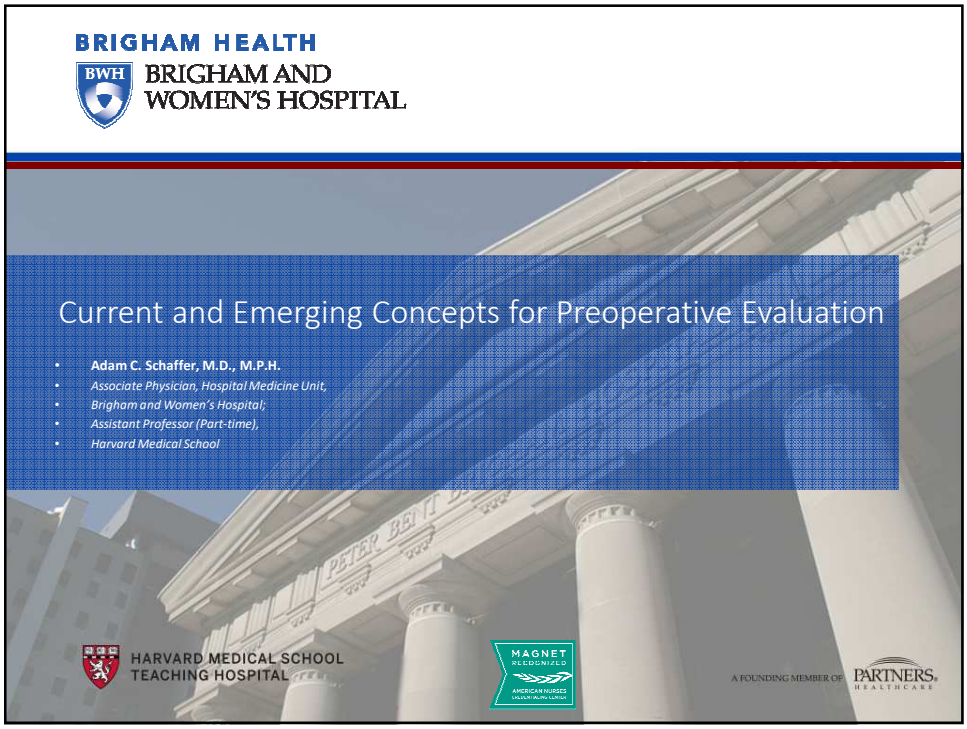

Conflicts of Interest

- I have no conflicts of interest to declare

Clinical Case

- 76-year-old male with severe COPD, on 3 L of home O_2 and chronic prednisone 7.5 mg daily, DMII on metformin, dyspnea with minimal exertion.
- No history of MI or CHF. His EKG is essentially normal.
- He has metastatic colon cancer, with a single metastasis to the brain causing left arm weakness
- You are seeing him in consultation prior to neurosurgery scheduled 48 h from now to resect the metastasis
- He underwent successful resection of a colon mass 3 years ago

Introduction

- The role of the clinician performing preoperative evaluation is **not** to provide medical "clearance" prior to surgery
- Instead, the clinician should:
  - Assess the patient's cardiac and other risks going into the procedure
  - Decide whether additional preoperative testing, such as a cardiac stress test, is needed
  - When indicated, recommend measures to reduce perioperative risk, such as beta blockers and statins
  - Assist the surgeon in deciding whether to go forward with the procedure

The Current Preop Guidelines were Published in 2014

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association.

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

Lee A. Fleisher, Kirsten E. Fleischmann, Andrew D. Auerbach, Susan A. Barnason, Joshua A. Beckman, Biykem Bozkurt, Victor G. Davila-Roman, Marie D. Gerhard-Herman, Thomas A. Holly, Garvan C. Kane, Joseph E. Marine, M. Timothy Nelson, Crystal C. Spencer, Annemarie Thompson, Henry H. Ting, Barry F. Uretsky and Duminda N. Wijeysundera

Circulation. published online August 1, 2014;
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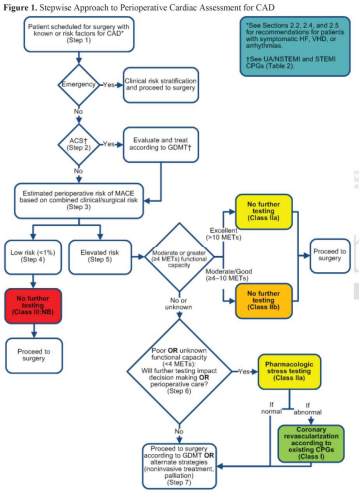
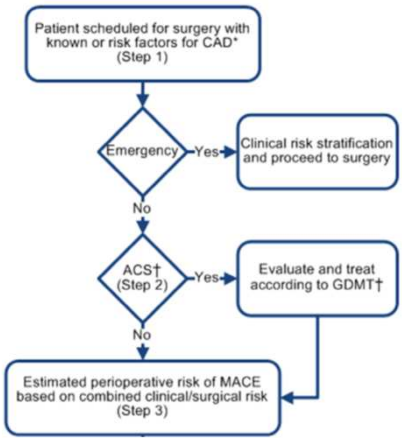
ACC/AHA 2014 Periop Guidelines

Figure 1. Stepwise Approach to Perioperative Cardiac Assessment for CAD



Source: Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management...Circulation. 2014 Dec 9;130(24):e278-333.

ACC/AHA 2014 Periop Guidelines



Source: Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management...Circulation. 2014 Dec 9;130(24):e278-333.

Risk assessment in the 2014 Guidelines

- For risk assessment, the 2014 guidelines recommend estimating the preoperative risk of a major adverse cardiac event (MACE), which here is defined as death or MI
- The risk of MACE is a function of both the risk associated with the procedure and the risk associated with the patient
- If there is a low risk of MACE, which is defined as < 1%, then one goes to surgery

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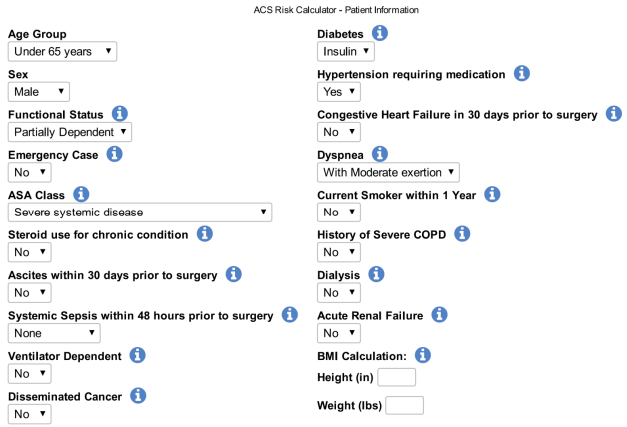
Risk assessment in the 2014 Guidelines

The new guidelines suggest three ways to determine if the MACE is ≥ 1%:

1. ACS NSQIP Surgical Risk Calculator (http://www.riskcalculator.facs.org/)
2. Perioperative Cardiac Risk Calculator (http://www.surgicalriskcalculator.com/miorcardiacarrest)
3. RCRI score (though one of the two options above is preferred because they outperform the RCRI score)

ACS NSQIP Surgical Risk Calculator



Source: Cohen ME, Ko CY, Bilimoria KY, et al. Optimizing ACS NSQIP modeling for evaluation of surgical quality and risk: .... Journal of the American College of Surgeons. Aug 2013;217(2):336-346.e331.

