PRE-OPERATIVE “CLEARANCE” FOR CARDIOVASCULAR PATIENTS

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DISCLOSURES

- none
**THERE IS NO REAL “CLEARANCE”....**

- For any pre-operative patients, our job is to access and minimize risk in the pre-operative setting

- With rare exceptions, emergency surgeries will proceed regardless of risk

- In the ideal setting, no patient should every proceed to the OR with decompensate heart failure or angina

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**WHAT CAUSES PERIOPERATIVE MORTALITY?**

- 0.7 - 0.8% All cause (4,038 out of 485,850 pts)
- 1:2680 Anesthesia
- 1:420 Surgical error
- 1:95 Underlying medical conditions (s)
- 67% Progression/complication of presenting disease
- 44% Progression/complication of underlying disease
- 30% Surgery contributed to mortality

- < 1/3 Cardiac
- > 1/3 Pulmonary
- 1/3 Other medical conditions

Fleisher, L, J Am Soc Anesthesiolgy, 2002;96(5):1039-1041
METs Can Complete Activity Without Stopping

1. Sit upright
2. Eat, dress, use toilet, make bed
3. Walk around house, shower
4. 1 flight stairs, walk up hill, 2 block @ 2 mph
   Light house work, dust, wash dishes, golf, bowl
5. 2 flights of stairs, walk on flat @ 4 mph, Sex
6-7. Scrubbing floors, weight lifting, moving furniture
8. Shovel snow
9. Doubles tennis, swing dancing
10. Recreational Sports:
    Singles tennis, soccer, basketball, skiing, jogging
12+. Competitive sports
FUNCTIONAL CAPACITY

- Peak exercise capacity an independent predictor of all mortality in normals and subjects with cardiovascular dz
  - < 5 METs: Poor Survival Prognosis (<50%)
  - 10 METs: Medical therapy = CABG (>75%)
  - ≥ 13 METs: Good Survival Prognosis (>90%)

- For each 1 MET there is a 12% improvement in survival


HOW DOES THIS RELATE TO SURGERY?

- < 4 METs Significantly Increases Risk MI, HF, Arrhythmia regardless of Surgical Risk

<table>
<thead>
<tr>
<th>Functional Capacity</th>
<th>Complication Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4 METs</td>
<td>&gt; 5%</td>
</tr>
<tr>
<td>4 - 10 METs</td>
<td>1-5%</td>
</tr>
<tr>
<td>&gt; 10 METs</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>

Eagle KA, et all, J Am Col Cardiol, 2002, 39, 542-533
WHO IS TOO SICK OR THE “ARE YOU NUTS?” ASSESSMENT

- Predictors of Risk for MI, Heart Failure, Death
  - Unstable Coronary Syndrome
    - angina, acute or recent MI
  - Decompensated Heart Failure
    - new onset, worsening HF, NYHA Class IV
  - Significant Arrhythmias
    - high grade AV block, symptomatic or new ventricular arrhythmia, tachycardia with rate > 100, symptomatic bradycardia
  - Severe Valvular Disease
    - severe aortic stenosis, symptomatic mitral stenosis

CARDIAC RISK STRATIFICATION FOR NONCARDIAC SURGICAL PROCEDURES

- Vascular (reported cardiac risk often more than 5%)
  - Aortic and other major vascular surgery
  - Peripheral vascular surgery
- Intermediate (reported cardiac risk generally 1% to 5%)
  - Intraperitoneal and intrathoracic surgery
  - Carotid endarterectomy
  - Head and neck surgery
  - Orthopedic surgery
  - Prostate surgery
- Low† (reported cardiac risk generally less than 1%)
  - Endoscopic procedures
  - Superficial procedure Cataract surgery
  - Breast surgery
  - Ambulatory surgery
RISK STRATIFICATION BASED ON NYHA FUNCTIONAL CLASS

