

# Managing Cardiac & Pulmonary Risk in the Surgical Patient

Hugo Quinny Cheng, MD

Division of Hospital Medicine

University of California, San Francisco

# Preoperative Evaluation Guidelines

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## Cardiac:

Fleisher L *et al.* 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery (2014). *J Am Coll Cardiol.* doi: 10.1016/j.jacc.2014.07.944.

## Pulmonary:

Qaseem A *et al.* Risk assessment for and strategies to reduce perioperative pulmonary complications for patients undergoing noncardiothoracic surgery: a guideline from the American College of Physicians. *Ann Intern Med*, 2006; 141:575-80.

# Preoperative Cardiac Evaluation

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1. Is this patient at increased risk for perioperative cardiac complications?
2. Does the patient need further preoperative medical tests to clarify this risk?
3. What should be done to reduce the risk of cardiac complications?

# Clinical Risk Prediction

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What increases this patient's risk for perioperative cardiac complications?

70-y.o. man with progressive weakness due to cervical myelopathy need spinal decompression & fusion. He needs help with some ADLs and walks slowly with a cane.

He has stable coronary artery disease & HTN

He is an active smoker.

# Question 1: What increases this patient's risk for perioperative cardiac complications?

1. History of coronary disease
2. History of HTN
3. Current smoker
4. Limited functional status
5. All of the above

# Identifying Higher Risk Patients

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Known cardiovascular disease predicts risk

Atherogenic risk factors (**except diabetes**) do not

<u>Risk Factor</u>	<u>Odds Ratio</u>
Ischemic heart disease	2.4
Congestive heart failure	1.9
Diabetes	2.8
History of Stroke or TIA	3.2
<i>Poor functional status</i>	<i>1.8</i>

# Surgery Specific Risk

## High

(> 5 % risk)

Major aortic or peripheral vascular surgery  
Emergent major surgery  
Long cases w/ large fluid shifts or blood loss

## Intermediate

(< 5 % risk)

Carotid endarterectomy  
Head & Neck  
Abdominal & Thoracic  
Orthopedic

## Low

(< 1% risk)

Endoscopic procedures  
Skin & Breast

# Revised Cardiac Risk Index

## Predictors:

- Ischemic heart disease
- Congestive heart failure
- Diabetes requiring insulin
- Creatinine > 2 mg/dL
- Stroke or TIA
- “High Risk” operation  
(intraperitoneal, intrathoracic,  
or suprainguinal vascular)

# of RCRI Predictors	Complications <i>MI &amp; cardiac arrest</i>
0	0.4%
1	1%
2	2.4%
≥ 3	5.4%

**RCRI ≥ 2 is “Elevated Risk”**



# NSQIP Cardiac Risk Prediction Tool

Derived from National Surgical Quality Improvement Program (NSQIP) database:

- > 400,000 patients in derivation & validation cohorts
- Wide range of operations
- “Complication” = 30-day incidence of MI & cardiac arrest

Independent  
Predictors

1. Type of surgery
2. Age
3. Serum creatinine > 1.5 mg/dL
4. Functional status (dependency for ADLs)
5. American Society of Anesth (ASA) class

# What is ASA Classification?

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## American Society of Anesthesiologists Physical Classification:

1. Healthy, normal
2. Mild systemic disease
3. Severe systemic disease
4. Severe systemic disease that is a constant threat to life
5. Moribund patient not expected to survive without surgery

# Gupta Perioperative Cardiac Risk

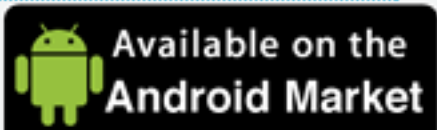
By clicking on the "Submit" button below, you acknowledge that you have read, understand, and agree to be bound by the terms of the [QxMD Online Calculator End Agreement](#).

**Estimate risk of perioperative myocardial infarction or cardiac arrest.**

Age	<input type="text" value="70"/>
Creatinine	<input type="text" value=" &lt;1.5 mg/dL / 133 µmol/L"/>
ASA Class	<input type="text" value="ASA 3"/>
	ASA 1 = Normal healthy patient ASA 2 = Patients with mild systemic disease ASA 3 = Patients with severe systemic disease ASA 4 = Patients with severe systemic disease that is a constant threat to life ASA 5 = Moribund patients who are not expected to survive without the operation
Preoperative Function	<input type="text" value="Partially Dependent"/>
Procedure	<input type="text" value="Spine"/>
	<input type="button" value="Submit"/>

## NSQIP Cardiac Risk Calculator

Install this Calculator On Your Smartphone or iPad for Free



[www.qxmd.com/calculate-online/cardiology/gupta-perioperative-cardiac-risk](http://www.qxmd.com/calculate-online/cardiology/gupta-perioperative-cardiac-risk)

70-y.o. with h/o CAD, now undergoing cervical spine surgery. Needs help with some ADLs.

Age 70

Cr < 1.5

ASA Class 3

Partially dependent

Spine surgery

### Estimate risk of perioperative myocardial infarction or cardiac arrest.

Age

Creatinine

ASA Class

ASA 1 = Normal healthy patient

ASA 2 = Patients with mild systemic disease

ASA 3 = Patients with severe systemic disease

ASA 4 = Patients with severe systemic disease that is a constant threat to life

ASA 5 = Moribund patients who are not expected to survive without the operation

Preoperative Function

Procedure

[www.qxmd.com/calculate-online/cardiology/gupta-perioperative-cardiac-risk](http://www.qxmd.com/calculate-online/cardiology/gupta-perioperative-cardiac-risk)

70-y.o. with h/o CAD undergoing cervical spine surgery for progressive weakness.

