENT

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Objectives
- Recognize the risk factors for perioperative cardiac complications
- Describe the common cardiac risk assessment classifications
- Compare and contrast different types of cardiac imaging
- Describe an evidence-based approach to perioperative cardiac planning and risk reduction

Essential Hypertension
- Risk Factors
  - Increased age
  - Excessive dietary intake of sodium
  - African-American descent
  - Alcohol consumption >2drinks/day
  - Obesity
  - Stress
  - Genetic Factors
  - Tobacco use

Hypertension
- What is the baseline BP?
- Does the patient have any complications of untreated hypertension?
- What end-organ damage should you be assessing?
- How is the hypertension being managed? (or is it being managed?)
- At what point do you delay/cancel the anesthetic?

ABCD Approach to Medical Management
- A - Angiotensin inhibition
  - ACEI: Lisinopril
  - ARB: Losartan, candesartan
  - With diuretic
- B - Beta antagonist
  - Atenolol
  - With diuretic
- C - Calcium channel blocker
  - Amlodipine
- D - Diuretic
  - Thiazides, chlorothalidone

Classification of HTN

<table>
<thead>
<tr>
<th>BP Classification</th>
<th>SBP</th>
<th>DBP</th>
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<tbody>
<tr>
<td>Normal</td>
<td>&lt;120</td>
<td>&lt;80</td>
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<tr>
<td>Pre-HTN</td>
<td>120-139</td>
<td>80-89</td>
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<tr>
<td>Stage I HTN</td>
<td>140-159</td>
<td>90-99</td>
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<tr>
<td>Stage II HTN</td>
<td>160-179</td>
<td>100-109</td>
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<tr>
<td>Stage III HTN</td>
<td>180-209</td>
<td>110-119</td>
</tr>
<tr>
<td>Stage IV HTN</td>
<td>&gt;210</td>
<td>&gt;120</td>
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</table>
Recommendations

- Stage I and II – proceed with anesthesia and surgery
- Stage III – consider postponing anesthesia and surgery, especially in patients with other CV risk factors and end-organ damage
- Stage IV – defer anesthesia and surgery whenever possible, being appropriate anti-hypertensive therapy, and arrange for outpatient follow up or inpatient BP control

CORONARY ARTERY DISEASE

CAD: Why do we care?

- Modifiable Risk Factors
  - Obesity, physical inactivity, high carb & fat intake, smoking, excessive ETOH consumption, stress, HTN, HLP, postmenopausal estrogen deficiency, and diabetes
- Non-modifiable Risk Factors
  - Age, family history, genetic abnormalities in lipid metabolism

Atherosclerosis

- Risk of developing ischemic dz depends on number, distribution and structure of the atheroma. And of the overall degree of narrowing of the vessel.
- Fixed Lesions
  - >75% - generally causes exercise/stress induced symptoms
  - Compensatory vasodilation can no longer meet metabolic needs
  - >90% - may cause symptoms at rest
  - Collaterals develop slowly over time

Atherosclerosis

- Plaque disruption (acute coronary syndrome, ACS)
  - Sympathetic surge causes shear forces on coronary plaque
  - Endothelial and systemic inflammation
  - Hypercoagulable state induced by surgical stress – risk of thrombosis
  - “Anesthesia Stress Test”
ASCVD Considerations

- Carotid bruits
- TIA/CVA
- Claudication (PAD)
- Azotemia ( renovascular disease)
- Prior revascularization
- Prior infarction (location; anterior vs inferior)
- Diabetes mellitus

Evaluation of Angina

- Angina Equivalents
  - Fatigue
  - Shortness of breath without pulmonary disease
  - Rapid onset of pulmonary edema
  - Indigestion or jaw pain
  - Cardiac arrhythmias
  - Syncope

- What provokes/relieves chest pain?
- When was the last time you had chest pain?
- Did you have chest pain when you had your heart attack?
- How about Prinzmetal’s variant angina

Evaluate type of MI

- Transmural injury
  - Necrosis involves full or nearly full thickness of the ventricular wall along a single vessel distribution

- Subendocardial injury
  - Necrosis limited to the inner 1/3 to 1/2 of the ventricular wall
  - May extend beyond the distribution of one vessel
  - Usually due to plaque disruption then lysis of the thrombosis before transmural injury occurs
  - Or may be due to prolonged and severe reductions in SBP

Loss of contractility can occur in <2 minutes; irreversible injury 20-40 minutes; microvascular injury takes over an hour to develop.

