Preoperative Clearance
Update 2012

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At the conclusion of this break-out session the participant *should be able to:*

1. Estimate perioperative cardiovascular risks for patients undergoing noncardiac surgery, using new risk prediction models.
2. Advise patients regarding beta-blockers, statins, and central alpha agonists in anticipation of noncardiac surgery.
3. Recommend appropriate management for patients receiving chronic anticoagulation or anti-platelet agents.

Case 1

86 y.o. patient sustains a right acetabular fracture after tripping over a rug at the assisted living center. Admitted to outside hospital but transferred to MGH because of "medical complexity". Medical problems include the following:

1. Heart failure
2. H/O coronary artery disease with CABG 2008
3. Aortic valve replacement 2008 because of aortic stenosis
4. Sick sinus syndrome requiring pacemaker, 2009
5. Atrial fibrillation, not on warfarin because of history of diverticular bleed four years ago.
6. Cirrhosis presumed due to long history of alcohol consumption, recent increased abdominal girth with imaging that discloses ascites.
7. Chronic kidney disease with baseline creatinine ~1.5 mg/dl

At baseline, has shortness of breath with walking across a room and often awakens at night short of breath. No chest pain. Appetite has been poor recently and has lost about 10 pounds during the past three months.

MEDICATIONS ON ADMISSION
ASA 81 mg PO QD
Vitamin D 1000U PO QD

Celexa 20 mg PO QD
Furosemide 40 mg PO BID
Metoprolol 12.5 mg PO BID
Protonix 40 mg PO QD
KCl 20 mEq PO QD
Zocor 20 mg PO QD
Tamsulosin 0.4 mg PO QD
FE 325 mg PO BID

PHYSICAL EXAM
VITALS: T Afebrile HR 70s (paced) BP 112-135/50-60's RR 18-20 SpO2 96-99% 2L
GEN male in NAD, somnolent, inattentive
HEENT NC/AT, PERRLA, sclera anicteric, MMM
NECK JVP elevated 10cm, pulsatile
CV RRR, S1/S2 ?split S1, +1/6 systolic murmur at LLSB
LUNGS CTAB anteriorly
ABD tense ascites, tender RLQ that is firm with small hematoma
EXT +2 LE edema

Labs:

WBC 5400; Hct 26.4; platelets 92,000
Creatinine 1.91; BUN 33;
Bilirubin 2.0; Albumin 3.1
Alk phos 175, SGOT 20, SGPT 10
INR 1.3

Orthopedics requests "clearance for surgery"

MGH Checklist for Medicine Consult Notes*

□ Does the note address the concerns and scope of the requesting service's initial request?

PREOPERATIVE RISK ASSESSMENT
□ Preoperative cardiac risk assessment
    □ Do you think there is undiagnosed ischemic heart disease?
    □ Do you recommend starting or titrating beta-blockers?
    □ Do you recommend checking troponins post-op?
□ Preoperative pulmonary risk assessment
    □ Expected difficulty extubating patient
□ Risk of post-op delirium
□ Risk of post-op renal failure
□ Perioperative risk of VTE with prophylaxis recommendations

MEDICATION ISSUES
□ Anticoagulation
□ Antiplatelet therapy
□ Diabetes meds – management while perioperative and NPO
□ ACE inhibitor – hold on the day of surgery?
□ Blood pressure control when patient is NPO
□ Diuretics – hold on the day of surgery?
□ How well do you know the outpatient medications
    □ Recommendations for what to do with them in the hospital?

OTHER PERIOPERATIVE CONSIDERATIONS
□ Volume status – any particular concerns?
□ Is there an indication for stress dose steroids?
□ Might the patient withdraw from alcohol or other drugs?
□ Is there a contraindication to cefazolin (Ancef) – often used perioperatively?
□ Seizure and QTc-prolongation risk, especially when adding new medications
□ Vitamin D checking and possible bisphosphonate start
□ Special cases: liver disease, low albumin, severe hypertension, pregnancy, advanced age, substance abuse, psychiatric medications
□ Psychosocial problems that may need to be addressed
□ Have you captured the patient's other acute and chronic medical problems?
□ Are there things that need to go in the discharge summary or be communicated to the PCP (e.g., newly diagnosed CHF or CAD, lung nodule seen on CT scan, etc.)?

