1. “Optimized” not “Cleared”
2. Identify red flags for cardiac and pulmonary complications
3. Optimize management
4. Prevent delirium
5. Don’t cause unnecessary delays
• 300 million patients annually undergo noncardiac surgery worldwide

• Leading cause of death is **MACE** (major adverse cardiac events)
  - Myocardial injury/infarction
  - CHF
  - Cardiogenic Shock
  - Cardiac arrest
  - Stroke/TIA
  - Death

-> 2 million deaths/year
Question:

Which of the following describes trends in preoperative MACE during the past 10 years?

A. Decreased
B. Increased
C. Not sure
Secular Trends in Postop MACE

![Graph showing trends in MAE, MI, and death](image)

*Smilowitz NR. *JAMA Cardiol* 2016 Dec 28. doi: 10.1001

Nauder Faraday MD; “Perioperative Management” Johns Hopkins
Perioperative MI

Myocardial Injury Occurs in the 1st Few Postop Days

Figure 1. Timing of perioperative MI and elevated levels of an isolated cardiac biomarker or enzyme.

POISE Trial Analysis

- N = 697
  - Death OR 2.54/1.65-3.90

- N = 271
  - Death OR 4.76/2.68-8.43

- N = 144
  - Death OR 4.00/2.65-6.06

Devereaux PJ. Ann Intern Med 2011;154:523-8

Nauder Faraday MD; "Perioperative Management" Johns Hopkins
The majority of perioperative myocardial ischemic events are caused by?

A. Physiologic O2 imbalance; ie hypertension, hypotension, tachycardia, etc
B. Anatomic O2 imbalance; ie plaque rupture/thrombosis
C. Both
D. Neither
Physiologic stress of surgery

**Perioperative MI:**
Physiologic or Anatomic?

<table>
<thead>
<tr>
<th>Event</th>
<th>Nonoperative MI (N=25)</th>
<th>Perioperative MI (N=42)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>2/3 Plaque rupture/thrombosis</td>
<td>2/3 Plaque rupture/thrombosis</td>
</tr>
<tr>
<td>Nonfatal SpontaneousACS (N=120)</td>
<td>2/3 Plaque rupture/thrombosis</td>
<td>2/3 Plaque rupture/thrombosis</td>
</tr>
</tbody>
</table>

**Myocardial Ischemia:**
O2 Supply-Demand Mismatch

**Physiologic Imbalance**
- Hyper-adrenergic Stimulation
  - Tachycardia
- Hypertension
- Hypotension
- Anemia

**Anatomic Imbalance**
- Plaque Rupture
- Thrombosis

*Dawood MM: Int J Cardiol 1996 57: 37-44*
*Gualandro DM, Atherosclerosis, 2012/222:191-5*
WHERE IS THE WINDOW OF OPPORTUNITY FOR DIAGNOSIS AND TREATMENT?

- Intraoperative - few
- POD1 - many
- Majority of events are SILENT
  - ? concurrent surgical pain
  - ? analgesic therapy
- Death occurs (well after) myocardial injury happens
- Pathophysiology is similar to nonoperative ACS

Management is conventional medical therapy:
- ASA or Plavix
- BBlocker
- Statin
1. What clinical features place an individual at increased risk of MACE?

2. Does existing data support routine use of non-invasive testing?

3. What are the 2014 AHA/ACC guidelines for risk assessment?

---

**ACC/AHA Clinical Practice Guideline**

2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery

*Published in 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.*

**Writing Committee Members**

Lee A. Fleisher, MD, FACC, FAHA, Chair; Kirsten E. Fleischmann, MD, MPH, FACC, Vice Chair; Andrew D. Auerbach, MD, MPH; Susan A. Barnason, PhD, RN, FAHA; Joshua A. Biskup, MD, FACC, FSCAI; Bytham Brucki, MD, PhD, FACC, FAHA; Victor G. Davila-Roman, MD, FACC, FASE; Marie D. Gerhard-Forstner, MD; Thomas A. Holly, MD, FACC, FASNC; Garvan C. Kase, MD, PhD, FAHA, FASE; Joseph F. Murphy, MD, FACC, FSCAI; M. Timothy Nelson, MD, FACC; Joseph C. Spencer, JD, MD; Ammerine Thompson, MD, MBA, FACC, FAHA; Barry F. Urena, MD, FACC, FAHA, FSCAI; Daniela N. Wijeyewickrama, MD, PhD; Evidence Review Committee Chair.
Monitoring and diagnosis of post-op MI

