Perioperative Medicine: Beyond Cardiac Risk Assessment

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Goals & Objectives

• Reflect on the history of perioperative risk assessment
• Review preoperative pulmonary risk assessment & management
• Learn to identify patients at risk for postoperative AKI and strategies to reduce this risk
• Consider the evidence on perioperative blood transfusions and how this applies to clinical practice
Perioperative Medicine: A Brief History

HISTORY IS THE FICTION WE INVENT TO PERSUADE OURSELVES THAT EVENTS ARE KNOWABLE AND THAT LIFE HAS ORDER AND DIRECTION.
1941: American Society of Anesthetists - Physical Classifications

<table>
<thead>
<tr>
<th>ASA Class (1941)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA 1</td>
<td>No systemic disturbance</td>
</tr>
<tr>
<td>ASA 2</td>
<td>Moderate and definite systemic disturbance either pre-existing or caused by the condition for which the surgery is planned</td>
</tr>
<tr>
<td>ASA 3</td>
<td>Severe systemic disturbance</td>
</tr>
<tr>
<td>ASA 4</td>
<td>Extreme systemic disorders that are an eminent threat to life regardless of type of treatment</td>
</tr>
<tr>
<td>ASA 5</td>
<td>Emergency surgery in patient who would otherwise be Class 1 or 2</td>
</tr>
<tr>
<td>ASA 6</td>
<td>Emergency surgery in patients that would otherwise be graded as class 3 or 4</td>
</tr>
</tbody>
</table>
1961: Dr. Robert Dripps

Describes relationship between ASA status and post-operative mortality
1977: Lee Goldman’s Cardiac Index (NEJM)

Table 4. Cardiac Risk Index.

<table>
<thead>
<tr>
<th>Class</th>
<th>Point Total</th>
<th>No or Only Minor Complication (N = 943)</th>
<th>Life-Threatening Complication* (N = 39)</th>
<th>Cardiac Deaths (N = 19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (N = 537)</td>
<td>0–5</td>
<td>532 (99)†</td>
<td>4 (0.7)</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>II (N = 316)</td>
<td>6–12</td>
<td>295 (93)</td>
<td>16 (5)</td>
<td>5 (2)</td>
</tr>
<tr>
<td>III (N = 130)</td>
<td>13–25</td>
<td>112 (86)</td>
<td>15 (11)</td>
<td>3 (2)</td>
</tr>
<tr>
<td>IV (N = 18)</td>
<td>&gt;26</td>
<td>4 (22)</td>
<td>4 (22)</td>
<td>10 (56)</td>
</tr>
</tbody>
</table>

*Documented intraoperative or postoperative myocardial infarction, pulmonary edema, or ventricular tachycardia without progression to cardiac death.
†Figures in parentheses denote %.

First pre-operative cardiac risk assessment tool

Table 3. Computation of the Cardiac Risk Index.

| Criteria* | Multivariate Discriminant Function Coefficient | "Points"
|-----------|-----------------------------------------------|--------|
| 1 History:  
(a) Age > 70 yr  
(b) MI in previous 6 mo | 0.191 0.384 | 5 10 |
| 2 Physical examination:  
(a) S3 gallop or JVD  
(b) Important VAS | 0.451 0.119 | 11 3 |
| 3 Electrocardiogram:  
(a) Rhythm other than sinus or PAC’s on last preoperative ECG  
(b) > 5 PVC’s/min documented at any time before operation | 0.283 0.278 | 7 7 |
| 4 General status:  
P02 < 60 or Pco2 > 50 mm Hg,  
K < 3.0 or HCO3 < 20 meq/liter,  
BUN > 50 or Cr > 3.0 mg/dl,  
abnormal SGOT, signs of chronic liver disease or patient bed ridden from noncardiac causes | 0.132 | 3 |
| 5 Operation:  
(a) Intraabdominal, intrathoracic or aortic operation  
(b) Emergency operation | 0.123 0.167 | 3 4 |
| Total possible | 53 points |