<table>
<thead>
<tr>
<th>NYHA Class</th>
<th>Low</th>
<th>Intermediate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>SURGERY</td>
<td>SURGERY</td>
<td>CAUTION</td>
</tr>
<tr>
<td>II</td>
<td>SURGERY</td>
<td>SURGERY</td>
<td>CAUTION</td>
</tr>
<tr>
<td>III</td>
<td>SURGERY</td>
<td>CAUTION</td>
<td>DELAY SURGERY</td>
</tr>
<tr>
<td>IV</td>
<td>CAUTION</td>
<td>DELAY SURGERY</td>
<td>DELAY SURGERY</td>
</tr>
</tbody>
</table>

Reginelli J P, Mills R M Heart 2001;85:505-507

INCREMENTAL IMPACT OF HF DIAGNOSIS ON NON-CARDIAC PERIOPERATIVE MORTALITY

WHAT TESTING IS NEEDED PRE-OP?

RECOMMENDATION FOR PREOPERATIVE NONINVASIVE EVALUATION OF LV FUNCTION

- **Class I (none)**
- **Class IIa**
  - It is reasonable for patients with dyspnea of unknown origin to undergo preoperative evaluation of LV function. (C)
  - It is reasonable for patients with current or prior HF with worsening dyspnea or other change in clinical status to undergo preoperative evaluation of LV function if not performed within 12 months. (C)
- **Class IIb**
  - Reassessment of LV function in clinically stable patients with previously documented cardiomyopathy is not well established. (C)
- **Class III**
  - Routine perioperative evaluation of LV function in patients is not recommended. (B)
RECOMMENDATIONS FOR PREOPERATIVE
RESTING 12-LEAD ECG

- Class I: Preoperative resting 12-lead ECG is recommended for pts with:
  - At least 1 clinical risk factor* who are undergoing vascular surgical procedures. (B)
  - Known CHD, peripheral arterial disease, or cerebrovascular disease who are undergoing intermediate-risk surgical procedures. (C)
- Class IIa: Preoperative resting 12-lead ECG is reasonable in persons with no clinical risk factors who are undergoing vascular surgical procedures. (B)
- Class IIb: Preoperative resting 12-lead ECG may be reasonable in patients with at least 1 clinical risk factor who are undergoing intermediate-risk operative procedures. (B)
- Class III: Preoperative and postoperative resting 12-lead ECGs are not indicated in asymptomatic persons undergoing low-risk surgical procedures. (B)

*Clinical risk factors include history of ischemic heart disease, history of compensated or prior HF, history of cerebrovascular disease, DM, and renal insufficiency

RECOMMENDATIONS FOR NONINVASIVE STRESS TESTING BEFORE NONCARDIAC SURGERY

- Class I: Patients with active cardiac conditions in whom noncardiac surgery is planned should be evaluated and treated per ACC/AHA guidelines before noncardiac surgery. (B)
- Class IIa: Noninvasive stress testing of patients with 3 or more clinical risk factors and poor functional capacity (less than 4 METs) who require vascular surgery is reasonable if it will change management. (B)
- Class IIb: Noninvasive stress testing may be considered for patients:
  - With at least 1 to 2 clinical risk factors and poor functional capacity (less than 4 METs) who require intermediate-risk noncardiac surgery if it will change management. (B)
  - With at least 1 to 2 clinical risk factors and good functional capacity (greater than or equal to 4 METs) who are undergoing vascular surgery. (B)
- Class III: Noninvasive testing is not useful for patients:
  - With no clinical risk factors undergoing intermediate-risk noncardiac surgery. (C)
  - Undergoing low-risk noncardiac surgery. (C)
## Risk Stratification Procedure Examples

- **Vascular** (reported cardiac risk often = 5%)
  - Aortic and other major vascular surgery
  - Peripheral vascular surgery

- **Intermediate** (reported cardiac risk generally 1-5%)
  - Intraperitoneal and intrathoracic surgery
  - Carotid endarterectomy
  - Head and neck surgery, orthopedic surgery, prostate surgery

- **Low** (reported cardiac risk generally < 1)
  - Endoscopic procedures, superficial procedures
  - Cataract surgery, breast surgery, ambulatory surgery