**ACC/AHA GUIDELINE RECOMMENDATIONS 2014**

- **EKG** if symptoms “YES” Class I
- **EKG** if high risk: surveillance “Maybe” Class IIb

- **PA cath** if high risk “Maybe” Class IIb

- **Echo** if symptoms or hemodynamic instability “Yes” Class I

- **Troponin** if symptoms “Yes” Class I
  - if high risk: surveillance “Maybe” Class IIb
65yo man scheduled for prostatectomy. He is asymptomatic, does normal daily activities comfortably, can mow his lawn, take long walks and climb 2 flights of steps.

- PMHx: H/o CAD with LAD stent 5 years earlier, IDDM, HTN
- Normal exam, normal EKG, Creatinine 1.2

Which statement is most accurate?

1. /A He is “low risk” and does not need a stress test

2. /B He is at “elevated risk” but has good functional capacity, and therefore he can proceed to surgery without a stress test

3. /C He is at “elevated risk” and should have an exercise treadmill test

4. /D His is at “elevated risk” and should have a stress test, but it should be a nuclear study or dobutamine echo to increase sensitivity
How do we assess Perioperative risk of MACE?

- Type of Surgery

- Type of patient
  - Functional Capacity
  - Clinical risk factors
Perioperative risk by type of surgery

Risk based on type of surgery

- **High Risk**
  - Emergent major (especially in elderly)
  - Aortic & other major vascular
  - Peripheral vascular

- **Intermediate Risk**
  - Carotid endarterectomy
  - Head or neck
  - Intrapenitoneal and intrathoracic
  - Orthopedic
  - Prostate

- **Low Risk**
  - Endoscopic procedures
  - Superficial procedures
  - Cataract
  - Breast
Question:

CLINICAL RISK FACTORS ALONE ARE INSUFFICIENT IN PREDICTING PERIOPERATIVE MACE

1/A. TRUE

2/B. FALSE
Major risk factors = "Hard stops"

- **UNSTABLE CORONARY SYNDROMES**

- **ACUTE DECOMPENSATED CHF**

- **SIGNIFICANT ARRHYTHMIA (HIGH DEGREE AVB, SYMPTOMATIC BRADYCARDIA, VT)**

- **SEVERE VALVULAR DISEASE (SEVERE AS OR SYMPTOMATIC MS)**

- **SEVERE VALVULAR DISEASE (I.E. SEVERE AS, SYMPTOMATIC MS)**
Suggested Risk Models/Calculators in Updated ACC/AHA Guidelines

NSQIP  WWW.RISKCALCULATOR.FACS.ORG

Risk Assessment by ACS NSQIP
(www.riskcalculator.facs.org)

Estimates the risk of:
- Death
- Any complication
- Pneumonia
- Cardiac complication
- Surgical site infection
- Urinary Tract Infection
- Venous thromboembolism
- Renal failure
- Serious complication

Revised Cardiac Risk Index

1 point for each:

- Hx CAD
- Hx stroke/TIA
- Hx CHF
- DM on insulin
- Renal insufficiency
  Creat > 2.0
- High Risk Surgery
  (chest, abd, vascular)

Lee et al. Circulation 1999;100:1043

Risk increases in proximity to cardiac event

- MI < 6 months
- PCI < 2 years
- CHF < 2 years

Hawn MT. JAMA 2013; 310: 1462-72
Can they do >4 METs activity?*

- Flight of stairs or a hill
- Run a short distance
- Walk 4 miles/hr on level ground
- Do heavy housework
- Moderate recreational activities: golf, bowling, dancing

---

**Self Reported Exercise Tolerance and Perioperative Complications**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Good Exercise Tolerance (%)</th>
<th>Poor Exercise Tolerance (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac</td>
<td>5.2</td>
<td>9.6</td>
<td>0.04</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>6.3</td>
<td>9.0</td>
<td>0.21</td>
</tr>
<tr>
<td>Infectious</td>
<td>2.2</td>
<td>2.9</td>
<td>0.60</td>
</tr>
<tr>
<td>Neurologic</td>
<td>2.2</td>
<td>5.5</td>
<td>0.03</td>
</tr>
<tr>
<td>Unexpected Transfer</td>
<td>5.6</td>
<td>11.1</td>
<td>0.02</td>
</tr>
<tr>
<td>Total Serious Complications</td>
<td>10.4</td>
<td>20.4</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Noninvasive tests are good at identifying patients most likely to have MACE (major adverse cardiac events)