Estimated risk of perioperative myocardial infarction or cardiac arrest: **0.72%**

[www.qxmd.com/calculate-online/cardiology/gupta-perioperative-cardiac-risk](http://www.qxmd.com/calculate-online/cardiology/gupta-perioperative-cardiac-risk)

Other findings:

- Excellent performance (AUC = 0.88)

Caveats:

- Doesn't account for all available information

# Which Prediction Tool is Better?

	<b>RCRI</b>	<b>NSQIP</b>
Sample size	~ 4000	~ 400,000
# of hospitals	1	> 200
Currency of data	1989 – 94	2007 – 08
Screen for MI?	CK-MB, ECG	No

## Which to choose?

- 2014 ACC/AHA guideline endorses both tools
- Personal practice: use NSQIP when quantifying risk

# ACC/AHA: When is Risk Excessive?

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- Unstable coronary syndromes
  - Recent MI with post-infarct ischemia
  - Class III or IV angina
- Decompensated CHF
- Significant arrhythmia
  - High grade atrioventricular block
  - Symptomatic ventricular arrhythmia
  - Supraventricular arrhythmia with uncontrolled rate
- Severe valve disease (e.g., critical aortic stenosis)

# ACC/AHA: When is Risk Excessive?

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Severe or unstable cardiac disease that requires urgent evaluation & treatment, regardless of planned surgery



# Utility of Stress Testing

Is further preoperative cardiac testing indicated?

A 63 y.o. man will undergo a Whipple procedure for newly diagnosed pancreatic cancer. He had a remote myocardial infarction, diabetes, and HTN. He has not had chest pain in the past year. Fair functional capacity.

Meds: lovastatin, atenolol, glyburide, benazepril, ASA

PEx: BP=115 / 70 HR=60; normal heart & lung exam

ECG: NSR, LVH, otherwise normal

## Question 2:

63 y.o. man s/f Whipple procedure. Remote MI, long-standing diabetes & HTN. No chest pain.

Should this patient receive further preoperative tests?

1. No further testing
2. Yes, exercise stress test
3. Yes, pharmacologic stress test

# Noninvasive Stress Testing

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## Predictive value:

- Mainly studied in vascular surgery patients
- Strong negative predictive value ~ 98% (neg LR = 0.1 - 0.2)
- Weak positive predictive value ~10 - 20% (pos LR = 2 - 3)
- Adds little information to lower risk patients
- More useful for cases with increased risk

# Stress Tests: More Useful in Patients at Higher Risk

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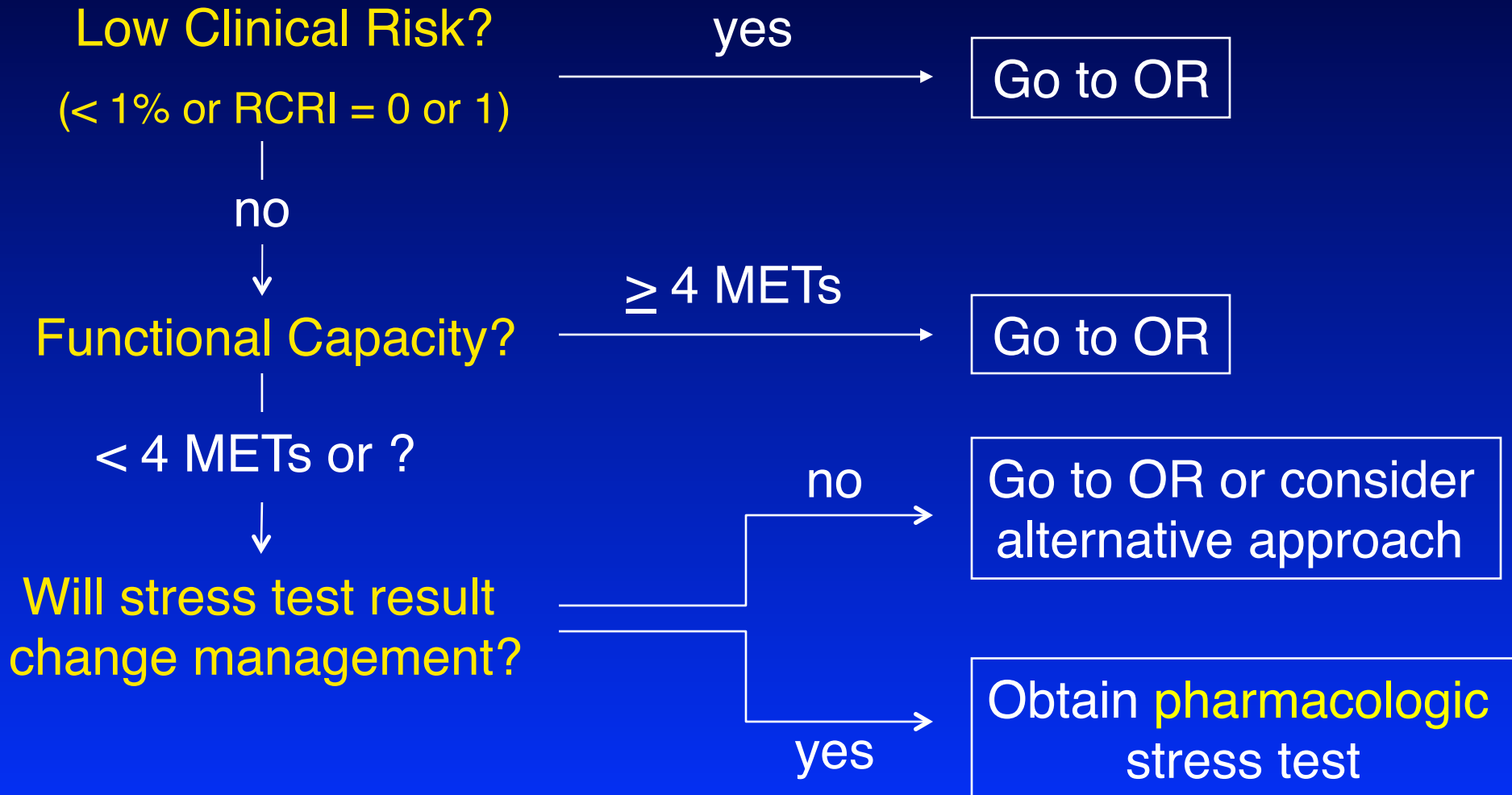
Pretest Probability = 1% (e.g. TKA)