Important Risk Factors to Assess

1. Amount of myocardium at risk +/- ventricular function
2. Ischemic threshold (or the heart rate where ischemia occurs)
3. Stability of symptoms
   1. Presence of associated arrhythmias
4. Current medical therapy

Patient medications

- Antihypertensives
  - Desire a well controlled BP
    - Positive interactions between β-antagonists and CCBs
    - ACEIs: recommendation is to hold prior to surgery due to refractory hypotension (controversial)
    - Clonidine
- Anticoagulants
  - Warfarin: d/c 5 days prior to surgery
  - ASA: d/c 7 -10 days prior to surgery
  - Thienopyridines: d/c 5-7 days prior to surgery
Recommendations:
Beta-Blocker Therapy

- Quality improvement measure for both reporting and P4P
- Class I
  - Continue current BB therapy (Level C)
  - Give to high risk patients undergoing vascular surgery with preop testing positive of ischemia (Level B)
- Class IIa
  - Vascular surgery with assessment of probable CAD or with multiple clinical risk factors (Level B)
  - Any patient with multiple risk factors for CAD and undergoing intermediate or high risk procedure (Level B)

- Class IIb
  - Intermediate or high risk surgery and patient at intermediate risk for CAD (Level C)
  - Vascular surgery with low cardiac risk (Level C)
- Class III
  - Should not be given to patients who have absolute contraindications to BB therapy (Level C)

These recommendations for perioperative beta blocker use were based on the results of the accompanied systematic review of 17 studies that found that "perioperative beta blockade started within one day or less before non-cardiac surgery prevents nonfatal myocardial infarction but increases risk of stroke, mortality, hypotension and bradycardia."

Coronary Stenting

- Recommendations:
  - Bare metal stents (30 days) vs. Drug-eluting stent (DES) (12 months) (I, B)
  - Consensus among providers with risk of surgery vs. discontinuation of antiplt meds (IIa, C)
  - DES: elective surgery may be considered after 180 days if risk of delay > risk of ischemia/stent thrombosis (IIb, B)
  - Mechanism of action

Coronary Stenting

- AHA/ACC Advisory: caution on premature discontinuation of anti platelet therapy
  - Most important to wait until no longer taking a thienopyridine
- Recommendations for emergency surgery
  - Higher rates of occlusion with both stents in emergency surgeries
  - Close monitoring requirement peri-operatively
  - In E-cases: no increased incidence of blood transfusion requirements or bleeding complications

“The patient’s inherent risk for bleeding, concomitant treatments that may increase this risk, the potential of the procedure to cause bleeding, and the patient’s risk for ischaemic events if antiplatelet therapy is stopped all must be considered.” Bertrand 2008
Perioperative Management

- Value of regional versus general anesthesia
  - Volatile or TIVA reasonable (IIa, A)
  - Consider neuraxial for postop pain mgt in AAA repair (IIa, B)
- Monitoring
  - Emergency TEE reasonable to determine cause of hemodynamic instability (IIa, C)
  - PAC considered when underlying medical conditions that significantly affect hemodynamics cannot be corrected prior to surgery (IIb, C)
  - Routine use of PAC, even in high risk patients, not recommended (III, A)

**Statins**

- HMG-CoA reductase inhibitors
  - Potential to decrease risk of MI in high risk patients
  - 0-30 days reduced risk of MI
  - 1 year – trend for decrease risk
- Decrease cholesterol synthesis
- Anti-inflammatory properties
  - Reduced CRP
- Vasodilatory effects
- Anti-thrombogenic
- Timing: 1-2 months before surgery vs. shorter time before surgery

**Risk for heart failure**

- Race
  - White versus Black
  - Gender
  - Male versus Female
- Co-morbid factors
  - Hypertension****
  - MI**
  - High cholesterol
  - Renal disease
  - Presence of inflammatory markers (c-reactive protein)
  - Tobacco

Heart Failure

- RV Failure Symptoms
  - Systemic Congestion
    - Peripheral edema/anasarca
    - Ascites/hepatomegaly/coagulopathy
    - Hepatojugular reflex
- LV Failure Symptoms
  - Pulmonary Congestion
    - Dyspnea/orthopnea/PND
    - Poor peripheral perfusion
    - Dizziness, confusion, cool extremities
    - Fatigue

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ACC/AHA & NYHA

Increasing Severity

Class I
- No symptoms
- No limitation of activity
- BNP not indicated
- NYHA class I

Class II
- Mild symptoms
- Limited by mild exertion
- BNP not indicated
- NYHA class II

Class III
- Moderate symptoms
- Limited by severe exertion
- BNP not indicated
- NYHA class III

Class IV
- Severe symptoms
- Limitation by both exertion and rest
- BNP indicated
- NYHA class IV

Preoperative considerations for HF

- What kind of heart failure is present?
  - Systolic versus diastolic
  - Preserved EF versus non-preserved EF
- Are the symptoms new or worsened?
  - Delay elective case and refer back to cardiologist
  - In optimal condition?
- Is it well compensated?
  - What is the NYHA or the ACC/AHA classification?
  - Do you have a recent BNP?
- Is the patient in sinus rhythm?