**Please do not include all of these items in your notes. This list is meant only to make sure we don't overlook things that we should catch.*

Cardiac risk assessment and management:

1. What is the risk of the surgical procedure?
2. What is the risk for the individual patient undergoing this procedure?
3. Are there ways to reduce the risk for the individual patient?

Estimates of risk for procedures

Table 4. Cardiac Risk* Stratification for Noncardiac Surgical Procedures

Risk Stratification	Procedure Examples
Vascular (reported cardiac risk often more than 5%)	Aortic and other major vascular surgery Peripheral vascular surgery
Intermediate (reported cardiac risk generally 1% to 5%)	Intraperitoneal and intrathoracic surgery Carotid endarterectomy Head and neck surgery Orthopedic surgery Prostate surgery
Low† (reported cardiac risk generally less than 1%)	Endoscopic procedures Superficial procedure Cataract surgery Breast surgery Ambulatory surgery

*Combined incidence of cardiac death and nonfatal myocardial infarction.
†These procedures do not generally require further preoperative cardiac testing.

From ACC/AHA guidelines[1]

From a study of 183,069 patients in the NSQIP (National Surgical Quality Improvement Program) database 2002-2004[2]:

Table 1. Categories of Procedures with Cardiac Adverse Event Rates (n = 183,069)

CPT range of primary procedure	Type of operation by area of body or system	Operations		Cardiac complication rate
		n	%	(%)
10000–29999	Integumentary and musculoskeletal system	22,020	12.0	1.49
30000–32999 38000–39999	Respiratory system, hemic and lymphatic systems, mediastinum, and diaphragm	2,880	1.6	1.32
33001–34900	Thoracoabdominal aneurysm, embolectomy/thrombectomy, venous reconstruction, and endovascular repair	2,867	1.6	3.21
35001–37799	Peripheral aneurysm, blood vessel repair, thromboendarterectomy, angioscopy, angioplasty and atherectomy, bypass and composite grafts, other artery and vein	29,810	16.3	2.27
40000–43499	Mouth, palate, salivary glands, pharynx, adenoids, and esophagus	2,589	1.4	1.16
43500–49429 49650–49999	Stomach, intestines, appendix and the mesentery, rectum and anus, liver, biliary tract, pancreas, abdomen, peritoneum, and omentum (nonhernia)	71,568	39.1	1.53
49491–49611	Hernioplasty, herniorrhaphy, herniotomy	44,970	24.6	0.18
60000–60999	Endocrine system	6,116	3.3	0.20
	CPT missing	249	0.1	3.61

CPT, current procedural terminology.

Cardiac adverse events = cardiac arrest or Q-wave MI within 30 days after surgery

Summary of cardiac risk prediction models for noncardiac surgery (Kindly provided by Doug Wright, MD, PhD, Co-director, Medicine Consult Service, MGH)

	Study type	Population	Defined Events	Risks Identified for Defined Events
Goldman[3]	Prospective observational cohort	1001 consecutive patients of MGH surgical services (no minor procedures)	• Cardiac death • Q-wave MI • Non-transmural MI • Pulmonary edema • Ventricular tachycardia Overall event rate: 5.8%	• 3d heart sound or JVD • Recent MI • Rhythm other than sinus or PACs • >5 PVCs per minute • Peritoneal, thoracic, aortic surgery • Age >70 • Important valvular AS • Emergency operation • Poor general medical condition
Detsky[4]	Prospective observational cohort	455 referred to consult service w/ "cardiac risk" (includes 187 minor procedures)	• Cardiac death • Q-wave MI • Non-Q-wave MI • Pulmonary edema • New/worse CHF • "Coronary insufficiency" (angina) • Ventricular tachycardia (none noted) Overall event rate: 10.3% (2.1% in "minor" group, 16% in "major")	Similar to Goldman, except: • 3d sound/JVD replaced by pulm edema • Angina (CCS III, IV, or UAP) added • Surgery type specified more precisely
RCRI[5]	Prospective observational	4315 (2893 + 1422)	• MI (based on CKMB) • Pulmonary edema	• "High-risk" surgery • Stroke/TIA