1/A. TRUE
2/B. FALSE
### Predictive value of noninvasive tests

#### Studies of Preop Vasodilator Stress
**Nuclear Perfusion Imaging**

<table>
<thead>
<tr>
<th>Study</th>
<th>Surgery</th>
<th>Patients (N)</th>
<th>Death/MI (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eagle et al.</td>
<td>Vascular</td>
<td>200</td>
<td>8</td>
<td>16</td>
<td>98</td>
</tr>
<tr>
<td>Cuber et al.</td>
<td>Abd. Aorta</td>
<td>116</td>
<td>10</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>Younis et al.</td>
<td>Vascular</td>
<td>111</td>
<td>7</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td>Hendel et al.</td>
<td>Vascular</td>
<td>327</td>
<td>9</td>
<td>14</td>
<td>99</td>
</tr>
<tr>
<td>Letie et al.</td>
<td>Mixed</td>
<td>355</td>
<td>8</td>
<td>17</td>
<td>99</td>
</tr>
<tr>
<td>Brown et al.</td>
<td>Vascular</td>
<td>231</td>
<td>5</td>
<td>13</td>
<td>99</td>
</tr>
<tr>
<td>Vanzetto et al.</td>
<td>Abd. Aorta</td>
<td>134</td>
<td>9</td>
<td>13</td>
<td>98</td>
</tr>
<tr>
<td>Baron et al.</td>
<td>Abd. Aorta</td>
<td>457</td>
<td>5</td>
<td>4</td>
<td>98</td>
</tr>
<tr>
<td>Bry et al.</td>
<td>Vascular</td>
<td>237</td>
<td>7</td>
<td>11</td>
<td>100</td>
</tr>
<tr>
<td>Younis et al.</td>
<td>General</td>
<td>161</td>
<td>9</td>
<td>16</td>
<td>98</td>
</tr>
<tr>
<td>Roghi et al.</td>
<td>Vascular</td>
<td>320</td>
<td>4</td>
<td>5</td>
<td>98</td>
</tr>
</tbody>
</table>

#### Studies of Preop Dobutamine Stress
**Echocardiography**

<table>
<thead>
<tr>
<th>Study</th>
<th>Surgery</th>
<th>Patients (N)</th>
<th>Death/MI (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poldermans</td>
<td>Vascular</td>
<td>131</td>
<td>4</td>
<td>14</td>
<td>100</td>
</tr>
<tr>
<td>(Circulation, 1993)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poldermans</td>
<td>Vascular</td>
<td>300</td>
<td>6</td>
<td>24</td>
<td>100</td>
</tr>
<tr>
<td>(JACC, 1999)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Das</td>
<td>General</td>
<td>53</td>
<td>6</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td>(JACC, 2000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boersma</td>
<td>Vascular</td>
<td>1097</td>
<td>3</td>
<td>14</td>
<td>98</td>
</tr>
<tr>
<td>(JAMA, 2001)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Grayburn and Hilfis. Ann Intern Med 2003;138:506*
Question:

REVASCULARIZATION WILL DECREASE THE RISK OF PERI-OPERATIVE MACE AND IMPROVE OUTCOMES

1. TRUE
2. FALSE
Outcomes with revascularization

### CARP Surgical Outcomes

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Revascularization (N=225)</th>
<th>No Revascularization (N=237)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Days Until Surgery</td>
<td>54</td>
<td>18</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Death – no. (%) within 30 days</td>
<td>7 (3.1)</td>
<td>8 (3.4)</td>
<td>0.87</td>
</tr>
<tr>
<td>MI – no. (%) (by enzymes)</td>
<td>26 (11.6)</td>
<td>34 (14.3)</td>
<td>0.37</td>
</tr>
<tr>
<td>Stroke – no. (%)</td>
<td>1 (0.4)</td>
<td>2 (0.8)</td>
<td>0.59</td>
</tr>
<tr>
<td>Median ICU days</td>
<td>2.0</td>
<td>2.0</td>
<td>0.25</td>
</tr>
<tr>
<td>Median hospital days</td>
<td>6.5</td>
<td>7.0</td>
<td>0.29</td>
</tr>
</tbody>
</table>