*M1 denotes myocardial infarction, JVD jugular-vein distention, VAS valvular aortic stenosis, PAC’s premature atrial contractions, ECG electrocardiogram, PVC’s premature ventricular contractions, P02 partial pressure of oxygen, Pco2 partial pressure of carbon dioxide, K potassium, HCO3 bicarbonate, BUN blood urea nitrogen, Cr creatinine, & SGOT serum glutamic oxaloacetic transaminase.
### 1999: Revised Cardiac Risk Index

<table>
<thead>
<tr>
<th>Clinical Variable</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>High risk surgery</td>
<td>1</td>
</tr>
<tr>
<td>h/o ischemic heart disease</td>
<td>1</td>
</tr>
<tr>
<td>h/o CHF</td>
<td>1</td>
</tr>
<tr>
<td>h/o CVA or TIA</td>
<td>1</td>
</tr>
<tr>
<td>Diabetes mellitus on insulin</td>
<td>1</td>
</tr>
<tr>
<td>Pre-op serum creatinine &gt; 2.0 mg/dl</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk class</th>
<th>Points</th>
<th>Risk of complications (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Very low</td>
<td>0</td>
<td>0.4</td>
</tr>
<tr>
<td>II. Low</td>
<td>1</td>
<td>0.9</td>
</tr>
<tr>
<td>III. Moderate</td>
<td>2</td>
<td>6.6</td>
</tr>
<tr>
<td>IV. High</td>
<td>3+</td>
<td>11.0</td>
</tr>
</tbody>
</table>

1999: The DECREASE-I Trial

- 112 patients with positive dobutamine stress echo prior to undergoing noncardiac vascular surgery
- RCT of oral bisoprolol vs placebo (2 years’ duration)
- Outcomes showed stunning three-fold reduction in cardiac death and MI in bisoprolol group

Poldermans was later fired from his post at Erasmus University amid findings of scientific misconduct, improper storage of data, and lack of informed consent after a 2011 investigation.
2008: POISE Trial

- Multicenter, international RCT
- 8351 patients at risk of cardiac events undergoing noncardiac surgery
- Metoprolol XL 200mg daily vs placebo
- Composite outcome: death, nonfatal MI, nonfatal arrest at 30 days
- Decreased risk of acute MI
- Increased risk of death and stroke
Assessment of Cardiac Risk in 3 Steps

1. Assess the risk of the surgical procedure
2. Assess the patient for RED FLAGS and CHRONIC DISEASES
   1. Review history including medications
   2. Assess functional status
   3. Physical examination
3. Apply validated clinical risk prediction tool
   1. Revised Cardiac Risk Index (RCRI)
   2. American College of Surgeons’ National Surgical Quality Improvement Program (ACS-NSQIP) risk model
2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines

Developed in Collaboration With the American College of Surgeons, American Society of Anesthesiologists, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Anesthesiologists, and Society of Vascular Medicine

Endorsed by the Society of Hospital Medicine
Case 1

A 76 year old male with a history of COPD (GOLD stage 2, FEV1 60% predicted), HTN and tobacco use is admitted to the General Surgery service with a small bowel obstruction. Despite several days of conservative measures, his obstruction has failed to resolve. You are consulted to “clear the patient for surgery” so he can undergo exploratory laparotomy.

T 37.0   HR 95   BP 150/80   RR 16   94% room air
Gen: uncomfortable
CV: RRR no murmurs. No JVD
Lungs CTAB
Abd distended, tympanic, absent sounds, mildly TTP
Ext no edema
Case 1

Which of the following recommendations will reduce this patient’s postoperative risk of pulmonary complications?

A. Give levofloxacin or moxifloxacin prior to surgery to prevent COPD exacerbation
B. Do not place a nasogastric tube post-operatively unless the patient has emesis
C. Administer scheduled albuterol nebs q4h on the day before to prevent COPD exacerbation
D. Ask anesthesia to use heliox in the OR to prevent atelectasis
Postoperative Pulmonary Complications (PPCs)

• Definition: atelectasis, hypoxia, pneumonia, respiratory failure, exacerbation of reactive airway disease (COPD or asthma)

• Equal to cardiac complications in terms of cost, length of stay

• Risk assessment tools are available to predict PPCs

• Further research needed on risk mitigation
ARISCAT (Canet) Pulmonary Risk Index