	cohort	elective surgeries	(CXR) • VF/cardiac arrest/CHB • ?? cardiac death Overall event rate: 2.1%	• CHF • CAD • Elevated Cr • Diabetes on insulin
Davenport[2]	"Prospective" observational cohort	183000 general and peripheral vascular operations from 128 VA and 14 private hospitals. 2002, 2003, 2004 NSQIP (excluded many breast, hernia surgeries) random assignment to training or validation sets	• New Q-wave MI • Cardiac arrest => CPR • (within 30 days of operation) Overall event rate: 1.3% (low due to strict event definition)	20 variables identified. Strongest: • ASA Class IV, V (vs I, II) • Age >65 (vs < 40) • High "work RVU" of procedure • Surgery type NOT identified: • Diabetes • CAD or angina (but only known if PTCA or cardiac surgery) • Earlier cardiac operation • CHF > 1 month prior • Obesity (up to BMI >40) • PVD
Gupta[6]	"Prospective" observational cohort	Trained on 2007 (211000), Validated on 2008 (257000) NSQIP (no trauma, transplant, or age <16; vascular surgeries treated separately)	• MI (STE, new LBBB, new Qs, new troponin >3x ULN w/ suspected ischemia) • Cardiac arrest => CPR • (within 30 days of operation) Overall event rate: 0.65%	• Type of surgery • Dependent functional status • Cr > 1.5 • ASA class • Increasing age NOT identified: • DM on insulin • CAD (BUT only known if PTCA or cardiac surgery) • Earlier cardiac operation • CHF
van Diepen[7] (CHF, CAD, A-fib)	Retrospective cohort	38000 pts in Alberta, divided by ICD-9 codes into 4 non-overlapping cohorts 1. Non-ischemic HF 2. Ischemic HF 3. CAD 4. Atrial fibrillation	• 30-day mortality	Unadjusted mortality: Non-ischemic HF – 8.5% Ischemic HF – 8.1% CAD – 2.3% Atrial fibrillation – 5.7%

More Detail:

Revised Cardiac Risk Index [5]

Six independent predictors

High-risk surgery (intraperitoneal, intrathoracic, or suprainguinal vascular)

History of ischemic heart disease (history of myocardial infarction, history of positive exercise stress test, current complaint of chest pain considered to be secondary to myocardial ischemia, using of nitrate therapy, or ECG with pathologic Q waves)

History of congestive heart failure (history of congestive heart failure, pulmonary edema, or paroxysmal nocturnal dyspnea; physical exam showing bilateral rales or S3 gallop; or chest radiograph showing pulmonary vascular redistribution)

History of cerebrovascular disease (history of transient ischemic attack or stroke)

Preoperative treatment with insulin

Preoperative serum creatinine >2.0 mg/dL

Major cardiac complications defined as cardiac death, ventricular fibrillation, complete heart block, acute myocardial infarction, pulmonary edema.

Data (Major cardiac complication rate)

Number of predictors	**Derivation cohort (n=2893)**	**Validation cohort (n=1422)**
None	0.5% (95% CI 0.2-1.1)	0.4% (95% CI 0.05-1.5)
1	1.3% (95% CI 0.7-2.1)	0.9% (95% CI 0.3-2.1)
2	3.6% (95% CI 2.1-5.6)	6.6% (95% CI 3.9-10.3)
3 or more	9.1% (95% CI 5.5-13.8)	11.0% (95% CI 5.8-18.4)

More data using the revised cardiac risk index. Mortality data.