### DECREASE-V Outcomes

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Revascularization n (%)</th>
<th>No Revascularization n (%)</th>
<th>HR (95%, CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td># Patients</td>
<td>49</td>
<td>52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Events up to 30 days</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All cause mortality</td>
<td>11 (22.6)</td>
<td>8 (11.5)</td>
<td>2.2 (0.74-6.6)</td>
<td>0.14</td>
</tr>
<tr>
<td>Nonfatal MI</td>
<td>17 (34.7)</td>
<td>16 (30.8)</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Composite</td>
<td>21 (42.9)</td>
<td>17 (32.7)</td>
<td>1.4 (0.73-2.8)</td>
<td>0.30</td>
</tr>
<tr>
<td>Events up to 1 year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All cause mortality</td>
<td>13 (26.5)</td>
<td>12 (23.1)</td>
<td>1.3 (0.55-2.9)</td>
<td>0.58</td>
</tr>
<tr>
<td>Nonfatal MI</td>
<td>18 (36.7)</td>
<td>19 (36.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composite</td>
<td>24 (49.0)</td>
<td>23 (44.2)</td>
<td>1.2 (0.68-2.3)</td>
<td>0.48</td>
</tr>
</tbody>
</table>

McFalas et al. NEJM 2004;151:2798

Stepwise approach to perioperative cardiac assessment for CAD based on 2014 ACC/AHA Guidelines

- Estimate major adverse cardiac event risk using:
  - Revised Cardiac Risk Index, which takes into consideration these factors:
    - High-risk surgery
    - History of ischemic heart disease
    - History of congestive heart failure
    - Pre-operative treatment with insulin
    - Pre-operative creatinine > 2 mg/dL

- For patients with no evidence of ongoing ACS:
  - Perioperative risk for MACE < 1%
    - Functional capacity: Unknown
      - Proceed to surgery
    - Functional capacity: Poor
      - Proceed to ACS evaluation
    - Functional capacity: Moderate to Good
      - Consider non-invasive testing if results would change management
      - Proceed to surgery
    - Functional capacity: Excellent
      - Proceed to surgery

- For patients with evidence of ischemic syndrome:
  - Perioperative risk for MACE > 1%
    - Proceed to surgery

References:
Akhles Y Patel, Kim A Eagle, Natahali Daleyova
Medications
ACC/AHA GUIDELINES (2014)

Class III- Harm
- Beta blocker therapy should not be started on the day of surgery

Class IIb-Benefit >Harm
- In patients with RCRI >3, it may be reasonable to begin BBlockers before surgery (Level of Evidence B)
- In patients with intermediate or high risk myocardial ischemia in preoperative risk stratification tests, it may be reasonable to begin perioperative beta blockers. (Level of Evidence: C)
- In patients in whom beta-blockers are started, it may be reasonable to begin them far enough in advance to assess safety and tolerability, preferably more than 1 day before surgery (Level of Evidence:B)
Meta-analysis of RCTs of Perioperative \( \beta \) blockade- 30-d Nonfatal MI

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Region</th>
<th>Site</th>
<th>Blocker</th>
<th>MI (pts.)</th>
<th>30-d Fatalities</th>
<th>30-d Nonfatal MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass et al. 2011</td>
<td>105</td>
<td>North America</td>
<td>Boston</td>
<td>Atenolol</td>
<td>71</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Généreux et al. 2012</td>
<td>85</td>
<td>Europe</td>
<td>London</td>
<td>Metoprolol</td>
<td>77</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Silva et al. 2009</td>
<td>109</td>
<td>Brazil</td>
<td>Sao Paulo</td>
<td>Propranolol</td>
<td>74</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Zuccaro et al. 2008</td>
<td>85</td>
<td>Europe</td>
<td>Rome</td>
<td>Metoprolol</td>
<td>77</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Duboc et al. 2009</td>
<td>109</td>
<td>Brazil</td>
<td>Sao Paulo</td>
<td>Propranolol</td>
<td>74</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Overall, 600 patients</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>75</td>
<td>2.1</td>
<td>15.9</td>
</tr>
</tbody>
</table>