### CARDIAC RISK STRATIFICATION FOR NONCARDIAC SURGICAL PROCEDURES

<table>
<thead>
<tr>
<th>Risk Stratification</th>
<th>Procedure Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vascular</td>
<td>• Aortic and other major vascular surgery</td>
</tr>
<tr>
<td>(reported cardiac risk often = 5%)</td>
<td>• Peripheral vascular surgery</td>
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<tr>
<td>(reported cardiac risk generally 1-5%)</td>
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<td>Low</td>
<td>• Head and neck surgery, orthopedic surgery, prostate surgery</td>
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<td>(reported cardiac risk generally &lt; 1)</td>
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</tr>
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<td></td>
<td>• Cataract surgery, breast surgery, ambulatory surgery</td>
</tr>
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</table>
**Surgery Specific Risk for Cardiac Death or Nonfatal MI**

- **High Risk ( > 5% )**
  - Aortic, Major vascular, Cardiothoracic, Emergent, long with large blood loss/fluid shifts

- **Intermediate Risk ( 1 - 5% )**
  - CEA, Head, Neck, Intraperitoneal, Intrathoracic, Orthopedic, Prostate

- **Low Risk ( < 1% )**
  - Ambulatory surgery, Endoscopy, Superficial Procedure, Cataract surgery, Breast surgery

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**What About Surgery Specific Risk?**

<table>
<thead>
<tr>
<th>Risk</th>
<th>Cardiac Death or nonfatal MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>&gt; 5%</td>
</tr>
<tr>
<td>Intermediate</td>
<td>1-5%</td>
</tr>
<tr>
<td>Low</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>

Emergency 2 - 5 times the surgical risk

CARDIAC EVALUATION AND CARE ALGORITHM FOR NONCARDIAC SURGERY

PERI-OPERATIVE B-BLOCKER USE
**RECOMMENDATIONS FOR BETA-BLOCKER MEDICAL THERAPY**

**CLASS I**
- Beta blockers should be continued in patients undergoing surgery who are receiving beta blockers to treat angina, symptomatic arrhythmias, hypertension, or other ACC/AHA class I guideline indications. (C)
- Beta blockers should be given to patients undergoing vascular surgery who are at high cardiac risk owing to the finding of ischemia on preoperative testing. (B)

**CLASS IIa**
- Beta blockers are probably recommended for patients undergoing vascular surgery in whom preoperative assessment identifies CHD. (B)
- Beta blockers are probably recommended for patients in whom preoperative assessment for vascular surgery identifies high cardiac risk, as defined by the presence of more than 1 clinical risk factor.* (B)
- Beta blockers are probably recommended for patients in whom preoperative assessment identifies CHD or high cardiac risk, as defined by the presence of more than 1 clinical risk factor,* who are undergoing intermediate-risk or vascular surgery. (B)

**CLASS IIb**
- The usefulness of beta blockers is uncertain for patients who are undergoing either intermediate-risk procedures or vascular surgery, in whom preoperative assessment identifies a single clinical risk factor.* (C)
- The usefulness of beta blockers is uncertain in patients undergoing vascular surgery with no clinical risk factors who are not currently taking beta blockers. (B)

**CLASS III**
- Beta blockers should not be given to patients undergoing surgery who have absolute contraindications to beta blockade. (C)
**RECOMMENDATIONS FOR PEROPEROPATIVE STATIN THERAPY**

- **Class I**
  - For patients currently taking statins and scheduled for noncardiac surgery, statins should be continued. (Level of Evidence: B)

- **Class IIa**
  - For patients undergoing vascular surgery with or without clinical risk factors, statin use is reasonable. (Level of Evidence: B)

- **Class IIb**
  - For patients with at least 1 clinical risk factor who are undergoing intermediate-risk procedures, statins may be considered. (Level of Evidence: C)
**APPRAOCH TO RISK PREDICTION**