Number of predictors	**Lindenauer et al. NEJM 2005**[8]	**Boersma et al. Am J Med 2005**[9]
0, all patients	1.4%	0.3%
0, hypertension	1.2%	
1, all patients	2.2%	0.7%
1, diabetes	1.7%	
1, ischemic heart disease	2.0%	
1, cerebrovascular disease	9.0%	
1, renal insufficiency	7.2%	
2, all patients	3.9%	1.7%
3, all patients	5.8%	3.6%
4 or more	7.4%	

An old “friend”:

ASA Physical Status Classification

ASA PS 1	Normal healthy patient	No organic, physiologic, or psychiatric disturbance; excludes the very young and very old; healthy with good exercise tolerance
ASA PS 2	Patients with mild systemic disease	No functional limitations; has a well-controlled disease of one body system; controlled hypertension or diabetes without systemic effects, cigarette smoking without chronic obstructive pulmonary disease (COPD); mild obesity, pregnancy
ASA PS 3	Patients with severe systemic disease	Some functional limitation; has a controlled disease of more than one body system or one major system; no immediate danger of death; controlled congestive heart failure (CHF), stable angina, old heart attack, poorly controlled hypertension, morbid obesity, chronic renal failure; bronchospastic disease with intermittent symptoms
ASA PS 4	Patients with severe systemic disease that is a constant threat to life	Has at least one severe disease that is poorly controlled or at end stage; possible risk of death; unstable angina, symptomatic COPD, symptomatic CHF, hepatorenal failure
ASA PS 5	Moribund patients who are not expected to survive without the operation	Not expected to survive > 24 hours without surgery; imminent risk of death; multiorgan failure, sepsis syndrome with hemodynamic instability, hypothermia, poorly controlled coagulopathy
ASA PS 6	A declared brain-dead patient who organs are being removed for donor purposes	

Patient Safety in Surgery Study model[2]:

Developed from a randomly-chosen cohort of 91,572 patients undergoing noncardiac surgery during 2002-2004. Drawn from 128 VA hospitals, 14 private hospitals. Risk model validated in a separate, equal sized cohort.

Cardiac adverse events defined as cardiac arrest requiring cardiopulmonary resuscitation or acute MI manifested by new Q waves on EKG. Non-Q-wave MI not counted in this study.

Cardiac adverse events occurred in 1.29% patients. **59% of patients who suffered a cardiac event died within 30 days of surgery** compared to 1.8% 30-day mortality among patients who did not experience a cardiac adverse event.

Data and the risk prediction model:

Table 4. Independent Predictors of Cardiac Adverse Events and Associated Risk Points

Predictor	Odds ratio	95% CI	p Value	Risk points
ASA physical status class				
4–5 versus 1–2	5.797	4.264–7.882	< 0.0001	6
3 versus 1–2	3.309	2.488–4.401	< 0.0001	3
Work RVU class of most complex procedure				
> 17 versus < 10	2.980	2.324–3.821	< 0.0001	3
10–17 versus < 10	1.837	1.450–2.328	< 0.0001	2
Emergency	1.713	1.463–2.006	< 0.0001	2
Preoperative creatinine ≥ 1.5 mg/dL	1.735	1.521–1.978	< 0.0001	2
Age (y)				
40–65 versus < 40	2.737	1.483–5.051	0.0013	3
> 65 versus < 40	4.618	2.503–8.520	< 0.0001	5
Preoperative sepsis	1.561	1.271–1.917	< 0.0001	2
Bleeding disorders	1.473	1.217–1.783	< 0.0001	1
Weight loss	1.605	1.334–1.932	< 0.0001	2
Congestive heart failure < 30 d before operation	1.593	1.300–1.953	< 0.0001	2
Type of operation				
Mouth, palate versus endocrine	3.473	1.104–10.924	0.0332	3
Thoracoabdominal aneurysm versus endocrine	3.365	1.156–9.795	0.0260	3
Peripheral aneurysm versus endocrine	3.050	1.084–8.582	0.0346	3
Stomach, intestines versus endocrine	3.193	1.176–8.667	0.0227	3
Respiratory and hemic versus endocrine	3.207	1.065–9.659	0.0383	3
Integumentary versus endocrine	3.054	1.096–8.508	0.0327	3
Hernia versus endocrine	1.451	0.509–4.138	0.4859	1
WBC count th/cumm				
Preoperative (< 2.5 versus 2.5–10)	1.698	0.873–3.304	0.1190	2
Preoperative (> 10 versus 2.5–10)	1.377	1.199–1.581	< 0.0001	1
Preoperative platelet count ≤ 150,000/cumm	1.444	1.219–1.710	< 0.0001	1
Impaired sensorium	1.352	1.076–1.698	0.0096	1
Dyspnea (yes versus no)	1.218	1.064–1.395	0.0041	1
CVA/stroke with neurologic deficit	1.304	1.083–1.571	0.0050	1
Ascites	1.503	1.133–1.992	0.0046	2
Wound class				
Contaminated versus clean	1.231	0.963–1.573	0.0967	1
Clean/contaminated versus clean	1.326	1.108–1.586	0.0021	1
Infected versus clean	1.054	0.817–1.360	0.6865	1
Preoperative albumin (≤ 3.5 versus > 3.5 g/dL)	1.180	1.028–1.356	0.0189	1
Gender (male versus female)	1.256	1.031–1.529	0.0235	1
Specialty (vascular versus general)	1.365	1.017–1.834	0.0383	1