Other Investigators

Pearce et al. 2013

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Region</th>
<th>Site</th>
<th>Blocker</th>
<th>MI (pts.)</th>
<th>30-d Fatalities</th>
<th>30-d Nonfatal MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schousboe et al. 2010</td>
<td>105</td>
<td>Europe</td>
<td>Copenhagen</td>
<td>Atenolol</td>
<td>71</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Généreux et al. 2012</td>
<td>85</td>
<td>Europe</td>
<td>London</td>
<td>Metoprolol</td>
<td>77</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Silva et al. 2009</td>
<td>109</td>
<td>Brazil</td>
<td>Sao Paulo</td>
<td>Propranolol</td>
<td>74</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Zuccaro et al. 2008</td>
<td>85</td>
<td>Europe</td>
<td>Rome</td>
<td>Metoprolol</td>
<td>77</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Duboc et al. 2009</td>
<td>109</td>
<td>Brazil</td>
<td>Sao Paulo</td>
<td>Propranolol</td>
<td>74</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Overall, 750 patients</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>75</td>
<td>2.1</td>
<td>15.9</td>
</tr>
</tbody>
</table>

Poledrani et al.

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Region</th>
<th>Site</th>
<th>Blocker</th>
<th>MI (pts.)</th>
<th>30-d Fatalities</th>
<th>30-d Nonfatal MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schousboe et al. 2010</td>
<td>105</td>
<td>Europe</td>
<td>Copenhagen</td>
<td>Atenolol</td>
<td>71</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Généreux et al. 2012</td>
<td>85</td>
<td>Europe</td>
<td>London</td>
<td>Metoprolol</td>
<td>77</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Silva et al. 2009</td>
<td>109</td>
<td>Brazil</td>
<td>Sao Paulo</td>
<td>Propranolol</td>
<td>74</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Zuccaro et al. 2008</td>
<td>85</td>
<td>Europe</td>
<td>Rome</td>
<td>Metoprolol</td>
<td>77</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Duboc et al. 2009</td>
<td>109</td>
<td>Brazil</td>
<td>Sao Paulo</td>
<td>Propranolol</td>
<td>74</td>
<td>2.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Overall, 900 patients</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>75</td>
<td>2.1</td>
<td>15.9</td>
</tr>
</tbody>
</table>

Wijeysundera et al. JACC 2014; 22:2406

Perioperative Beta Blockers: Benefit with Recent CHF and MI

- Retrospective cohort study of administrative databases
- 28,263 pts with ischemic heart disease, undergoing noncardiac surgery
- Exposure: beta blocker use within 4 mos of surgery
- Outcome: 30-d MI, stroke, CV death

• **CONTINUE IF ON**

• **ONE OBSERVATIONAL STUDY SUGGESTS DECREASED MORTALITY IF STARTED 1-2 DAYS PRE-OP**

• **START IF VASCULAR SURGERY**

• **START PERIOPERATIVE IF CLINICAL INDICATIONS**
ACEI/ARB and MACE: VISION Prospective Cohort Study

Outcome | Events in Adjusted Cox Models | HR (95% CI) | p-value
--- | --- | --- | ---
Death, MNS, or stroke | 192/2184 (12.6%) vs. 149/2857 (5.8%) | 0.36 (0.26-0.50) <0.01
Death | 133/2184 (6.1%) vs. 110/2857 (3.8%) | 0.48 (0.33-0.68) <0.01
ACEI/ARB | Intraop systolic hypotension | 39/1288 (3.0%) vs. 23/1940 (1.2%) | 1.00 (0.62-1.60) 0.96
| Intraop diastolic hypotension | 72/1288 (5.6%) vs. 42/1940 (2.1%) | 1.35 (0.90-2.03) 0.17
| Postop systolic hypotension | 111/1288 (8.6%) vs. 53/1940 (2.7%) | 3.04 (2.05-4.46) <0.01
| Postop diastolic hypotension | 204/1288 (16.0%) vs. 105/1940 (5.4%) | 3.19 (2.22-4.67) <0.01