- Positive Test: Posttest probability = 2 - 3%
- Negative Test: Posttest probability = 0 - 1%

Pretest Probability = 10% (e.g. AAA repair)

- Positive Test: Posttest probability = 18-25%
- Negative Test: Posttest probability = 2%

# 2014 ACC/AHA Guideline



# Revascularization

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Should this patient have coronary revascularization?

A 63 y.o. man pancreatic cancer is being considered for a Whipple procedure. History of remote MI, diabetes, HTN. No chest pain in the past year. Fair functional capacity. Persantine-Mibi last year showed mild inferior reversibility. Coronary cath showed a 75% RCA lesion and normal LVEF. He did not receive PCI.

## Question 3:

63 y.o. man with CAD undergoing Whipple procedure. His P-Mibi showed mild inferior reversibility. Angiogram showed a 75% RCA lesion and normal LVEF.

1. No, proceed to surgery
2. Consult cardiologist for possible PCI

# CARP Trial: Coronary Artery Revascularization Prophylaxis

510 patients undergoing vascular surgery

- At least 1 vessel with 70% occlusion
- Excluded left main dz, AS, or LVEF < 20%

Choice of CABG or PCI  
plus  
Medical management

Medical management  
alone

1° Endpoint: Long-term mortality  
2° Endpoint: MI, Stroke, Limb loss, Dialysis



# CARP: Complications After CABG or PCI

Complication	%
Mortality	1.7%
MI	5.8%

# CARP: Outcomes After Vascular Surgery

	Revascularized (n=225)	Med Mgt Only (n=237)
Death before surgery	10 (4%)	1
Death < 30 days post-op	7 (3%)	8 (3%)
Postoperative MI	26 (12%)	34 (14%)
Long-term mortality (2.7 yrs after randomization)	70 (22%)	67 (23%)

p = NS for all comparisons

# ACC/AHA Guidelines for PCI

- Indications for PCI are same as for nonsurgical patients
- Avoid PCI if antiplatelet drugs will need to be held prematurely
- Delay elective surgery after elective PCI:
  - Bare metal stent: 30 days
  - Drug eluting stent: 6 months (optimal)  
3 months (if harm in delay)
- Continue or restart antiplatelet agents (especially ASA) as soon as possible, unless bleeding risk precludes

# Medical Management

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Question 4:

Which medication(s) should be given before surgery?

80-y.o. woman with a remote stroke, diabetes, and HTN will undergo repair of hip fracture. She has been out of care, and she is not taking any medications other than metformin for diabetes.

1. Metoprolol
2. Aspirin
3. Atorvastatin

# Rise & Fall of Beta-blockers

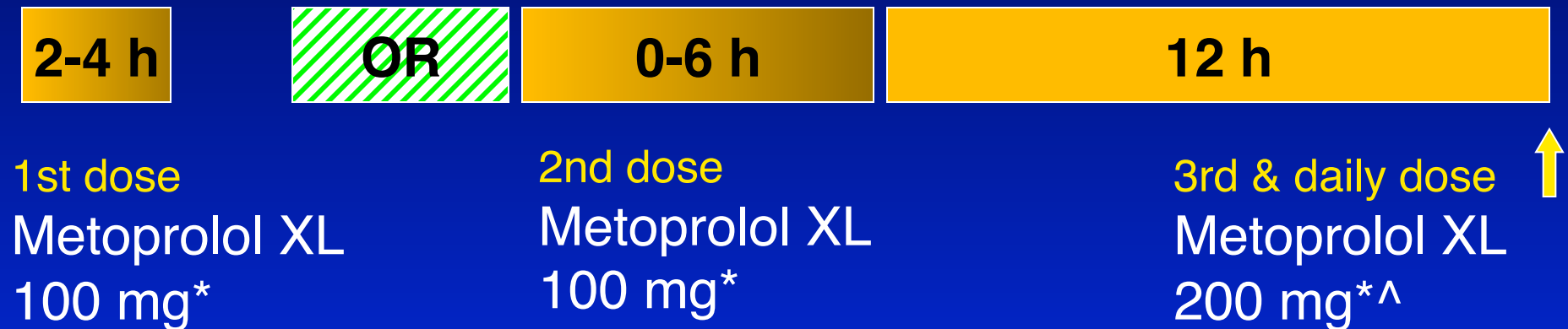
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- Early trials showed that starting beta-blockers prevented postoperative MI and reduce mortality
- Subsequent studies less impressive, and some positive studies discredited for fraud
- Largest study found small benefit on MI prevention, but increased overall mortality

# POISE: Biggest $\beta$ -blocker Trial

Patients: 8351 pts with s/f major noncardiac surgery

- CAD, CHF, CVA/TIA, CKD, DM, or high-risk surgery
- Not already taking  $\beta$ -blocker