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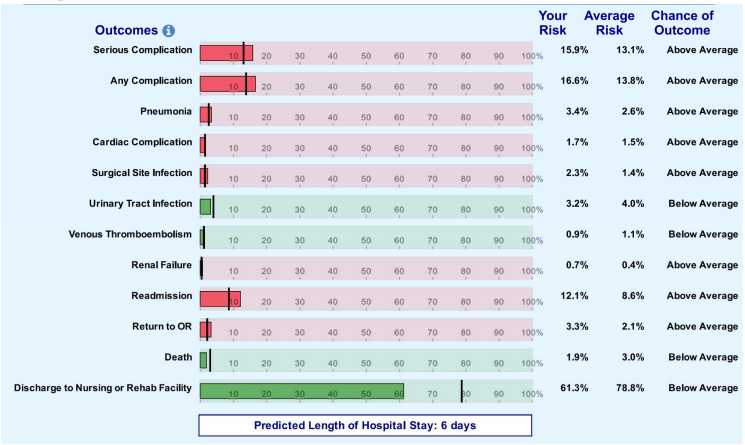
ACS NSQIP
Surgical Risk Calculator



Source: Cohen ME, Ko CY, Bilimoria KY, et al. Optimizing ACS NSQIP modeling for evaluation of surgical quality and risk: .... Journal of the American College of Surgeons. Aug 2013;217(2):336-346.e331.

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Perioperative Cardiac Risk Calculator

Estimate risk of perioperative myocardial infarction or cardiac arrest.

Age
Creatinine <1.5 mg/dL / 133 µmol/L
ASA Class ASA 1

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 Totally Independent
Procedure Anorectal
Submit

Source: Gupta PK, Gupta H, et al. Development and validation of a risk calculator for prediction of cardiac risk after surgery. Circulation. Jul 26 2011;124(4):381-387.

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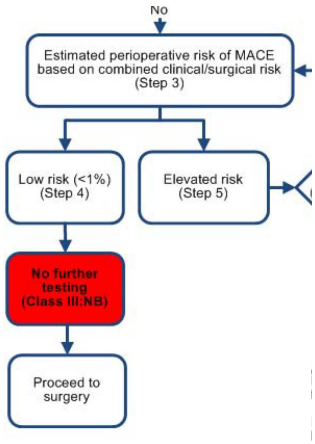
Risk Assessment: RCRI

Risk Factor	Definition
1. High-risk type of surgery	Intraperitoneal, intrathoracic, or suprainguinal vascular procedures
2. Ischemic heart disease	History of MI, positive stress test, current cardiac CP, nitrate usage, ECG with pathologic Q waves
3. History of congestive heart failure	History of CHF, pulmonary edema, or PND; rales or S3 on exam; chest x-ray with pulmonary edema
4. History of cerebrovascular disease	History of transient ischemic attack or stroke
5. Insulin therapy for diabetes	
6. Preoperative serum creatinine > 2.0 mg/dL	

- "A patient with 0 or 1 [RCRI] predictor(s) of risk would have a low risk of MACE. Patients with ≥ 2 predictors of risk would have elevated risk."

Sources: Lee TH, Marcantonio ER, Mangione CM, et al. Derivation and prospective validation of a simple index for prediction of cardiac risk of major noncardiac surgery. *Circulation*. Sep 7 1999;100(10):1043-1049.
Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management…Circulation. 2014 Dec 9;130(24):e278-333.

The 2014 preop evaluation guidelines



- Under the guidelines, if your risk of MACE is low (< 1%), then you go to surgery
- If you risk is elevated (≥ 1%), then you consider the patient's functional capacity

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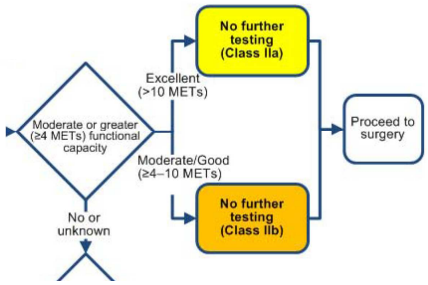
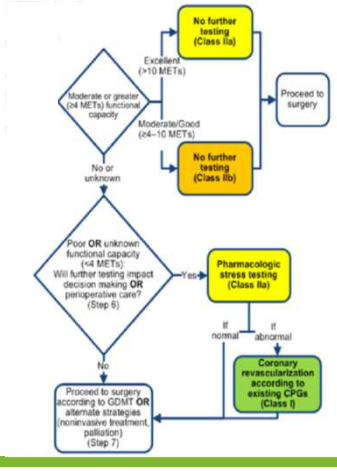
The 2014 preop evaluation guidelines



- If your functional capacity is ≥ 4 METs, then you proceed to surgery

The 2014 preop evaluation guidelines



- If your functional capacity is < 4 METs, then consider a pharmacologic stress testing, **if it will change management**
- Changing management can mean:
  - Determining the need for Coronary revascularization
  - Deciding whether to go forward with surgery

METs Value for Activities

Major Heading	Code Number	METs	Example
Bicycling	01015	8.0	Bicycling, general
Conditioning Exercises	02101	2.5	Mild stretching
Dancing	03016	8.5	Aerobic, step, with 6–8 inch step
	03017	10.0	Aerobic, step, with 10–12 inch step
	03031	4.5	Disco, folk, square, line dancing, Irish step dancing, polka, contra, and country dancing.
	03050	5.5	Anishinaabe Jingle Dancing or other traditional American Indian dancing
Home Activities	05021	3.5	Mopping
	05025	2.5	Multiple household tasks all at once, light effort
	05026	3.5	Multiple household tasks all at once, moderate effort
	05027	4.0	Multiple household tasks all at once, vigorous effort
	05043	3.5	Vacuuming
	05045	6.0	Butchering animals
	05053	2.5	Feeding animals
	05148	2.5	Watering plants
	05149	2.5	Building a fire inside
	05181	3.0	Carrying small children
	04010	4.0	fishing and hunting, digging worms, with shovel
	10010	1.8	music playing, accordion
	10020	2.0	music playing, cello
	12170	15.0	running, running, stairs, up
	09065	1.8	miscellaneous, sitting - in class, general, including note-taking or class discussion

Source: Ainsworth BE, Haskell WL, Whitt MC, et al. Compendium of physical activities: an update of activity codes and MET intensities. *Medicine & Science in Sports & Exercise.* Sep 2000;32(9 Suppl):S498-504.

Duke Activity Status Index

1. Take care of yourself by eating, dressing, bathing, toileting (2.75)
2. Walk indoors, such as around your house (1.75)
3. Walk a block or 2 on level ground (2.75)
4. Climb a flight of stairs or walk up hill (5.50)
5. Run a short distance (8.00)
6. Do light housework, such as dusting or washing dishes (2.70)
7. Do moderate housework, such as vacuuming, sweeping, or carrying groceries (3.50)
8. Do heavy housework, such as scrubbing floors or moving heavy furniture (8.00)
9. Do yard work, such as raking, weeding, or pushing a power mower (4.50)
10. Have sexual relations (5.25)
11. Moderate recreation, such as golf, bowling, dance, doubles tennis (6.00)
12. Strenuous sports, such as swimming, singles tennis, football, basketball (7.50)

Source: Hlatky MA, et al. A brief self-administered questionnaire … (the Duke Activity Status Index). The American Journal of Cardiology. 1989;64(10):651-654.