- Age
- Pre-operative oxygen saturation
- Location of surgical incision
- Duration of surgery
- Respiratory infection in last 30d
- Pre-operative Hgb ≤ 10g/dL
- Emergency surgery
Interventions Known to Reduce PPCs

• Post-operative deep breathing, incentive spirometry, chest physiotherapy
  – No clear superlative strategy
  – Any of the above are superior to no intervention in reducing PPCs

• Selective use of nasogastric tubes (NGTs)
  – Reduced rates of pneumonia and atelectasis compared to routine use
Aim: Evaluate efficacy of pre-op inspiratory muscle training on reduction of PPCs

Methods: systematic review

Outcomes: pneumonia, atelectasis, mortality, LOS

Results: pre-op IMT associated with reduction of post-op atelectasis, pneumonia and LOS

Application: recommend home pre-op IMT for patients at elevated risk of PPCs

Further studies needed to identify ideal duration/frequency/type of IMT

Katsura M, Kuriyama A, Takeshima T, Fukuhara S, Furukawa TA
Acute Kidney Injury (AKI)

- Independent risk factor for increased mortality
- Patients more likely to be discharged to NH, LTACH or SNF
- Most of the literature on perioperative AKI involves cardiac surgeries (incidence 5-15%)
- Relatively few large studies on incidence and prevention of AKI in the general surgical population
AKI and General Surgery: Risk Factors

# Perioperative AKI Risk Prediction Tool

<table>
<thead>
<tr>
<th>Clinical Variable</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraperitoneal surgery</td>
<td>1</td>
</tr>
<tr>
<td>Renal insufficiency</td>
<td>1</td>
</tr>
<tr>
<td>Ascites</td>
<td>1</td>
</tr>
<tr>
<td>Active CHF</td>
<td>1</td>
</tr>
<tr>
<td>Emergency surgery</td>
<td>1</td>
</tr>
<tr>
<td>Age &gt; 56 years</td>
<td>1</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1</td>
</tr>
<tr>
<td>HTN</td>
<td>1</td>
</tr>
<tr>
<td>Male sex</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Risk Class</th>
<th>Points</th>
<th>Risk of AKI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>0-2</td>
<td>0.2%</td>
</tr>
<tr>
<td>Class II</td>
<td>3</td>
<td>0.8%</td>
</tr>
<tr>
<td>Class III</td>
<td>4</td>
<td>2.0%</td>
</tr>
<tr>
<td>Class IV</td>
<td>5</td>
<td>3.6%</td>
</tr>
<tr>
<td>Class V</td>
<td>6+</td>
<td>9.5%</td>
</tr>
</tbody>
</table>

Risk Reduction: Volume & Vasopressors

• Volume expansion has been the mainstay of therapy for years

• Goal-directed therapy (GDT) reduces incidence of AKI
  – Only when GDT protocol used vasopressors
  – Only in groups where GDT patients received no more IVF than usual care group

IVF: Too Much of a Good Thing?

- Several studies in critically ill patients link positive fluid balance with AKI and mortality
- Similar findings in cardiovascular surgery patients

AKI & Renin-Angiotensinogen System Inhibitors

- Pre-operative ACEI use is related to intra-operative hypotension in multiple studies
- Failure to resume ACEI within 48h linked with increased 30d mortality
- Increased risk of AKI in patients on ARB/ACEI in orthopedic surgery patients in one study
- Meta-analysis: slightly reduced risk of postop AKI for pre-op ARBs but not ACEIs

Post-operative AKI: Take Home Points

• Early and frequent volume assessment
• Judicious use of fluids & pressors
• Avoidance of volume overload; consider early diuresis +/- RRT for the overloaded patient
• Reasonable to continue ACEI/ARB if CHF or HTN
• Reasonable to hold ACEI day of surgery; resume within 48h if clinical status permits
Perioperative Anemia