**PREOPERATIVE RISK EVALUATION**

- **Risk Assessment**
  - Global Assessment of Risk
  - Cardiac Perioperative Risk
- **Goldman Risk Index, Functional capacity, Surgical risk**
  - Pulmonary Perioperative Risk
- **Risk Factor Evaluation**
  - DVT Risk
- **Risk Factor Evaluation**
  - Endocarditis Risk
- **Sanford Guidelines**
  - Risk from Medical Conditions
  - Risk from Medications
GLOBAL ASSESSMENT OF RISK OR “LOOKS GOOD FROM A FAR”

- American Society of Anesthesiologists Preoperative Patient Classification
  - Created in 1941
  - Purpose was to assess the degree of a patient’s “sickness”
  - NPV far exceeds PPV – better at defining healthy than incapacitated
  - Not originally intended to predict operative risk, but…… (millions of patients later)

AS A PATIENT CLASSIFICATION

<table>
<thead>
<tr>
<th>Class</th>
<th>48 hr Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy</td>
<td>0.07%</td>
</tr>
<tr>
<td>Mild Systemic Disease</td>
<td>0.24%</td>
</tr>
<tr>
<td>Severe Systemic Disease, limits activity but not incapacitating</td>
<td>1.24%</td>
</tr>
<tr>
<td>Incapacitating Systemic Disease which is a constant threat to life</td>
<td>7.5%</td>
</tr>
<tr>
<td>Moribund, not expected to survive 24 hours with or without surgery</td>
<td>34%</td>
</tr>
<tr>
<td>Emergent Surgery</td>
<td>Double Risk</td>
</tr>
</tbody>
</table>
CARDIAC PERIOPERATIVE RISK

- Revised Goldman Cardiac Risk Index
- Functional Capacity
- Risk Specific to Type of Surgery

GOLDMAN’S CARDIAC RISK INDEX

- **History**
  - Age > 70 (5 points)
  - MI within 6 months (10 points)
- **Cardiac Exam**
  - Signs of CHF: S3, JVD (11 points)
  - Severe AS (3 points)
- **ECG**
  - Rhythm other than sinus or PAC (7 points)
  - 5 or more PVC’s per minute (7 points)
- **General Medical Condition**
  - PO2<60, PCO2>50, K<3, HCO3<20, BUN>50, CR>3, elevated SGOT, chronic liver disease, bedridden (3 points)
- **Operation**
  - Emergency (4 points)
  - Intraperitoneal, intrathoracic, or aortic (3 points)

<table>
<thead>
<tr>
<th>0-5</th>
<th>Class 1</th>
<th>1% Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-12</td>
<td>Class II</td>
<td>7% Complication</td>
</tr>
<tr>
<td>13-25</td>
<td>Class III</td>
<td>14%</td>
</tr>
<tr>
<td>26-53</td>
<td>Class IV</td>
<td>78%</td>
</tr>
</tbody>
</table>
BEYOND THE GOLDMAN CARDIAC RISK INDEX

- 2893 patients
- Elective non-cardiac surgery
- Monitored for cardiac complications
  - MI
  - Pulmonary Edema
  - Ventricular Fibrillation
  - Cardiac Arrest
  - Complete Heart Block

NOT all cause mortality


SIX INDEPENDENT PREDICTORS OF MAJOR CARDIAC COMPLICATIONS

- High Risk Surgery
- History of Ischemic Heart Disease
  - History MI, History positive stress test, angina, using NTG, Pathologic Q
- Not History CABG or PTCA or Stent
- History of Heart Failure
- History of Cerebrovascular Disease
- DM treated with insulin
- Serum Creatinine > 2.0

## Revised Goldman Cardiac Risk Index

**VS. CARDIAC DEATH, MI, CARDIAC ARREST, VFIB, PULMONARY EDEMA, COMPLETE HEART BLOCK**

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Rate</th>
<th>Rate with Beta Blockers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.4-1.0%</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>1-2</td>
<td>2.2-6.6%</td>
<td>0.8-1.6%</td>
</tr>
<tr>
<td>≥3</td>
<td>&gt; 9%</td>
<td>&gt; 3%</td>
</tr>
</tbody>
</table>