Duke Activity Status Index

- Methods to use the DASI:
  - Online METs calculators based on DASI
  - DASI scores > 34 are associated with a reduced risk of 30-d death or MI

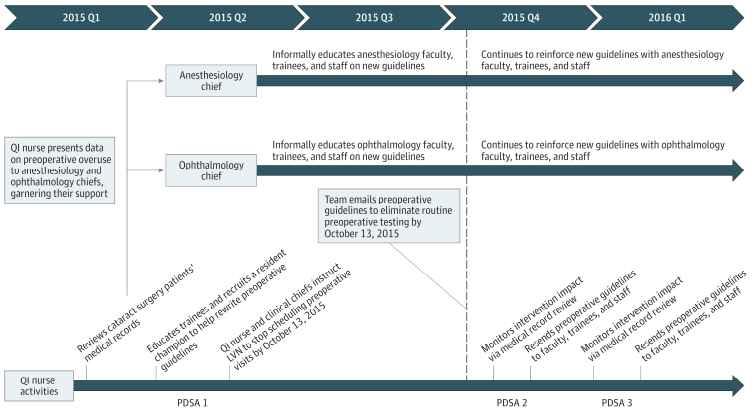
Source: Wijeysundera, et al. Integration of the Duke Activity Status Index into preoperative risk evaluation .... Br J Anaesth. 2020;124(3):261-270.

Preoperative ECGs in the 2014 ACC/AHA Guidelines

- Class IIa: Preop resting 12-lead ECG is reasonable fo patients with known coronary heart disease, signifi arrhythmia, peripheral arterial disease, cerebrovasc disease, or other significant structural heart disease except for those undergoing low-risk surgery
- Class IIb: Preop resting 12-lead ECG may be conside for asymptomatic patients without known coronary heart disease, except for those undergoing low- surgery
- Class III: Routine preop resting 12-lead ECG is not useful for asymptomatic patients undergoing low-risk surgical procedures

An Intervention to Reduce Low-Value Preoperative Care

Figure 1. Multicomponent Intervention Timeline



Mafi JN, Godoy-Travieso P, Wei E, et al. Evaluation of an Intervention to Reduce Low-Value Preoperative Care for Patients Undergoing Cataract Surgery at a Safety-Net Health System. JAMA Intern Med. 2019 May 1;179(5):648-657.

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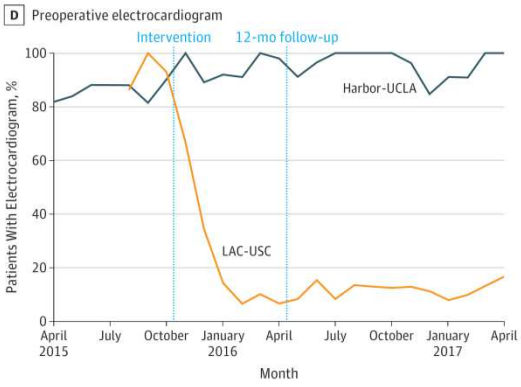
An Intervention to Reduce Low-Value Preoperative Care



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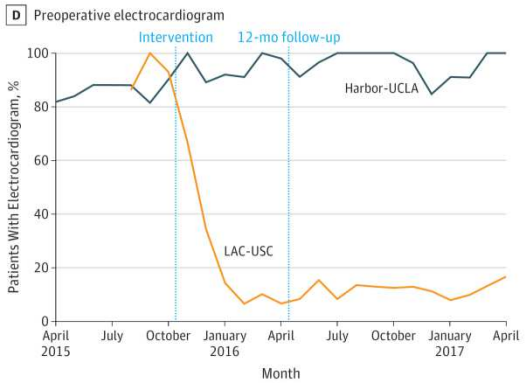
An Intervention to Reduce Low-Value Preoperative Care



"In a simulation of a FFS [fee-for-service] health system at 3 years, $88,151 in losses were estimated, and for societal 3-year perspectives, $217,322 in savings were estimated."

Mafi JN, Godoy-Travieso P, Wei E, et al. Evaluation of an Intervention to Reduce Low-Value Preoperative Care for Patients Undergoing Cataract Surgery at a Safety-Net Health System. JAMA Intern Med. 2019 May 1;179(5):648-657.

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Perioperative Beta Blockers: 2014 Guideline Recommendations

- Perioperative beta blockade appears to be of benefit in selected patients who are at elevated risk of perioperative cardiac events
- Per the ACC/AHA 2014 Periop Guidelines, there is one class I indication for perioperative beta-blocker use:
  - "Beta blockers should be continued in patients undergoing surgery who have been on beta blockers chronically"
- What to do in patients who are not already on beta blockers is unsettled

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Perioperative Beta Blockers: The POISE Trial

- The PeriOperative ISchemic Evaluation (POISE) Trial enrolled 8351 patients undergoing noncardiac surgery with at least one cardiac risk factor
- Patients were randomized to either placebo or controlled-release metoprolol (CR metoprolol) 100 mg orally 2 – 4 h before surgery, a postop dose of CR metoprolol based on heart rate and BP, and then 200 mg of CR metoprolol orally daily for the next 30 d
- The beta blocker arm had a lower rate of the primary outcome (30-day cardiac events): 5.8% in the beta blocker arm versus 6.9% in the placebo arm (P=0.04)
- However, the total mortality was higher in the CR metoprolol group (3.1%) than in the placebo group (2.3%) (P=0.03)
- The general view of this trial is that the dose of periop beta blockers given was too large, and so led to the increased stroke rate

Source: Poise Study Group. Effects of extended-release metoprolol succinate in patients undergoing non-cardiac surgery (POISE trial).... *Lancet.* May 31 2008;371(9627):1839-1847.

Perioperative Beta Blockers: The POISE Trial

- The PeriOperative ISchemic Evaluation (POISE) Trial enrolled 8351 patients undergoing noncardiac surgery with at least one cardiac risk factor
- Patients were randomized to either placebo or controlled-release

Giving high doses of beta blockers without dose titration to beta blocker naïve patients right before surgery increases mortality

- However, the total mortality was higher in the CR metoprolol group (3.1%) than in the placebo group (2.3%) (P=0.03)
- The general view of this trial is that the dose of periop beta blockers given was too large, and so led to the increased stroke rate

Source: Poise Study Group. Effects of extended-release metoprolol succinate in patients undergoing non-cardiac surgery (POISE trial).... *Lancet.* May 31 2008;371(9627):1839-1847.

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Perioperative Beta Blockers: The POISE Trial

Unanswered questions:

- What if we gave moderate-dose beta blockers?
- What if we started beta blockers a week or even 30 days before surgery?

Source: Poise Study Group. Effects of extended-release metoprolol succinate in patients undergoing non-cardiac surgery (POISE trial).... *Lancet.* May 31 2008;371(9627):1839-1847.