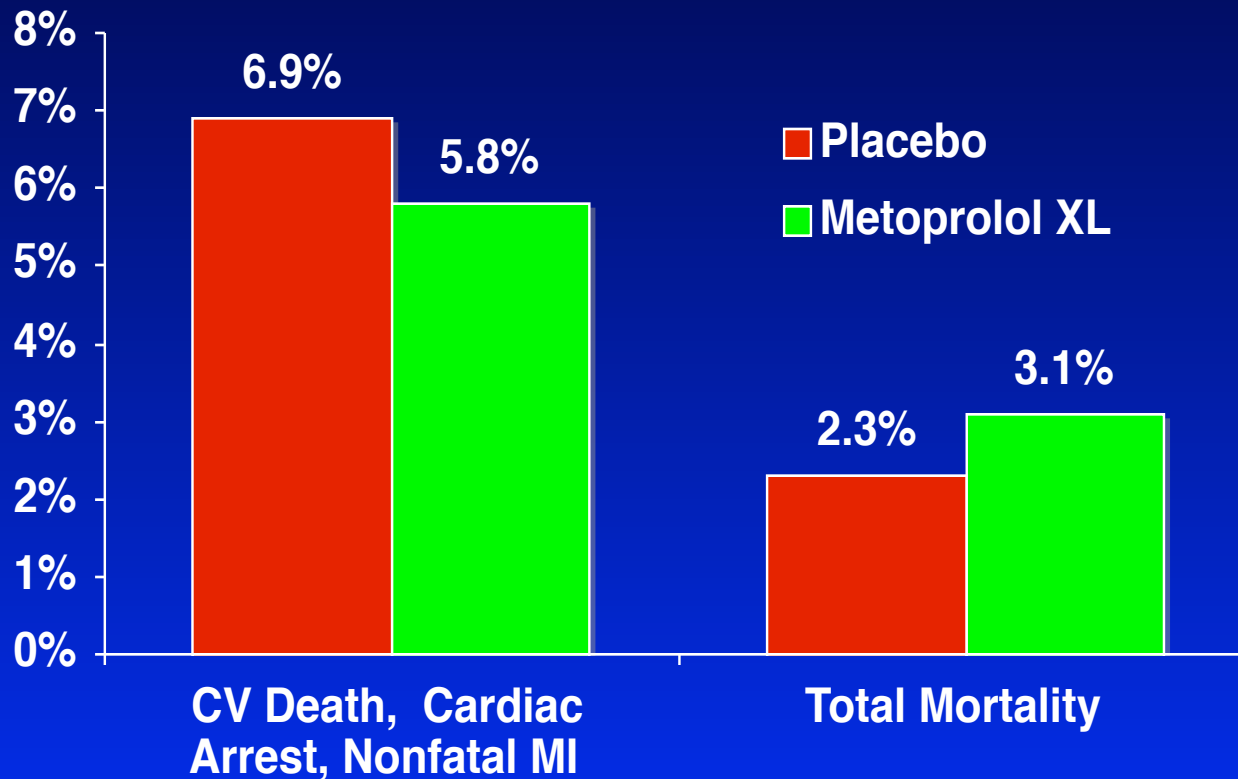


\* Study drug held for SBP < 100 or HR < 50

^ Daily dose reduced to 100 mg if persistent bradycardia or hypotension

Outcome: 30-day cardiac mortality, nonfatal arrest or MI

# POISE Trial Results



Metoprolol XL:  
Reduced cardiac events  
(mostly nonfatal MI)

but

Increased risk of stroke  
& total mortality

# 2014 ACC / AHA Guideline for $\beta$ -blockers

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## Definite indications to continue if... (Helps)

- Already using  $\beta$ -blocker to treat angina, HTN, arrhythmia

## Reasonable to consider initiation if... (Maybe)

- High clinical risk (RCRI score  $\geq 3$ )
- Ischemia seen on preoperative stress test
- Compelling indication for long-term beta-blockade

## Avoid initiation... (Harms)

- On day of surgery



# Trial of Perioperative Aspirin (POISE 2)

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## Before surgery:

- 10,100 patients with cardiac disease or risk factors undergoing major noncardiac surgery
- Aspirin 200 mg or placebo started right before surgery

## After surgery:

- Aspirin or placebo given daily x 30 days
- Study drug stopped if major or life-threatening bleed

# POISE 2: Aspirin Results

	<b>Aspirin</b>	<b>Placebo</b>	<b>Hazard Ratio</b>
Death or MI	7.0%	7.1%	0.99 (NS)
Non-fatal MI	6.2%	6.3%	0.98 (NS)
Major Bleeding	4.6%	3.8%	1.23 (p = 0.04)