n = 91,403; c-index = 0.8558; Hosmer-Lemeshow chi-square test = 9.0811; p = 0.3355.
ASA, American Society of Anesthesiologists; CVA, cerebrovascular accident; DVT, deep vein thrombosis; PGY, post-graduate year of surgeon; RBC, red blood cell; RVU, relative value unit; WBC, white blood cell count.

Tally points by using the right hand column and then use the following figure to estimate risk:

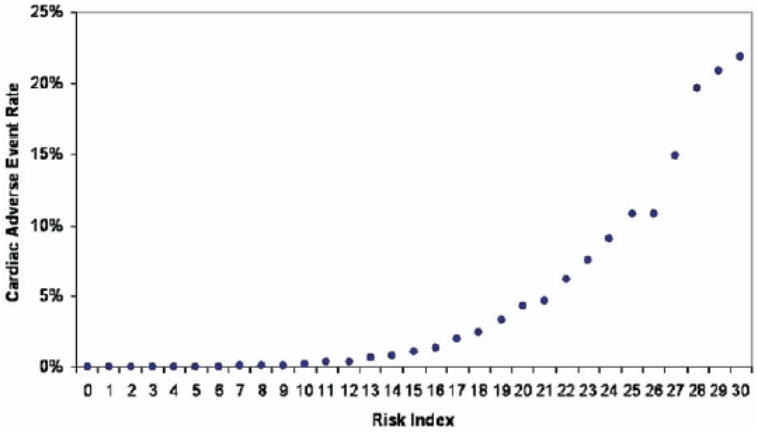


Figure 1. Cardiac adverse event rates by risk index. A risk index for each patient was calculated by summing the individual risk factor scores according to Table 4. The graph displays the rate of cardiac adverse events for patients grouped by risk index for groups with at least 90 patients. The risk index was effective in predicting cardiac events (c-index = 0.85).

Risk index categories (by thirds of the study population)	Risk index range	Estimated cardiac risk
Low	< 9 points	0.06%
Middle	9 to 14 points	0.42%
High	>14 points	3.14%

The MICA (Myocardial infarction or cardiac arrest) risk calculator ("Gupta model").