• Post-op anemia is an independent RF for death (cardiac surgery)
• RBC transfusion is associated with acute lung injury, circulatory overload, transfusion reactions
• Recent studies link transfusions to risk of AKI, respiratory failure, infections
• Thresholds for RBC transfusion not clearly defined in the postoperative patient population
• Studies are small and results are mixed
• **Aims**: compare restrictive (Hct ≥ 24%) vs liberal (Hct ≥ 30%) transfusion strategy in elective cardiac surgery patients

• **Methods**: RCT; 502 adult patients in ICU at university hospital cardiac surgery referral center in Brazil

• **Outcomes**: 30 day mortality; severe morbidity (shock, ARDS, AKI requiring dialysis)

• **Results**: no difference
FOCUS trial

Aim: determine if higher threshold for RBC transfusion (10mg/dL vs 8mg/dL) affected recovery or mortality in hip fracture patients

Methods: RCT; 2,016 patients age 50+ with RFs for or prior hx of CAD undergoing hip fx surgery

Outcomes: death and functional status at 60d

Results: no difference
Transfusion Guidelines

American Association of Blood Banks

– recommend threshold of Hgb 8 g/dL for adults undergoing orthopedic or cardiac surgery, or those with preexisting CVD

– Recommend threshold of Hgb 7 g/dL for all other hospitalized adults

JAMA. 2016;316(19):2025-2035
Aim: determine if perioperative IV iron reduces incidence of transfusion in patients undergoing scheduled abdominal surgery

Methods: RCT; 72 patients with iron-def anemia; 15mg/kg body weight IV iron given prior to surgery + 0.5mg per 1mL EBL, given on or before POD 2.

Outcomes: # of transfusions; Hgb at discharge and at follow up; hospital length of stay

Results: fewer transfusions and shorter LOS for IV iron group
Primary Outcome: Perioperative RBC Transfusions

<table>
<thead>
<tr>
<th>Transfusion Events</th>
<th>Intervention (N = 40)</th>
<th>Control (N = 32)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td>0</td>
<td>2</td>
<td>0.190</td>
</tr>
<tr>
<td># of units</td>
<td>N/A</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Intraoperative</td>
<td>0</td>
<td>5</td>
<td>0.014</td>
</tr>
<tr>
<td># of units</td>
<td>N/A</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Postoperative</td>
<td>5</td>
<td>10</td>
<td>0.079</td>
</tr>
<tr>
<td># of units</td>
<td>8</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td><strong>Total # events</strong></td>
<td><strong>5</strong></td>
<td><strong>17</strong></td>
<td><strong>&lt; 0.001</strong></td>
</tr>
</tbody>
</table>

Secondary Outcomes:

Hematological Indices Across Study Period

<table>
<thead>
<tr>
<th></th>
<th>Intervention N = 40</th>
<th>Control N = 32</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hemoglobin, g/dL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Randomization</td>
<td>10.7</td>
<td>10.6</td>
<td>0.76</td>
</tr>
<tr>
<td>Admission</td>
<td>11.5</td>
<td>10.7</td>
<td>0.12</td>
</tr>
<tr>
<td>Discharge</td>
<td>10.3</td>
<td>10.2</td>
<td>0.31</td>
</tr>
<tr>
<td>4 weeks</td>
<td><strong>12.2</strong></td>
<td><strong>11.1</strong></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Iron Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fe @ randomization</td>
<td>19</td>
<td>37</td>
<td>0.06</td>
</tr>
<tr>
<td>Fe @ 4 weeks</td>
<td><strong>248</strong></td>
<td><strong>99</strong></td>
<td><strong>0.002</strong></td>
</tr>
<tr>
<td><strong>Length of Stay, days</strong></td>
<td>6</td>
<td>9</td>
<td>0.05</td>
</tr>
</tbody>
</table>

What Did We Learn?

• Incentive spirometry and selective use of nasogastric tubes can prevent postoperative pulmonary complications
• A risk prediction tool can identify those at risk for acute kidney injury (though how to best reduce this risk is not clear)
• Target Hgb of 8g/dL is recommended for patients with CVD and all patients undergoing orthopedic or cardiovascular surgery
• Look for more data on the use of IV iron to manage perioperative iron deficiency anemia
References

7. Livhits M, Gibbons MM, de VC, et al. Coronary revascularization after myocardial infarction can reduc
References