Roshanov PS, Anesthesiology. 2017;126(1):16-27
Management of Anticoagulants

Assess bleeding risk: Procedure and Patient risk factors

Assess thrombotic risk: Indications for anticoagulation
Assess bleeding risk: PROCEDURE

**Very high risk-Closed space**
- CNS
- Intraocular procedures

**High risk-High blood loss**
- Aortic, cardiac, hepatic
- *Some* abdominal, urologic, Pulmonary, ENT, GYN, plastic/reconstructive

**Moderate risk- low to mod blood loss**
- Most peripheral limb orthopedic, peripheral vascular
- *Most* abdominal, pulmonary, ENT, GYN, plastic/reconstructive

**Low risk- min blood loss or easy local control**
- Minor surgery- skin, dental, cataract

Baron TH. NEJM  2013; 368:2113-24
Doherty JU. JACC  2017; S0735-1097 (16)
Indications for Anticoagulant Tx

**Chronic Atrial Fibrillation:** CHADS2/CHA2DSVLA score
- CHF = 1 point
- HTN = 1 point
- Age >75 = 1 point
- Diabetes = 1 point
- Stroke/TIA = 2 points
(Vascular dz = 1, Age 65-74=1, Sc = female = 1)

**Prosthetic cardiac valve**
- Mechanical vs. bioprosthetic
- Mitral vs Aortic
- Presence/absence of AF or atrial dilation

**PE/DVT**
- Time of diagnosis of VTE
- Presence/absence of hypercoaguable state
When to stop Anticoagulants?

D/C anticoagulant 3-5 t1/2 before surgery

- **Warfarin**: t 1/2 = 36-42 h
  - If INR 2-3->D/C 5 days before surgery; may adjust according
    - to baseline INR
    - Check INR 24 h before surgery: target <1.5

- **LMWH**: t1/2 = 4.5-7 h
  - D/C 24h before surgery; adjust according to renal clearance

- **Unfractionated heparin**: t1/2 = 05-2.5 h
  - D/C 6 h before surgery

- **Direct oral anticoagulants (DOAC)**
  - **Dabigatran**: t1/2 = 15-30 h
    - D/C 3-5 days before surgery; adjust according to renal clearance
  - **Rivaroxaban, apixaban, edoxaban**: t1/2=7-17 h
    - D/C 2-3 days before surgery
When to bridge?

- Bridge High Risk patients and ? Mod-High risk
- Multidisciplinary decision
- Patient input and acceptance
Post-op Pulmonary Complications

PPC
Post-operative Pulmonary Complications (PPCs)

LACK OF A STANDARDIZED DEFINITION

~3-10% of patients undergoing major surgery will experience PPC:

- Pneumonia
- Bronchospasm
- Respiratory failure
- Atelectasis
- Significant Pleural effusion
- Aspiration
- Failed extubation
- Early Reintubation

## Risk factors for Perioperative Pulmonary Complications

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Relative Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ≥ 70</td>
<td>7.46</td>
</tr>
<tr>
<td>Age 50 - 69</td>
<td>4.14</td>
</tr>
<tr>
<td>Age 30 - 49</td>
<td>2.29</td>
</tr>
<tr>
<td>COPD</td>
<td>3.13</td>
</tr>
<tr>
<td>GA &gt; 180 min.</td>
<td>1.52</td>
</tr>
<tr>
<td>Major abd. surg</td>
<td>3.90</td>
</tr>
<tr>
<td>Emergency surg</td>
<td>3.49</td>
</tr>
</tbody>
</table>

*Obesity is not a risk factor*

PPCs, Mortality, and LOS After Noncardiothoracic Surgery

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>22 (1.8)</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>4 (0.3)</td>
</tr>
<tr>
<td>Atelectasis</td>
<td>206 (17.1)</td>
</tr>
<tr>
<td>Pleural effusion</td>
<td>116 (9.7)</td>
</tr>
<tr>
<td>Bronchospasm</td>
<td>13 (1.1)</td>
</tr>
<tr>
<td>ARDS</td>
<td>2 (0.2)</td>
</tr>
</tbody>
</table>
| Respiratory dysfunction requiring prolonged (>1 d) PO
  
  by nasal cannula                                   | 235 (19.6)|
  
  by face mask                                      | 12 (1.0)|
  
  PO noninvasive ventilation                        | 46 (3.8)|
  
  reintubation + PO mechanical ventilation          | 21 (1.7)|
  
  at least 1 PPC                                    | 401 (33.4)|

- 7 US academic institutions, prospective,
- 1202 pts, ASA 3, Non-CT surgery, ≥ 2 hours of GA
- Nonmodifiable risk factors: emergency; surgical site (abdominal vs non-abdominal): age
- Potentially modifiable risk factors: colloid use; preop oxygenation; blood loss; anesthesia duration; tidal volume