Classification of valvular stenosis

Aortic Stenosis

- Mild: Mean gradient <25, Valve area >1.5
- Moderate: Mean gradient 25-40, Valve area 1.5-1
- Severe: Mean gradient >40, Valve area <1

- Critical stenosis: Valve area <0.7 cm²

Mitral Stenosis

- Mean gradient <5, Valve area 1.5
- 5-10, Valve area 1.5-1
- >10, Valve area <1

Pacemaker Management

- Know your pacemaker!
  - BIV may not have an async mode
  - Establish pacemaker dependence preoperatively
  - Determine pacemaker function
  - Remember to disable the ICD, if necessary
  - Determine whether EMI is likely to occur
  - Monitor operation of the device
  - Evaluate proper functioning at the conclusion of the case

ACC/AHA recommendations for the mgmt of diastolic heart failure

- Avoid tachycardia
- Avoid ischemia
- Avoid hypertension

Preoperative considerations for HF

- Does the patient have an implanted device?
  - ICD or biventricular pacemaker
- Continue most home medications except ACEI and ARBs
- Preoperative medications
  - Avoid NSAIDs
- Intraoperative medications
  - Systolic HF: avoid CCBs
  - Diastolic HF: no real contraindications

ASA Guidelines, 2011
**Risk Assessment**

The risk of preoperative complications depends on the condition of the patient prior to surgery, the prevalence of co-morbidities, and the magnitude and duration of the surgery.

**Cardiac Risk Assessment**

- Goldman Cardiac Risk Index (1977)
- Detsky Risk Index (1986)
- American College of Physicians (1997)
- American Heart Association/American College of Cardiologists (2002)

**Revised Cardiac Risk Index (2007)**

1. History of IHD
2. History of CHF
3. History of CVD
4. History of DM
5. Chronic Kidney Disease
6. Surgery type: intrathoracic, suprainguinal vascular, intraperitoneal

**Pre-Operative Risk Factors**

- CAD, previous MI, heart failure, aortic stenosis, poorly controlled HTN (LVH)
- Age older than 70 years
- Diabetes (independent predictor of M&M) autonomic neuropathy
- Poor functional capacity

**Functional Capacity**

- Metabolic Equivalents
  - 1 MET (poor)
    - ADLs, light housework, walk 1-2 block slowly on level ground
  - 4 METs (moderate)
    - Climb 1 flight of stairs, heavy housework, moderate recreational activities, e.g. golf, dancing
  - >10 METs (excellent)
    - Strenuous sports

1 MET = basal metabolic rate = metabolic demand at rest
**Surgical Risk**

- **High Risk *(>5%)*
  - Emergency surgery
  - Aortic, peripheral vascular, or prolonged procedures with fluid shifts and blood loss
- **Intermediate Risk *(1-5%)*
  - Orthopedic, urologic, or uncomplicated ENT/abdominal/thoracic surgery
- **Low Risk *(<1%)*
  - Endoscopic, derm, breast, or cataract surgery

*risk of MI and cardiac death within 30 days after surgery

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**Factors to Consider**

- Is surgery urgently required?
- Recent MI (8 - 30 days) versus Acute MI (7 days or less)
- Has the patient recently undergone revascularization?
- Has the patient been reevaluated for CAD in the past 2 years?
- Is the patient at risk for adverse cardiac events?
- What is the patient’s functional capacity?

Mehta (2005)

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**Factors to consider**

- What is the probability of complications based on surgery & institutional experience?
- Is testing necessary?
- Do the benefits of the surgery outweigh the probability of postop cardiac complications?
- What is needed to modify perioperative care to reduce probability of post op cardiac complications?
- Long term risk stratification measures

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**Level of risk**

<table>
<thead>
<tr>
<th>Level of risk</th>
<th>Clinical Predators</th>
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<tbody>
<tr>
<td>Major</td>
<td>Unstable coronary syndromes; Decompensated heart failure; Significant arrhythmias (High grade block, uncontrolled SVT, symptomatic vent arrhythmias) Severe valvular disease</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Mild angina; Previous MI by history or presence of Q wave Compensated or prior heart failure Diabetes mellitus, especially IDDM</td>
</tr>
<tr>
<td>Minor</td>
<td>Advanced age; Abnormal BKG (SVT, BMI, ST abnormalities); Rhythms other than sinus Low functional capacity (&lt;4 METs); History of CVA; Uncontrolled systemic hypertension</td>
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ACC/AHA Practice Guidelines 2006

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**Perioperative risk reduction**

- Changes in anesthetic technique
- Aggressive treatment of hemodynamic changes
- Aggressive monitoring techniques
- Admission to the ICU

**Rational Utilization of Resources**
Preoperative Testing

Imaging should be reserved when test results would change or influence the anesthetic management.