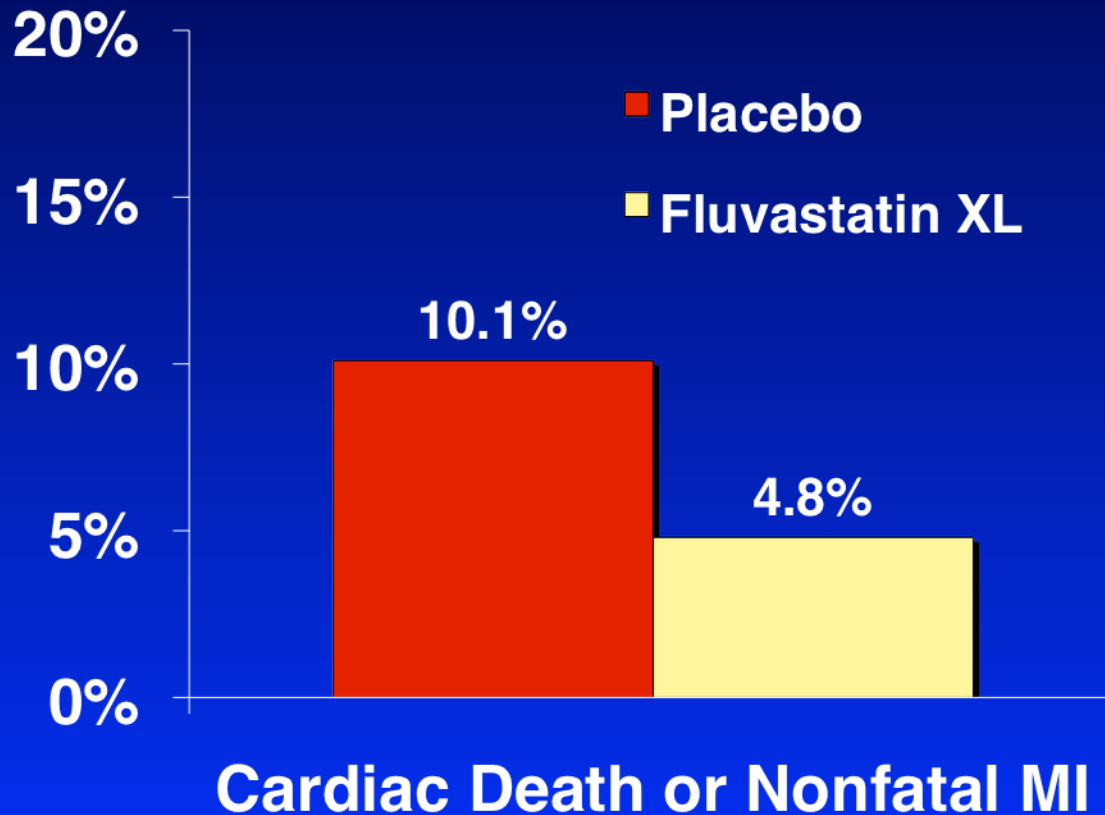
# 2014 ACC / AHA Guidelines

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## *Aspirin (for patients without stent)*

- Not unreasonable to continue ASA in elective surgery if benefits outweigh risks from bleeding (Class 2b)
- Initiation of ASA does not benefit patients undergoing elective noncardiac surgery (Class 3)

# Trial of Statins in Vascular Surgery



Reduced nonfatal MI

No difference in rates of  
LFT or CPK elevation

# 2014 ACC / AHA Guideline (Statins)

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**Definitely continue if...** (Class I)

- Patient is already taking statins chronically

**Reasonable to initiate if...** (Class 2a)

- Patient is having vascular surgery

**Not unreasonable to initiate if...** (Class 2b)

- Patient has elevated clinical risk and is undergoing a moderate or high risk operation

# Take Home Points

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Use a validated clinical prediction tool:

- RCRI is easy to use & has become the “new standard”
- NSQIP tool may be more broadly applicable

Reserve stress testing for highest risk patients:

- Elevated risk and poor functional status
- Only do stress test if results will change management (e.g., cancel, delay, or modify surgery)

# Take Home Points

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Beware perioperative coronary revascularization:

- Indications are the same as for non-surgical patients
- Don't perform PCI if patient may have upcoming surgery that requires stopping antiplatelet therapy

Medical management:

- Only consider starting in very high risk patients after considering risks, and not immediately before surgery
- Possible role for initiating statin





# Preoperative Pulmonary Evaluation

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1. Is this patient at increased risk for perioperative pulmonary complications?
2. Does the patient need further preoperative medical tests to clarify this risk?
3. What should be done to reduce the risk of pulmonary complications?

# Pulmonary Risk Prediction

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What do you recommend for this patient?

A 65 y.o. man is to undergo repair of an abdominal aortic aneurysm. He has COPD and continues to smoke. He denies change in cough, or worsening of his chronic dyspnea when walking uphill.

Exam:            Resp Rate 20      O<sub>2</sub> sat 95% RA  
                  Lungs: prolonged expiration, no wheeze

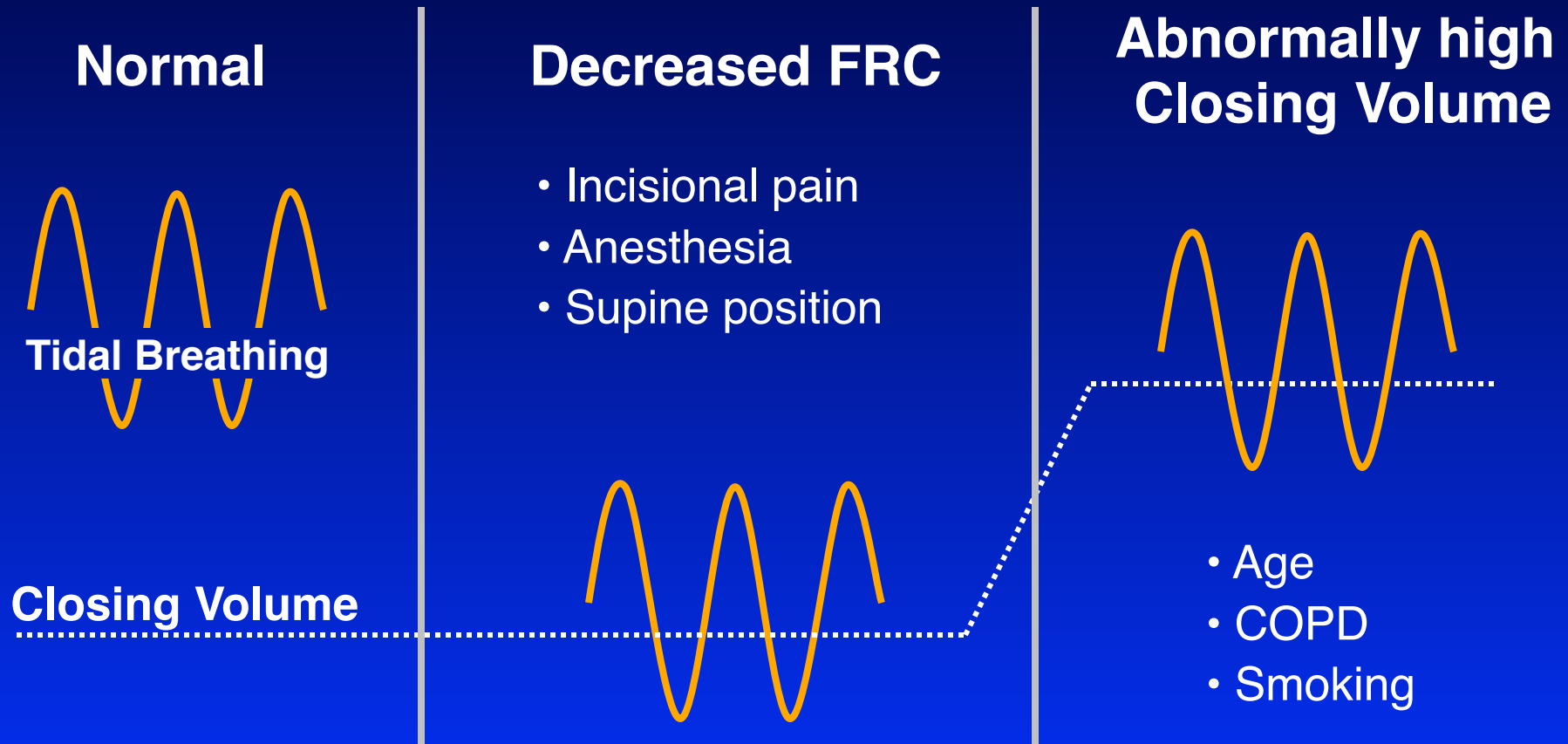
## Question 5:

65 y.o. man is s/f repair of an AAA. He has COPD and smokes. No change in cough or usual chronic dyspnea.

Which of the following will be **most** helpful?

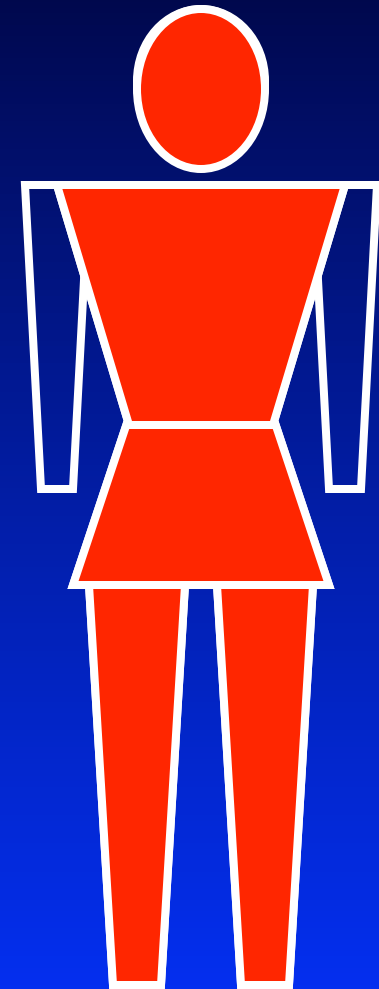
1. Obtain PFTs
2. Quit smoking first before surgery
3. Incentive spirometry after surgery

# Pathophysiology of Postoperative Pulmonary Complications



# Procedure Related Risk Factors

	<u>Risk Factor</u>	<u>Odds Ratio</u>
Surgical Site	Neurosurgery	2.5
	Head & Neck	2.2
	<b>Aortic</b>	<b>6.9</b>
	<b>Thoracic</b>	<b>4.2</b>
	<b>Abdominal</b>	<b>3.0</b>
	Vascular	2.1
	Emergency surgery	2.2
	Prolonged surgery	2.3
	General anesthesia	1.8



# Patient Related Risk Factors

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<u>Risk Factor</u>	<u>Odds Ratio</u>
Age 60 - 69	2.3
70 - 79	5.6
Congestive heart failure	2.9
COPD	2.4

ASA Class  $\geq$  II vs. Class I

Odds ratio = 4.9

ASA Class  $\geq$  III vs. Class I or II

Odds ratio = 3.1

Class I: no systemic disease

Class II: mild systemic disease

Class III: severe systemic disease

Class IV: systemic disease that is a constant threat to life

# Respiratory Failure Prediction Tool

- Derived from National Surgical Quality Improvement Program (NSQIP) database:
  - > 400 K patients in derivation & validation cohorts
  - Wide range of operations
  - “Respiratory Failure” = on vent > 48 hrs or reintubation

## **Independent Predictors**

1. American Society of Anesth (ASA) class
2. Functional status (dependency)
3. Type / location of surgery
4. Emergency surgery
5. Preoperative sepsis or SIRS

# [www.qxmd.com/calculate-online/respirology/postoperative-respiratory-failure-risk-calculator](http://www.qxmd.com/calculate-online/respirology/postoperative-respiratory-failure-risk-calculator)

Emergency surgery?  
**No**

ASA Class  
**3 (severe systemic)**

Function/dependency  
**Independent**

Surgery type **Aortic**

Sepsis or SIRS? **No**

**Estimate risk of postoperative respiratory failure.**

Emergency case?

ASA Class

ASA 1 = Normal healthy patient  
ASA 2 = Patients with mild systemic disease  
ASA 3 = Patients with severe systemic disease  
ASA 4 = Patients with severe systemic disease that is a constant threat to life  
ASA 5 = Moribund patients who are not expected to survive without the operation

Preoperative Function

Procedure

Sepsis



[www.qxmd.com/calculate-online/respirology/  
postoperative-respiratory-failure-risk-calculator](http://www.qxmd.com/calculate-online/respirology/postoperative-respiratory-failure-risk-calculator)

Emergency surgery?