Fernandez-Bustamante JAMA Surgery Published online November 9, 2016
Post-Operative induced respiratory depression (POIRD)

PREVENTABLE WITH BETTER ASSESSMENT OF SEDATION LEVEL, MONITORING OF OXYGENATION AND VENTILATION, AND EARLY RESPONSE AND INTERVENTION

- 90% of POIRD occurs within 24 hours of surgery
- 97% preventable with better monitoring and response
- Risk factors: multiple prescribers, use of sedating meds, inadequate nursing assessment and response

Lee Anesthesiology 2015; 122: 659-65
Postoperative Hypoxemia

COMMON, UNDERESTIMATED, AND SUSTAINED

- \(O_2\) sat recorded at 1-minute intervals in 1500 patients > 45 yo for up to 48 hours after noncardiac surgery
- **Common**: 21% pts had ≥ 10 min/h with \(SpO2\) values < 90%; 8% ≥ 20 min/h < 90%; and 8% ≥ 5 min/h < 85%
- **Sustained** hypoxia common: 37% pts had at least 1 \(SpO2\) < 90% for an hour or more; 11% had at least 1 episode lasting ≥ 6 hours; and 3% had saturations < 80% for at least 30 min
- Hypoxemia, according to medical records, occurred in 5% of monitored pts; nurses missed 90% of hypoxemic episodes in which saturation was < 90% > 1 hour

McAlister Am J Respir Crit Care Med 2005; 171:514-517
PPC prevention

- Wear CPAP/BiPAP in sleep apnea
- Optimize bronchodilators and steroids
- Optimize nutrition
- Stop smoking
- Consider spirometry post op
- Alert anesthesia to high risk Asthma patients
  - Systemic steroids within 6 months
  - Long term high dose ICS
Delirium

Avoiding delirium is more successful than treating it
Symptoms of Delirium in Approximate Order of Specificity

1. Instability of mental status findings over time.
2. Non-auditory hallucinations
   (visual hallucinations are symptoms of delirium until proven otherwise)
4. Impaired attention.
5. Disorientation.
6. Impaired level of consciousness.
7. Auditory hallucinations.
8. Delusions.
9. Affective symptoms.

Causes of Delirium: Almost Anything!

- I - Infection
- W - Withdrawal
- A - Acute metabolic
- T - Trauma
- C - CNS pathology
- D - Deficiencies
- E - Endocrine
- A - Acute vascular/MI
- T - Toxins/Drugs
- H - Heavy Metals
Avoiding delirium is more successful than treating it.

Risk factors for delirium
NICE pathway

- 65 years or older
- Cognitive impairment (past or present) and/or dementia
- Current hip fracture
- Severe illness (a clinical condition that is deteriorating or is at risk of deterioration)

*Patients with delirium need a MEDICAL EVALUATION*
AVOIDING DELIRIUM IS MORE SUCCESSFUL THAN TREATING IT