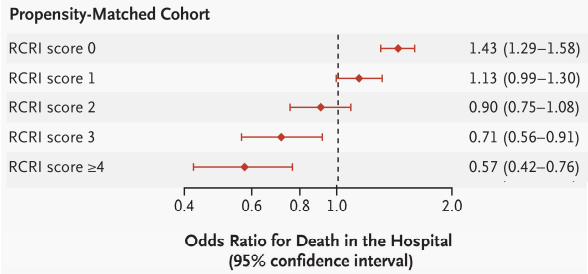
Perioperative Beta Blockers: Retrospective Data

- A large retrospective cohort study examining the benefits of periop beta blockers based on the cardiac risk of the patient
- Patients undergoing noncardiac surgery (mainly orthopedic and abdominal procedures) were included
- Patients receiving prophylactic periop beta blockers were compared with patients not receiving beta blockers
- This study is debated:
  - On the one hand, it was quite large (n=663,635)
  - On the other hand, it was retrospective, and based on the use of an administrative database. No charts were reviewed. Beta blockers started on hospital day 1 or 2 were considered prophylactic

Source: Lindenauer PK, et al. Perioperative beta-blocker therapy .... *New England Journal of Medicine.* Jul 28 2005;353(4):349-361.

Perioperative Beta Blockers: Retrospective Data

- Patients without cardiac risk factors who got periop beta blockers seemed to be harmed by them
- Patients with an RCRI of at least 2, and certainly with an RCRI of 3, appeared to benefit from beta blockers

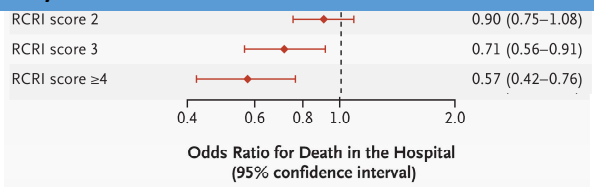


Source: Lindenauer PK, et al. Perioperative beta-blocker therapy …. *New England Journal of Medicine.* Jul 28 2005;353(4):349-361.

Perioperative Beta Blockers: Retrospective Data

- Patients without cardiac risk factors who got periop beta blockers seemed to be harmed by them
- Patients with an RCRI of at least 2, and certainly with an

As the RCRI score goes up, the benefit from beta blockers increases. Beta blockers conferred a mortality benefit with an RCRI score ≥ 3.



Source: Lindenauer PK, et al. Perioperative beta-blocker therapy …. *New England Journal of Medicine.* Jul 28 2005;353(4):349-361.

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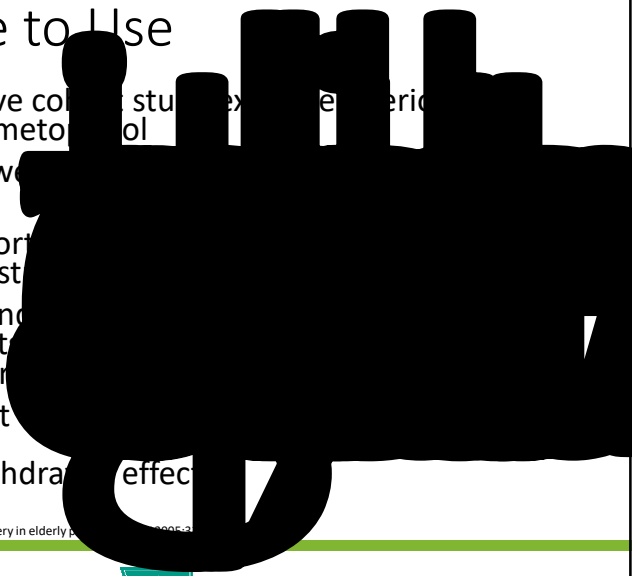
Perioperative Beta Blockers: 2014 ACC/AHA Recommendations

- The 2014 AHA guidelines are offer mainly IIb recommendations about when to start periop beta blockers in those who are not on them
- In patients with an RCRI score of 3 or more, it may be reasonable to begin beta blockers prior to surgery (class IIb recommendation)
- "In patients with a compelling long-term indication for beta-blocker therapy but no other RCRI risk factors, initiating beta blockers in the perioperative setting as an approach to reduce perioperative risk is of uncertain benefit"
- Beta-blocker therapy should not be started on the day of surgery (class III recommendation)

Perioperative Beta Blockers: Which One to Use

- One retrospective co[illegible] stu[illegible]ex[illegible]e[illegible]eric[illegible] atenolol versus meto[illegible]ol
- 37151 patients w[illegible] > 65 years old
- Abdominal and ort[illegible] common in this st[illegible]
- The combined en[illegible] lower for patient[illegible] receiving metopr[illegible]
- This was thought [illegible] of the shorter- beta-blocker withdra[illegible] effec[illegible]



Source: Redelmeier D, et al. Beta blockers for elective surgery in elderly p[illegible]

Periop Beta Blockers
Take Home Points

- In patients who are already on beta blockers, continue them on beta blockers perioperatively
- You want to avoid beta blocker withdrawal
- In patients not already on beta blockers with an RCRI score of ≥ 3 "it may be reasonable to begin beta blockers before surgery"
- If beta blocker are being started in preparation for surgery, you want to start them well ahead of surgery and not on the day of surgery

Perioperative Statins

- The DECREASE-III trial enrolled 497 patients, age > 40, at elevated cardiac risk, scheduled to undergo noncardiac vascular surgery
- All patients had to be statin naïve
- All patients were on beta blockers
  - Patients who were already taking a beta blocker were continued on this beta blocker
  - Patients who were not on a beta blocker were started on one, and their dose was titrated based on their HR
- Patients were randomized to fluvastatin 80 mg daily or a placebo. This statin was started on average 37 days prior to surgery and continued for at least 30 days after surgery

Source: Schouten O, Boersma E, Hoeks SE, et al. Fluvastatin and perioperative events in patients undergoing vascular surgery. *NEJM*. Sep 3 2009;361(10):980-989.

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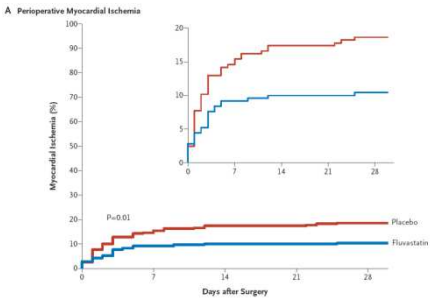
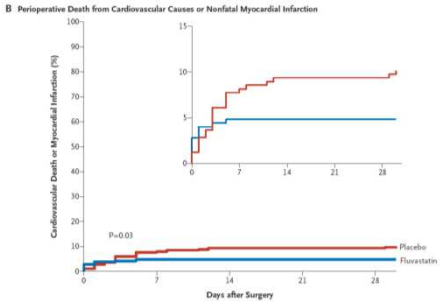
Perioperative Statins

Perioperative Myocardial Ischemia: 10.8% in the statin arm vs. 19.0% in the placebo arm (P = 0.01)



Perioperative death from CV cause or MI: 4.8% in the statin arm vs. 10.1% in the placebo arm (P = 0.03)



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Perioperative Statins

- Retrospective study including 781,000 patients
- Patients received lipid-lowering therapy on HD 1 or 2 were compared to those not on therapy
- 91% of lipid lowering therapy was statins
- The primary outcome was in-hospital mortality

Table 7. Number Needed to Treat in Propensity Matched Cohort by Revised Cardiac Risk Index Score

	Revised Cardiac Risk Index Score					
	0	1	2	3	≥4	Overall
Patients, No. (%)	45 371 (34)	43 756 (33)	27 853 (21)	11 706 (9)	3149 (2)	131 835 (100)
In-hospital mortality, No. (%)*	647 (1.43)	1136 (2.60)	1253 (4.50)	828 (7.07)	294 (9.34)	4158 (3.15)
NNT (95% CI)†	186 (168-214)	103 (93-119)	60 (54-69)	39 (35-45)	30 (27-35)	85 (77-98)

Lindenauer PK, Pekow P, Wang Ket et al. Lipid-lowering therapy and in-hospital mortality following major noncardiac surgery. *JAMA.* May 5 2004;291(17):2092-2099.