No

ASA Class

3 (severe systemic)

Function/dependency

Independent

Surgery type Aortic

Sepsis or SIRS? No

**Estimated risk of postoperative  
respiratory failure: 6.7 %**

# Pulmonary Function Tests & Spirometry

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PFT & spirometry add little to risk assessment

- Usually just tells you what you already know
- Abnormal chest exam findings more predictive of PPC
- Can't use results to identify patients with prohibitively high risk of PPC or mortality
- Use as diagnostic tool to evaluate unexplained findings

# Preoperative Prevention Strategies

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## Optimize chronic lung disease

- Treat COPD exacerbation (steroids, antibiotics)

## Smoking cessation

- Limited evidence for benefit for PPC but other benefits
- May require 8 weeks of cessation for benefit

## Respiratory conditioning

- Education on lung expansion & Inspiratory muscle training
- Benefit seen in RCTs in cardiac surgery

# Preoperative Smoking Cessation Counseling

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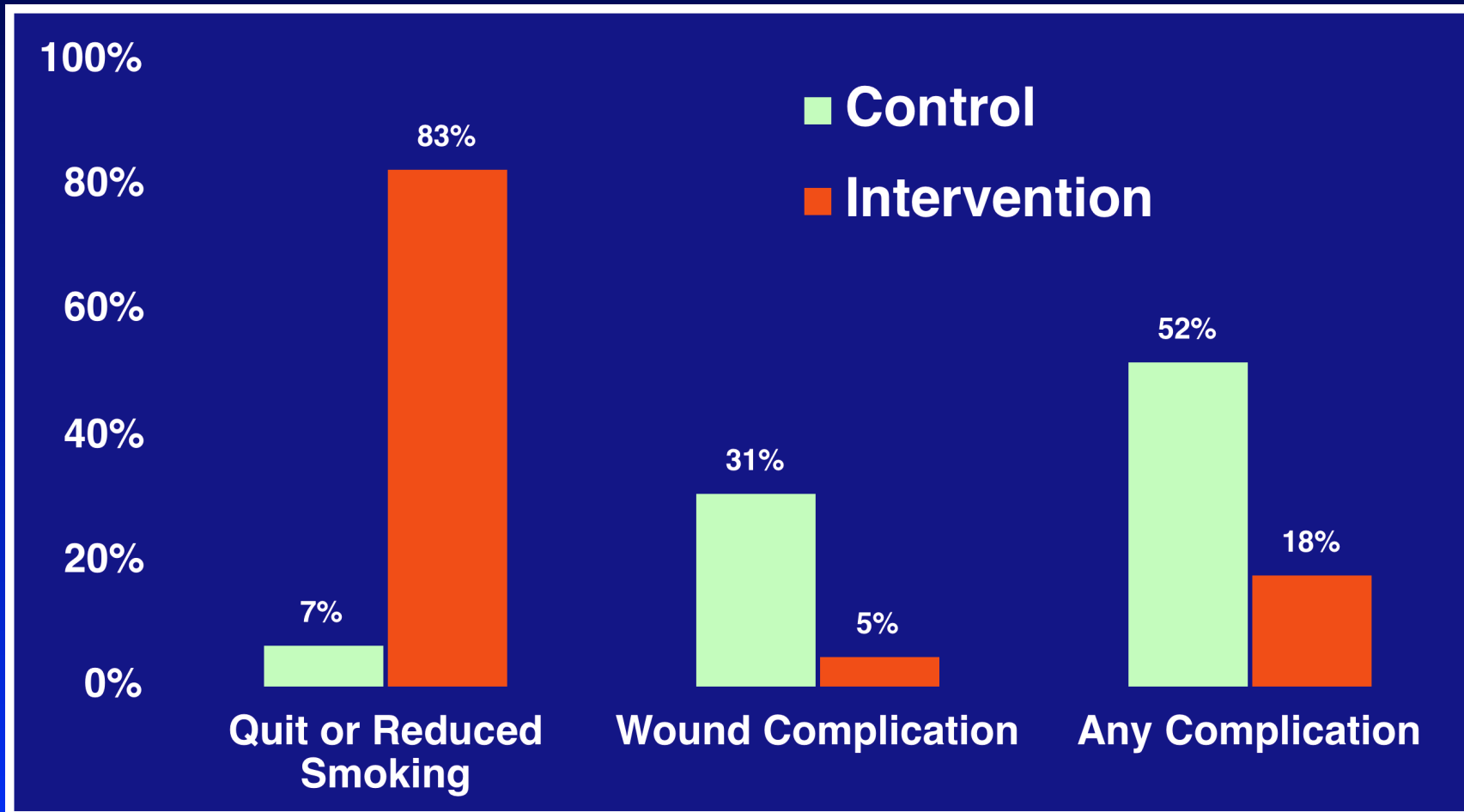
## RCTs of Preoperative Smoking Cessation Counseling:

1. 120 patients undergoing arthroplasty in 6-8 weeks
2. 60 patients undergoing colorectal resection in 2-3 weeks