Avoid meds that cause delirium

Commonly Used Medications
Associated with Postoperative Delirium

<table>
<thead>
<tr>
<th>Drug class or drug</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drugs with anticholinergic</td>
<td>Tricyclic antidepressants: amitriptyline, doxepin, imipramine</td>
</tr>
<tr>
<td>properties</td>
<td>Antihistamines: cyproheptadine, diphenhydramine, hydroxyzine</td>
</tr>
<tr>
<td></td>
<td>Antimuscarinics: oxybuprocaine, isobutylisopropylmethylxanthine</td>
</tr>
<tr>
<td></td>
<td>Antispasmodics: hyoscyamine, scopolamine</td>
</tr>
<tr>
<td></td>
<td>First-generation antipsychotics: chlorpromazine, thioridazine</td>
</tr>
<tr>
<td></td>
<td>H₂-receptor antagonists: cimetidine, ranitidine</td>
</tr>
<tr>
<td>Skeletal muscle relaxants</td>
<td>cyclobenzaprine, tiapride, perazine</td>
</tr>
<tr>
<td>Antiemetics</td>
<td>promethazine</td>
</tr>
<tr>
<td>Olanzapine</td>
<td></td>
</tr>
<tr>
<td>Venlafaxine</td>
<td></td>
</tr>
<tr>
<td>Lorazepam</td>
<td></td>
</tr>
<tr>
<td>Flunitrazepam</td>
<td></td>
</tr>
<tr>
<td>Metyrapone</td>
<td></td>
</tr>
<tr>
<td>Mepiridine</td>
<td></td>
</tr>
<tr>
<td>Sedative hypnotics</td>
<td>Benzodiazepines: alprazolam, diazepam, lorazepam, midazolam</td>
</tr>
<tr>
<td>Sedative – hypnotics</td>
<td>zolpidem, zaleplon</td>
</tr>
<tr>
<td>Polypharmacy</td>
<td>Starting ≥ 5 new medications increase risk of delirium</td>
</tr>
</tbody>
</table>
AVOIDING DELIRIUM IS MORE SUCCESSFUL THAN TREATING IT

Pain control decreases delirium

Nerve Blockade Versus No Blockade for Hip Fracture: Effect on Delirium-Meta Analysis

<table>
<thead>
<tr>
<th>Study</th>
<th>Blockade</th>
<th>Control</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carvalho et al. (2007)</td>
<td>0.69 (0.43 - 1.10)</td>
<td>1.19 (0.78 - 1.82)</td>
<td>0.397</td>
<td>0.041</td>
<td></td>
</tr>
<tr>
<td>Marra et al. (2006)</td>
<td>0.63 (0.41 - 1.00)</td>
<td>1.32 (0.85 - 2.03)</td>
<td>0.074</td>
<td>0.053</td>
<td></td>
</tr>
<tr>
<td>Husemoller et al. (2005)</td>
<td>0.72 (0.48 - 1.07)</td>
<td>1.17 (0.77 - 1.78)</td>
<td>0.145</td>
<td>0.057</td>
<td></td>
</tr>
<tr>
<td>Barba et al. (2010)</td>
<td>0.60 (0.39 - 0.94)</td>
<td>1.27 (0.83 - 1.95)</td>
<td>0.095</td>
<td>0.071</td>
<td></td>
</tr>
</tbody>
</table>

Note: The odds ratio for nerve blockade is significantly lower than for control, indicating a protective effect against delirium.
MCI decreases delirium

AVOIDING DELIRIUM IS MORE SUCCESSFUL THAN TREATING IT
AVOIDING DELIRIUM IS MORE SUCCESSFUL THAN TREATING IT

MCI decreases delirium

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Standardized Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td>Orientation protocol: board with names of care team members and day's schedule, communication to reorient to surroundings.</td>
</tr>
<tr>
<td>Impairment</td>
<td>Therapeutic activities protocol: cognitively stimulating activities thrice daily (eg. discussion of current events or word games)</td>
</tr>
<tr>
<td>Sleep deprivation</td>
<td>Nonpharmacologic sleep protocol: at bedtime, warm milk or herbal tea, relaxation tapes or music, and back massage.</td>
</tr>
<tr>
<td></td>
<td>Sleep-enhancement protocol: unit wise noise reduction strategies, and adjust schedules to allow sleep (eg. medications and procedures)</td>
</tr>
<tr>
<td>Immobility</td>
<td>Early mobilization protocol: ambulation or active range of motion exercises thrice daily, minimal use of immobilizing equipment.</td>
</tr>
<tr>
<td>Visual impairment</td>
<td>Vision protocol: visual aids (glasses or magnifying lens) and adaptive equipment (eg. large print books) with daily reinforcement of their use.</td>
</tr>
<tr>
<td>Hearing impairment</td>
<td>Hearing protocol: portable amplifying devices, ear wax removal, and special communication techniques with daily reinforcement of these adaptations.</td>
</tr>
<tr>
<td>Dehydration</td>
<td>Dehydration protocol: early recognition of dehydration and volume repletion (encourage oral intake of fluids).</td>
</tr>
</tbody>
</table>