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Perioperative Statins

- Retrospective study including 781,000 patients
- Patients received lipid-lowering therapy on HD 1 or

For patients with an RCRI score ≥ 4, the NNT with lipid lowering therapy to prevent an in-hospital death is 30.

Table 7. Number Needed to Treat in Propensity Matched Cohort by Revised Cardiac Risk Index Score

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	0	1	2	3	≥4	Overall
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In-hospital mortality, No. (%)*	647 (1.43)	1136 (2.60)	1253 (4.50)	828 (7.07)	294 (9.34)	4158 (3.15)
NNT (95% CI)†	186 (168-214)	103 (93-119)	60 (54-69)	39 (35-45)	30 (27-35)	85 (77-98)

Lindenauer PK, Pekow P, Wang Ket et al. Lipid-lowering therapy and in-hospital mortality following major noncardiac surgery. *JAMA.* May 5 2004;291(17):2092-2099.

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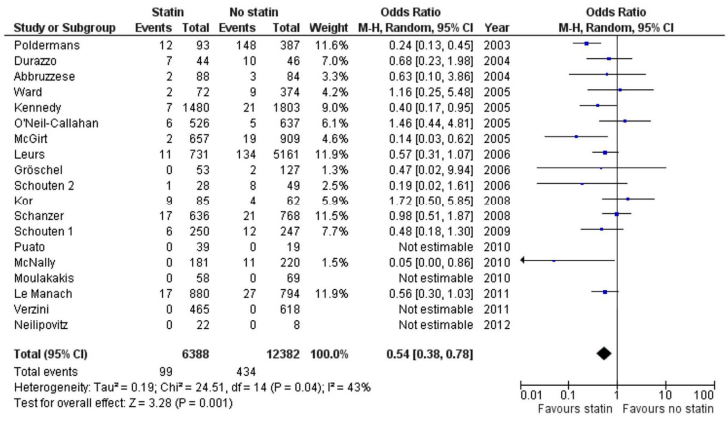
Perioperative Statins: Meta-Analysis



Source: Antoniou GA, Hajibandeh S, Vallabhaneni SR, Brennan JA, Torella F. Meta-analysis of the effects of statins on perioperative outcomes in vascular and endovascular surgery. *Journal of Vascular Surgery*. Feb 2015;61(2):519-532 e511

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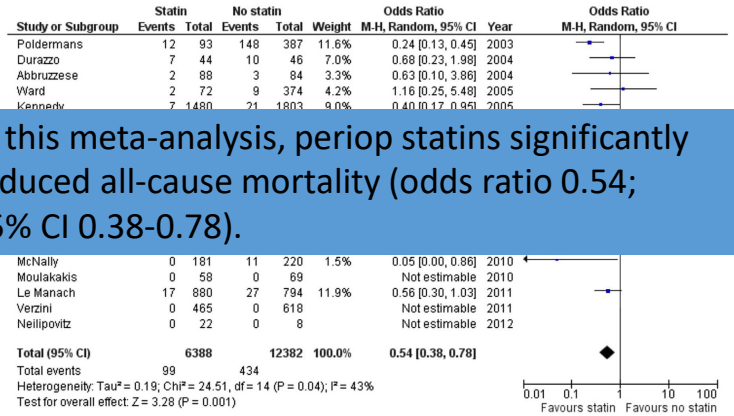
Perioperative Statins: Meta-Analysis



In this meta-analysis, periop statins significantly reduced all-cause mortality (odds ratio 0.54; 95% CI 0.38-0.78).

Source: Antoniou GA, Hajibandeh S, Vallabhaneni SR, Brennan JA, Torella F. Meta-analysis of the effects of statins on perioperative outcomes in vascular and endovascular surgery. *Journal of Vascular Surgery*. Feb 2015;61(2):519-532 e511

Perioperative Statins: 2014 ACC/AHA Recommendations

- Statins should be continued in patients currently taking statins and scheduled for noncardiac surgery (class I)
- Perioperative initiation of statin use is reasonable in patients undergoing vascular surgery (class IIa)
- Perioperative initiation of statins may be considered in patients with clinical indications according to GDMT who are undergoing elevated-risk procedures (class IIb)

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Perioperative Aspirin

- The POISE 2 Trial was an that looked at the effect of perioperative ASA
- The trial enrolled 10,010 patients undergoing noncardiac surgery who were at risk for vascular complications
- Patient within the coronary stent critical periods were excluded
- The primary endpoint was death or nonfatal MI at 30 days
- The patients were stratified by whether they were already taking ASA (continuation group) or not (initiation group)

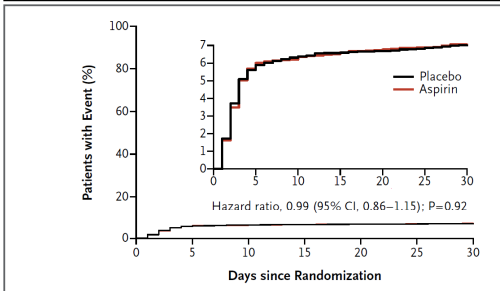
Source: Devereaux PJ, Mrkobrada M, Sessler DI, et al. Aspirin in patients undergoing noncardiac surgery. *NEJM*. Apr 17 2014;370(16):1494-1503.

Perioperative Aspirin

- There was no benefit to ASA in the primary outcome or any of the secondary outcomes
- The negative results were the same for the continuation group and the initiation group
- Taking ASA was associated with an increased risk of major bleeding
- Starting at POD#8, there was no significant difference in the bleeding risk between and ASA and placebo groups

Source: Devereaux PJ, Mrkobrada M, Sessler DI, et al. Aspirin in patients undergoing noncardiac surgery. *NEJM*. Apr 17 2014;370(16):1494-1503.

Perioperative Aspirin



No. at Risk

Placebo	5012	4724	4696	4680	4669	4662	4652
Aspirin	4998	4713	4678	4665	4660	4653	4643

Figure 1. Kaplan–Meier Estimates of the Primary Composite Outcome of Death or Nonfatal Myocardial Infarction at 30 Days.
The inset shows the same data on an enlarged y axis.

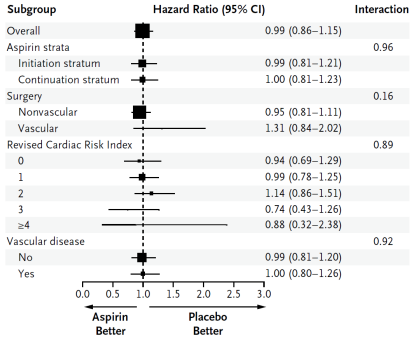


Figure 2. Subgroup Analyses of the Primary Outcome.
The primary composite outcome was death or nonfatal myocardial infarction at 30 days. The area of each square is proportional to the size of the corresponding subgroup. The Revised Cardiac Risk Index ranges from 0 to 6, with higher scores indicating greater risk.