B-type Natriuretic Peptide

- "emergency" neurohormone resembling atrial natriuretic peptide but synthesized primarily in the ventricles
- N-terminal pro-hormone BNP
- Secreted in response to increased ventricular volume, pressure overload, or increased wall tension
- Can be used in diagnosis of CHF; values rise and fall in response to exacerbation and resolution of CHF
- Why do we care?

Troponin

- Very sensitive and specific indicators of damage to the myocardium
- Differentiate between unstable angina or MI in patients with chest pain or ACS, can also occur in patients with coronary vasospasm
- Marker of all heart muscle damage, not just MI
  - Severe tachycardia
  - Heart failure, where they also predict mortality and ventricular rhythm abnormalities
  - Myocarditis and pericarditis
  - Cardiomyopathy, cardiac contusion, defibrillation and cardioversion.
  - Cardiac surgery and heart transplantation, PCI, or radiofrequency ablation

Your Basic Chest Xray

- Key findings
  - Heart size (CT ratio)
  - Pulmonary vascular markings (Kerley’s lines)
- Usefulness in redo sternotomies

Electrocardiogram

- What are you looking for?
  - AV block or an IVCD
  - Atrial fibrillation/flutter
  - Ischemia or infarction
  - Hypertrophy
  - New BBB (especially a LBBB)

EKG (IIa, Class B recommendation)
  Reasonable with abnormal conduction, known CAD, PAD, CVA

Left Ventricular Function

- LVEDP
  - >15 usually indicates some degree of ventricular dysfunction
- Ejection Fraction
  - Stroke volume/end diastolic volume
  - Can have heart failure with and without decreased ejection fraction
  - Normal EF 75%
  - Heart failure EF <40%
**Echocardiography**

- Routine rest echo not recommended
- Reasonable for patients with dyspnea of unknown origin or patients with HF with worsening symptoms (IIa, Class B recommendation)
- Equivocal evidence for LV dysfunction follow up
- Assess ejection fraction and valvular function
- Limited predictive value of rest echo; failure to detect all IHD
- Doppler function

**Stress Echocardiography**

- Can assess static function and/or dynamic function
- Dobutamine stress echo
- Hibernating or stunned myocardium
- High sensitivity and specificity for perioperative cardiac death and MI
- Should not be used for patients with severe arrhythmias, significant hypertension, large thrombus-laden aortic aneurysms, or hypotension

**Exercise Electrocardiography**

- Least invasive, most cost effective method of detecting ischemia
- Goal: provoke ischemia by exercise
- Positive test
  - Syncope (decreased CO)
  - ST segment changes (ischemia)
  - Decrease in BP (global LV dysfunction)

**So...when do I need an exercise stress test?**

- Elevated risk but good FC – not necessary (IIA, B)
- Elevated risk but unknown FC – reasonable if will change management (IIb, B)
- Reasonable for high risk procedures (III, B)
- Elevated risk but moderate FC – may be reasonable to forgo additional testing (IIb, B)
- Elevated risk with poor FC – may be reasonable in conjunction with cardiac imaging (IIb, C)

**Pharmacologic Stress Thallium Imaging**

- Unable to exercise
- Two categories of agents
  - Coronary vasodilators
  - Inotropes (increase demand)
- Thallium-201 or Cardiolyte
- How does it work?
  - Diminished uptake and delayed clearance of the radioisotope in the stenotic zone compared with increased uptake and more rapid clearance in normally perfused myocardium

**Exercise Nuclear Imaging**

- Fixed vs. Reversible
- Reasonable for patients at elevated risk with poor FC if it changes management (IIA, B)
- No benefit to routine screening

Tomography.files.wordpress.com
Angiography

- "Gold Standard" for defining coronary anatomy
- Information on ventricular function
- Information on valvular function
- Intra-cardiac pressure measurements
- What important information don't we get?

References

ACC/AHA 2006 Guidelines for the management of valvular disease, Circulation