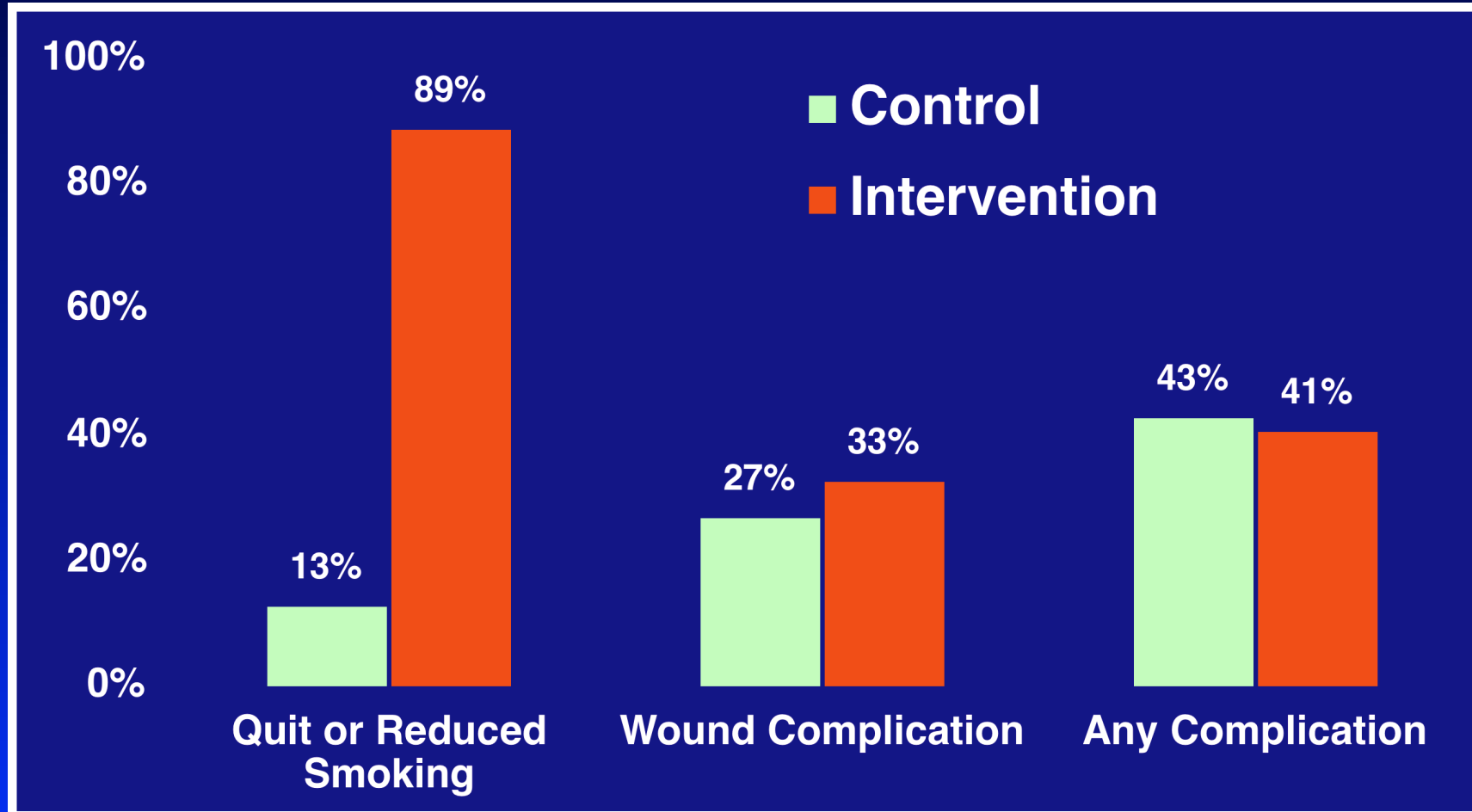
**Intervention:** Smoking cessation counseling & offer free nicotine replacement products

**Outcomes:** Postop complications, especially wound related (e.g., dehiscence, infection, hematoma)

# Smoking Cessation 6-8 Weeks Before TKA or THA



# Smoking Cessation 2-3 Weeks Before Colorectal Surgery



# Postoperative Prevention Strategies

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## Lung expansion maneuvers

- Deep breathing or incentive spirometry recommended, though quality of evidence poor
- Consideration of CPAP for very high risk patients

## I COUGH – a multi-intervention strategy to prevent PPC

- Incentive spirometry, **C**oughing & deep breathing, **O**ral care, **U**nderstanding, **G**et out of bed tid, **H**ead of bed elevated
- Reduced postop pneumonia and unplanned reintubation

# Causes of Postoperative Hypoxemia

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## Upper airway obstruction

- Early onset - often POD 0 or prior to leaving PACU
- Airway edema, vocal cord injury, laryngospasm, OSA

## Atelectasis

- Often onset POD 1-2
- Secretion management: chest therapy, pulmonary toilet
- Positive airway pressure: CPAP, BiPAP, EzPAP

## Pulmonary edema

- Often onset by POD 2
- Cardiogenic vs. non-cardiogenic



# Causes of Postoperative Hypoxemia

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## Pneumonia

- Most common in first 5 days postop (unless on ventilator)
- Think Staph aureus & gram negative rods
- Pseudomonas? Risk with  $\geq 5$  days hospitalization or prior antibiotic exposure, dialysis, nursing home

## Other etiologies:

- Pulmonary embolism
- Bronchospasm
- Effusions – common after abdominal surgery, usually small, exudative and usually don't require treatment

# Take Home Points

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## Patient related risks:

- Elderly
- COPD
- Severe medical comorbidity
- Functionally dependent or generally debilitated

## Procedure related risks:

- Thoracic surgery
- Abdominal surgery
- Emergency surgery
- Prolonged surgery > 3 hrs
- General anesthesia

# Take Home Points

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## Pulmonary function tests:

- Should not be done routinely
- Consider to help evaluate unexplained symptoms

## Risk reduction:

- Patients at increased risk for pulmonary complications should receive lung expansion maneuvers
- Smoking cessation likely beneficial but may require two months lead time to be effective

*Thank You*

quinny.cheng@ucsf.edu