Source: Devereaux PJ, Mrkobrada M, Sessler DI, et al. Aspirin in patients undergoing noncardiac surgery. *NEJM*. Apr 17 2014;370(16):1494-1503.

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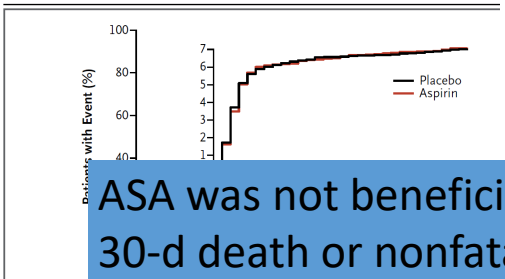
Perioperative Aspirin



ASA was not beneficial in reducing 30-d death or nonfatal MI overall or in any of the subgroups

No. at Risk
Placebo
Aspirin

Figure 1. Kaplan–Meier Estimates of the Primary Composite Outcome of Death or Nonfatal Myocardial Infarction at 30 Days.
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Perioperative Clonidine

- As a companion to the periop ASA trial, there was a parallel periop clonidine trial
- The trial, as RCT, enrolled 10,010 patients undergoing noncardiac surgery who were at risk for vascular complications
- The primary endpoint was death or nonfatal MI at 30 days
- There was no benefit to periop clonidine in reducing the primary endpoint
- Patients in the clonidine arm had an increase the risk of clinically important hypotension and nonfatal cardiac arrest.

Source: Devereaux PJ, Sessler DI, Leslie K, et al. Clonidine in patients undergoing noncardiac surgery. *NEJM. Apr 17 2014;370(16):1504-1513.*

Should We Hold ACEI/ARB Periop?

- Prospective cohort study of 14,687 patients (including 4,802 on ACEI or ARBs), ≥ 45 y.o., undergoing inpatient noncardiac surgery
- Primary endpoint was all-cause death, stroke, or myocardial injury after noncardiac surgery at 30 days postop
- 26% of patients had [redacted] held in the 24 h prior to surgery

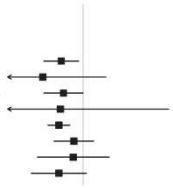
Source: Roshanov et al. Withholding versus Continuing Angiotensin converting Enzyme Inhibitors …. Anesthesiology. Jan 2017;126(1):16-27.

Should We Hold ACEI/ARB Periop?

- Patient characteristics were similar in those in whom ACEI/ARB were held and those in whom they were continued
- The primary endpoint was lower in the held group (12.0%) compared to the continuation group (12.9%)
- But unable to analyze by subgroup (e.g., CHF)

A

Medication withheld	Outcome	Events in withheld *vs.* continued	aRR (95% CI), p–value
ACEI/ARBs	Death, MINS, or stroke	150/1245 (12.0%) *vs.* 459/3557 (12.9%)	0.82 (0.70–0.96), 0.01
	Death	25/1245 (2.0%) *vs.* 74/3557 (2.1%)	0.69 (0.39–1.24), 0.21
	MINS	132/1245 (10.6%) *vs.* 399/3541 (11.3%)	0.84 (0.70–0.998), 0.048
	Stroke	8/1245 (0.6%) *vs.* 26/3557 (0.7%)	0.81 (0.30–2.2), 0.68
	Intraop. hypotension	290/1245 (23.3%) *vs.* 1017/3557 (28.6%)	0.80 (0.73–0.88), <0.001
	Postop. hypotension	242/1245 (19.4%) *vs.* 719/3557 (20.2%)	0.92 (0.77–1.10), 0.36
	MI (Exploratory)	57/1245 (4.6%) *vs.* 148/3557 (4.2%)	0.91 (0.66–1.27), 0.59
	Death, MI, or stroke (Exploratory)	78/1245 (6.3%) *vs.* 221/3557 (6.2%)	0.81 (0.62–1.03), 0.08



Source: Roshanov et al. Withholding versus Continuing Angiotensin-converting Enzyme Inhibitors .... Anesthesiology. Jan 2017;126(1):16-27.

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Periop Management of Diabetes Medications

Figure. Suggested Administration of Insulin and Other Diabetes Medications on the Morning of Surgery

Patient due for elective surgery	Medication plan for morning of surgery		
	Hold	50% Dose	Continue normal therapy
No known type 1 diabetes and no similar clinical features			
▸ Noninsulin therapies only	●		
Combination of insulin and noninsulin therapies			
▸ Long- and intermediate-acting insulin		●	
▸ Short- or rapid-acting insulin and noninsulin therapies	●		
Known type 1 diabetes or similar clinical features present[a]	Continue basal insulin therapy		
Combination of short- or rapid-acting and intermediate-acting insulin	●		
▸ Short- or rapid-acting insulin			
▸ Intermediate-acting insulin		●	
Combination of short- or rapid-acting and long-acting insulin	●		
▸ Short- or rapid-acting insulin			
▸ Long-acting insulin (appropriate dose)			●
▸ Long-acting insulin (inappropriately high dose)		●	
Indications for inappropriately high long-acting insulin dose: Frequent hypglycemia, especially at night or early morning; Steep overnight decline in blood glucose (>40 mg/dL); Patient requires bedtime snack to avoid hypoglycemia; Long-acting insulin dose is >60% of total daily insulin dose			
Insulin pump therapy	●	Discontinue insulin pump and start intravenous insulin infusion therapy	
▸ Continued perioperative insulin pump use is not indicated			
▸ Continued perioperative insulin pump use is indicated			●
Indications for continued perioperative use: Patient has good glucose control and is adept at pump usage; Short surgery duration (<2 h) and quick recovery expected; No hemodynamic compromise; Pump infusion site is not close to surgical field			Reduce to 25% if basal rate is inappropriately high

Simha V, Shah P. Perioperative Glucose Control in Patients With Diabetes Undergoing Elective Surgery. *JAMA*. Jan 7 2019.

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Bridging Anticoagulation

- The BRIDGE trial randomized 1884 patients with Afib on coumadin who were scheduled for an elective procedure to either bridging with LMWH (dalteparin) or placebo.
- Patients had to have at least 1 of the $CHADS_2$ risk factors.
- The mean $CHADS_2$ score was 2.3

Source: Douketis JD, Spyropoulos AC, Kaatz S, et al. Perioperative Bridging Anticoagulation in Patients with Atrial Fibrillation. *NEJM*. 2015;373(9):823-833.

Bridging Anticoagulation

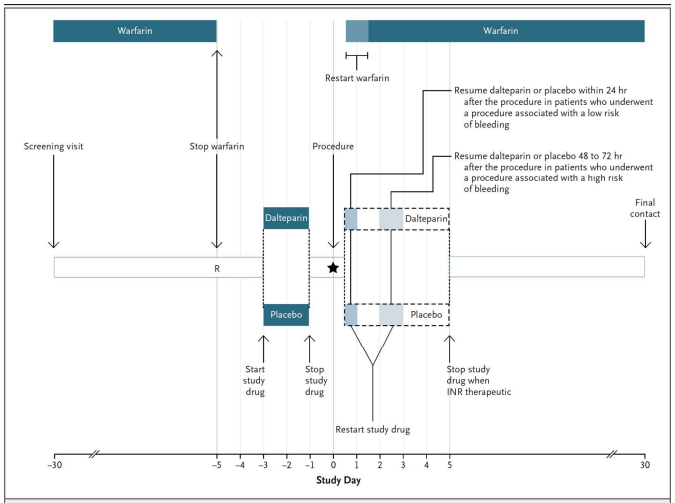

Figure 1. BRIDGE Study Design.