Auerbach, A, Goldman, L. Circulation 2006; 113:1361

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**What about other complications**
EVALUATING PULMONARY RISK
IT’S NO LONGER JUST A GUESS

- Pulmonary Complications
  - MORE COMMON than Cardiac Complications
  - Cause Significantly LONGER Hospital Stays

- MOST COSTLY Complications

- Pulmonary Complications 6.8% across all types Sx
  - Atelectasis, Pulmonary Infection,
  - Prolonged Mechanical Ventilation, Respiratory Failure,
  - Chronic Lung Disease Exacerbation, Bronchospasm

PREDICTORS OF PULMONARY COMPLICATIONS

<table>
<thead>
<tr>
<th>Patient Related</th>
<th>Odds Ratio of Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt; 50, 60, 70, 80</td>
<td>1.5, 2.28, 3.9, 5.63</td>
</tr>
<tr>
<td>Chronic Lung Disease</td>
<td>2.36</td>
</tr>
<tr>
<td>Asthma</td>
<td>Uncontrolled 3, Controlled 1</td>
</tr>
<tr>
<td>Smoking</td>
<td>Current 5.5; 2-mo Cessation 1.26</td>
</tr>
<tr>
<td>Heart Failure</td>
<td>2.93</td>
</tr>
<tr>
<td>Albumin</td>
<td>2.53</td>
</tr>
<tr>
<td>BUN</td>
<td>2.29</td>
</tr>
<tr>
<td>Functional Dependence</td>
<td>Total 2.51; Partial 1.65</td>
</tr>
<tr>
<td>ASA Class ≥ 2</td>
<td>4.87</td>
</tr>
</tbody>
</table>

**Predictors of Complication Risk**

<table>
<thead>
<tr>
<th>Procedure Related</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical Site</td>
<td>Upper Abdominal 2.8</td>
</tr>
<tr>
<td>Duration &gt; 3-4 hours</td>
<td>2.14</td>
</tr>
<tr>
<td>Type of Anesthesia</td>
<td>General 1.8 vs Spinal</td>
</tr>
<tr>
<td>Emergency</td>
<td>2.21</td>
</tr>
</tbody>
</table>


**DVT Risk**

- **LOW RISK (<2%)**
  - Age < 40 and duration < 60 min and NO RISK FACTORS
  - Calf DVT 2%  Proximal DVT 0.4%
  - Significant PE 1-2%  Fatal PE 0.1-0.4%
  - Tx: Ted hose, early ambulation

- **Moderate Risk (10-40)**
  - Age 40-60, duration > 60 min or Risk Factors
  - Calf DVT 10-20%  Proximal DVT 2-4%
  - Significant PE 1-2%  Fatal PE 0.1-0.4%
  - Tx: LMWH, SCD

- Additional risk factors include advance age, cancer, prior DVT, obesity, HF, paralysis, hypercoagulable state
DVT RISK

- **High Risk (40)**
  - Age > 60
  - Age > 40 - 60 With Additional Risk Factor
    - Calf DVT 20 - 40 %
    - Proximal DVT 4 - 8 %
    - Significant PE 1 - 2 %
    - Fatal PE 0.4 - 1.0 %
  - TX: LMWH, SCD, Consider Prolonged Anticoagulation

- **Highest Risk (40-60)**
  - Age > 40 with Multiple Additional Risk Factors of THR, TKR, Hip Fracture, Major Trauma, Spinal Cord
    - Calf DVT 40 - 80 %
    - Proximal DVT 10 - 20 %
    - Significant PE 4 - 10 %
    - Fatal PE 0.2 - 5 %
  - TX: Long Term LMWH/Anticoagulation, Vena Cava Interruption

CONCLUSIONS...
SUMMARY

- Heart Failure adds risk to all operations - the better compensated the less the risk

- Pulmonary complications are more common than cardiac complications

- Do not stop the beta-blockers

- Look out for DVT and PE’s