Source: Douketis JD, Spyropoulos AC, Kaatz S, et al. Perioperative Bridging Anticoagulation in Patients with Atrial Fibrillation. *NEJM*. 2015;373(9):823-833.

Bridging Anticoagulation

Table 3. Study Outcomes.

Outcome	No Bridging (N=918)	Bridging (N=895)	P Value
	number of patients (percent)		
Primary			
Arterial thromboembolism	4 (0.4)	3 (0.3)	0.01*, 0.73†
Stroke	2 (0.2)	3 (0.3)	
Transient ischemic attack	2 (0.2)	0	
Systemic embolism	0	0	
Major bleeding	12 (1.3)	29 (3.2)	0.005†
Secondary			
Death	5 (0.5)	4 (0.4)	0.88†
Myocardial infarction	7 (0.8)	14 (1.6)	0.10†
Deep-vein thrombosis	0	1 (0.1)	0.25†
Pulmonary embolism	0	1 (0.1)	0.25†
Minor bleeding	110 (12.0)	187 (20.9)	<0.001†

* P value for noninferiority.
† P value for superiority.

Source: Douketis JD, Spyropoulos AC, Kaatz S, et al. Perioperative Bridging Anticoagulation in Patients with Atrial Fibrillation. *NEJM*. 2015;373(9):823-833.

Bridging Anticoagulation

$CHADS_2$ score‡	No Bridging (N = 950)	Bridging (N = 934)
Mean	2.3±1.03	2.4±1.07
Distribution — no. (%)		
0	1 (0.1)	1 (0.1)
1	216 (22.7)	212 (22.7)
2	382 (40.2)	351 (37.6)
3	229 (24.1)	232 (24.8)
4	96 (10.1)	106 (11.3)
5	23 (2.4)	27 (2.9)
6	3 (0.3)	5 (0.5)

Source: Douketis JD, Spyropoulos AC, Kaatz S, et al. Perioperative Bridging Anticoagulation in Patients with Atrial Fibrillation. *NEJM*. 2015;373(9):823-833.

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Bridging Anticoagulation

$CHADS_2$ score‡	No Bridging (N = 950)	Bridging (N = 934)
Mean	2.3±1.03	2.4±1.07
Distribution — no. (%)		
0		0.1)
1		22.7)
2		37.6)
3		24.8)
4		11.3)
5		2.9)
6		0.5)

In patients with a mean $CHADS_2$ score of 2.3, periop bridging anticoagulation does not reduce thromboembolic events

Douketis JD, Spyropoulos AC, Kaatz S, et al. Perioperative Bridging Anticoagulation in Patients with Atrial Fibrillation. *NEJM*. 2015;373(9):823-833.

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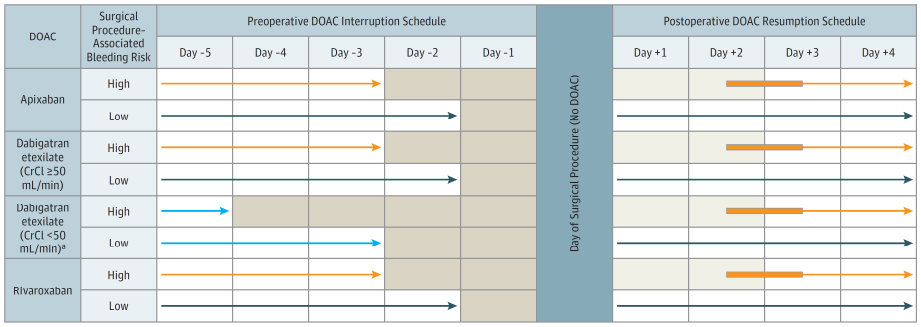
Periop DOAC Management

Figure. Perioperative Direct Oral Anticoagulant (DOAC) Management Protocol



No DOAC was taken on certain days (shaded) and on the day of the elective surgery or procedure. The light blue arrows refer to an exception to the basic management, a subgroup of patients taking dabigatran with a creatinine clearance (CrCl) less than 50 ng/mL. The orange arrows refer to patients having a high-bleed-risk surgical procedure. Dark blue arrows refer to patients having a low-bleed-risk surgical procedure. The thickened orange part of arrows refer to flexibility in the timing of DOAC resumption after a procedure.

[a] Cancer diagnosed within 3 months or has been treated within 6 months or metastatic.

Douketis JD, Spyropoulos AC, Duncan J. Perioperative Management of Patients with Atrial Fibrillation Receiving a Direct Oral Anticoagulant. JAMA Intern Med. 2019 Aug 5. [Epub ahead of print]

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Perioperative Pulmonary Complications

Table 1. The Seven ARISCAT Risk Predictors, β Regression Coefficients, and Points Assigned*

	β Regression Coefficients	Score
Age (yr)		
≤50	0	0
51–80	0.331	3
>80	1.619	16
Preoperative Spo_2		
≥96%	0	0
91–95%	0.802	8
≤90%	2.375	24
Respiratory infection in the last month		
No	0	0
Yes	1.698	17
Preoperative anemia (Hb ≤10 g/dl)		
No	0	0
Yes	1.105	11
Surgical incision		
Peripheral	0	0
Upper abdominal	1.480	15
Intrathoracic	2.431	24
Duration of surgery (h)		
<2	0	0
2–3	1.593	16
>3	2.268	23
Emergency procedure		
No	0	0
Yes	0.768	8

*Three levels of risk were indicated by the following cutoffs: <26 points, low risk; 26–44 points, moderate risk; and ≥45 points, high risk.
ARISCAT = Assess Respiratory Risk in Surgical Patients in Catalonia; Hb = hemoglobin; Spo_2 = arterial oxyhemoglobin saturation by pulse oximetry.

- Tested on 5,859 patients in 63 centers
- Respiratory complications were defined as:
  - Respiratory infection or failure
  - Bronchospasm
  - Atelectasis
  - Pleural effusion
  - Pneumothorax
  - Aspiration pneumonitis
- Score:
  - < 26 denotes a 3.4% risk
  - 26-45 denotes a 13.0% risk
  - >45 denotes a 38.0% risk

Source: Mazo V, Sabate S, et al. Prospective external validation of a predictive score for postoperative pulmonary complications. *Anesthesiology*. 2014;121(2):219-231.

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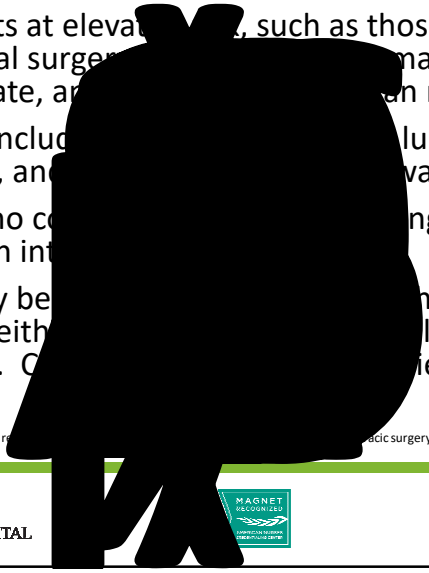
Perioperative Pulmonary Risk Reduction Strategies: Lung Expansion

- In patients at eleva , such as those undergoing abdominal surge maneuver is appropriate, a n no intervention
- Options inclu lung expansion exercises, an vay pressure
- There is no c ng one lung expansion int
- CPAP may be o are unable to undergo eith lung expansion exercises. C ients.

Source: Lawrence VA, et al. Strategies to r acic surgery: systematic review for the American College of Physicians. *Annals of Internal Medicine.*



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Perioperative Pulmonary Risk Reduction Strategies

- Smoking cessation
  - May help reduce the incidence of postop pulmonary complications
  - However, smoking cessation immediately (< 8 weeks) prior to surgery may increase the risk of postop pulmonary complications
- Anesthesia techniques need to be considered
  - Patients who had residual muscle blockade after receiving the long-acting neuromuscular-blocking agent pancuronium had an increased rate of postop pulmonary complications compared to patients without residual muscle blockade
  - Use of either spinal or epidural anesthesia, as compared to general anesthesia, may also reduce the incidence of postop pulmonary complications

Source: Lawrence VA, et al. Strategies to reduce postoperative pulmonary complications after noncardiothoracic surgery: systematic review for the American College of Physicians. *Annals of Internal Medicine.* Apr 18 2006;144(8):596-608.

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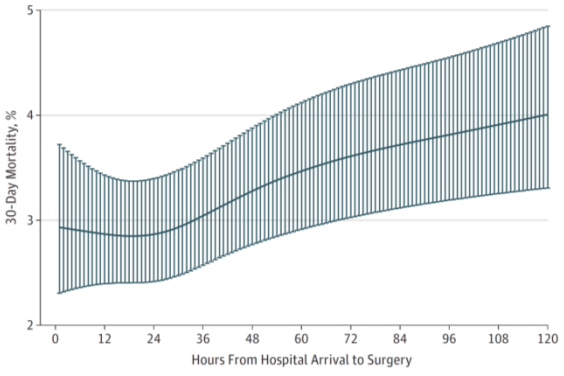
The Timing of Surgery for Hip Fracture Patients

- Retrospective cohort analysis of 42,230 hip fracture patients in Ontario
- Mean age around 80, around 70% female
- Primary outcome was 30-d mortality



Source: Pincus D, Ravi B, Wasserstein D, et al. Association Between Wait Time and 30-Day Mortality in Adults Undergoing Hip Fracture Surgery. JAMA. Nov 28 2017;318(20):1994-2003..

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Periop Issues for OSA Patients

- Both respiratory and cardiovascular periop complications are more common in patients with untreated OSA than comparable patients without OSA
- Prescribing CPAP for patients with OSA perioperatively reduced the risk of cardiovascular but not pulmonary complications
- Neglecting to prescribe CPAP in patients on CPAP when postop in the hospital is an "unforced error"

Source: Mutter TC, Chateau D, Moffatt M, Ramsey C, Roos LL, Kryger M. A matched cohort study of postoperative outcomes in obstructive sleep apnea: could preoperative diagnosis and treatment prevent complications? *Anesthesiology*. Oct 2014;121(4):707-718.

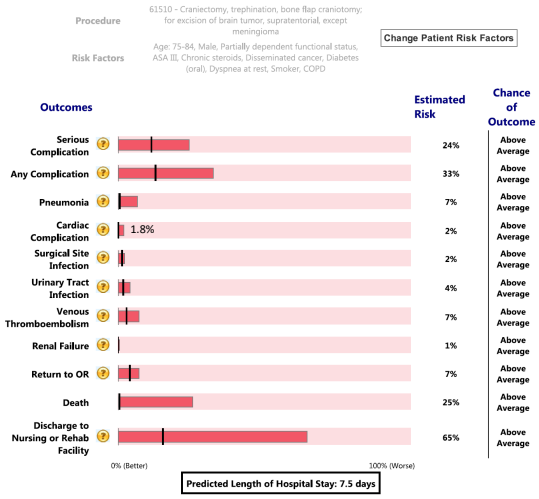
Periop Issues for Obese Patients

- There are an increasing number of case reports of obese patients having postop rhabdomyolysis
- It is likely that the immobilization and weight on the gluteal muscle results in necrosis
- If an obese patient has postop AKI, consider rhabdomyolysis and check a CK
- Obese patients has restrictive lung physiology, and so consider CPAP in hypoxic obese patients postop

Clinical Case

- 76-year-old male with severe COPD, on 3 L of home O_2 and chronic prednisone 7.5 mg daily, DMII on metformin, dyspnea with minimal exertion.
- No history of MI or CHF. His EKG is essentially normal.
- He has metastatic colon cancer, with a single metastasis to the brain causing left arm weakness
- You are seeing him in consultation prior to neurosurgery scheduled 48 h from now to resect the metastasis
- He underwent successful resection of a colon mass 3 years ago

Clinical Case



Clinical Case

- What actually happened:
  - The neurosurgeon cancelled the case
  - The patient was scheduled for brain XRT instead
  - Surgery remains on the table as an option
- If the patent undergoes surgery, consider cort stim versus stress dose steroids

Multiple Choice Question 1

- You are asked to perform a preop evaluation on a 71 y.o. F with a hx of HTN, DMII on metformin, hyperlipidemia, and osteoarthritis, who is scheduled for a L knee replacement tomorrow. Physical exam is unremarkable. Medications include ASA, metformin, amlodipine, and atorvastatin. Which of the following is the most appropriate recommendation in this patient?

a) The patient should be started on atenolol
b) The patient should continue her atorvastatin in the perioperative period
c) The patient should continue her ASA in the perioperative period
d) The patient should undergo a preop nuclear stress test
e) The patient should undergo an preop EKG stress test

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Multiple Choice Question 1

- The correct answer is (b): The patient should continue her atorvastatin in the perioperative period. Continuing statins perioperatively is a class I recommendation as per the 2014 ACC/AHA Guidelines.
- As per the guideline, beta blockers should not be started in the 24 hours prior to surgery, and so (a) is incorrect. Given the POISE 2 trial, there is no evidence to support a recommendation to continue the ASA, making answer (c) incorrect. This patient has a MACE risk of 0.1%, and so a preop stress test is not indicated, regardless of the modality, and so answers (d) and (e) are incorrect.

Multiple Choice Question 2

- A 74-year-old male is being admitted in 2 days for a R total knee replacement. His past medical history includes OSA on CPAP, obesity, hypertension, and chronic kidney diseases. His MACE risk is 0.7%. Medications include amlodipine, simvastatin, and atenolol. Which of the following is the most appropriate recommendation in this patient?

a) The patient's beta blocker should be held to avoid intraoperative hypotension
b) The patient should undergo a preop nuclear stress test
c) The patient should undergo an preop EKG stress test
d) The patient should continue his CPAP while in the hospital
e) Given the patient's cardiac risk, the surgery should be cancelled

Multiple Choice Question 2

- The correct answer is (d): The patient should continue his CPAP while in the hospital. Periop CPAP in OSA patients has been found to reduce cardiovascular complications.
- Continuing a patient's beta blockers periop in those who are already on them is a class I recommendation, and so choice (a) incorrect. The patient's MACE risk is < 1%, and so he is not at elevated cardiac risk. Thus there is no need for a stress test and no reason to cancel his surgery on account of his cardiac risk. Therefore, answers (b), (c), and (e) are incorrect.