Another risk model from the NSQIP database, analyzing 211,410 patients from 2007[10], derived and validated a model that includes the following factors (see also the table below):

ASA class
Dependent functional status
Increasing age
Abnormal creatinine (>1.5 mg/dL)
Type of surgery

Table 2. Estimates, Standard Errors, and Variables Associated With Myocardial Infarction or Cardiac Arrest in Stepwise Logistic Regression Analysis (2007 NSQIP Data Set–Final Model)

Parameter	Estimate	SE	Adjusted OR	95% Wald CI
Intercept	−5.25	0.24		
Totally dependent functional status*	1.03	0.09	2.79	2.36–3.30
Partially dependent functional status*	0.65	0.08	1.92	1.65–2.23
ASA class 1†	−5.17	0.72	0.01	0.001–0.02
ASA class 2†	−3.29	0.17	0.04	0.03–0.05
ASA class 3†	−1.92	0.13	0.15	0.11–0.19
ASA class 4†	−0.95	0.12	0.39	0.30–0.49
Creatinine (abnormal)‡	0.61	0.06	1.84	1.63–2.09
Creatinine (missing)‡	−0.10	0.15	0.91	0.68–1.21
Age per year of increase	0.02	0.002	1.02	1.01–1.02
Anorectal§	−0.16	0.52	0.85	0.31–2.37
Aortic§	1.60	0.17	4.96	3.55–6.93
Bariatric§	−0.25	0.30	0.78	0.43–1.40
Brain§	1.40	0.42	4.04	1.79–9.13
Breast§	−1.61	0.47	0.20	0.08–0.50
Cardiac§	1.01	0.30	2.74	1.51–4.99
ENT§	0.71	0.73	2.04	0.49–8.47
Foregut/hepato-pancreatobiliary§	1.39	0.17	4.02	2.89–5.60
GBAAS§	0.59	0.18	1.81	1.27–2.58
Intestinal§	1.14	0.16	3.12	2.29–4.24
Neck§	0.18	0.29	1.20	0.68–2.12
Obstetric/gynecologic§	0.76	0.43	2.14	0.91–5.05
Orthopedic§	0.80	0.18	2.22	1.55–3.17
Other abdomen§	1.13	0.19	3.11	2.13–4.54
Peripheral vascular§	0.86	0.16	2.36	1.72–3.25
Skin§	0.54	0.25	1.72	1.06–2.79
Spine§	0.21	0.60	1.24	0.38–4.00
Thoracic§	0.40	0.42	1.49	0.67–3.32
Vein§	−1.09	1.01	0.34	0.05–2.43
Urology§	−0.26	0.52	0.77	0.28–2.14

NSQIP indicates National Surgical Quality Improvement Program; SE, standard error; OR, odds ratio; CI, confidence interval; ASA, American Society of Anesthesiologists; ENT, ear, nose, and throat; GBAAS, gallbladder, adrenal, appendix, spleen surgery.

Abnormal creatinine was creatinine >1.5 mg/dL.

The estimate and the SE refer to the estimate of the logistic regression coefficient for the specific variable and its associated SE. C statistic=0.884.

Reference groups were as follows: *Independent functional status; †ASA class 5; ‡normal creatinine; §hernia surgery. 0.4% of ASA class data were missing.

Available in an interactive spreadsheet:

http://www.surgicalriskcalculator.com/miorcardiacarrest

Estimated risk of myocardial infarction (EKG changes c/w MI or troponins > 3 times upper limit in setting of suspected myocardial ischemia) or cardiac arrest within 30 days post-op.

Additional key history: exercise tolerance…

Table 3. Estimated Energy Requirements for Various Activities

1 MET	Can you . . . Take care of yourself?	4 METs	Can you . . . Climb a flight of stairs or walk up a hill?
	Eat, dress, or use the toilet?		Walk on level ground at 4 mph (6.4 kph)?
	Walk indoors around the house?		Run a short distance?
	Walk a block or 2 on level ground at 2 to 3 mph (3.2 to 4.8 kph)?		Do heavy work around the house like scrubbing floors or lifting or moving heavy furniture?
4 METs	Do light work around the house like dusting or washing dishes?		Participate in moderate recreational activities like golf, bowling, dancing, doubles tennis, or throwing a baseball or football?
		Greater than 10 METs	Participate in strenuous sports like swimming, singles tennis, football, basketball, or skiing?

kph indicates kilometers per hour; MET, metabolic equivalent; and mph, miles per hour.

Algorithm from the ACC/AHA 2009 Guidelines[1]

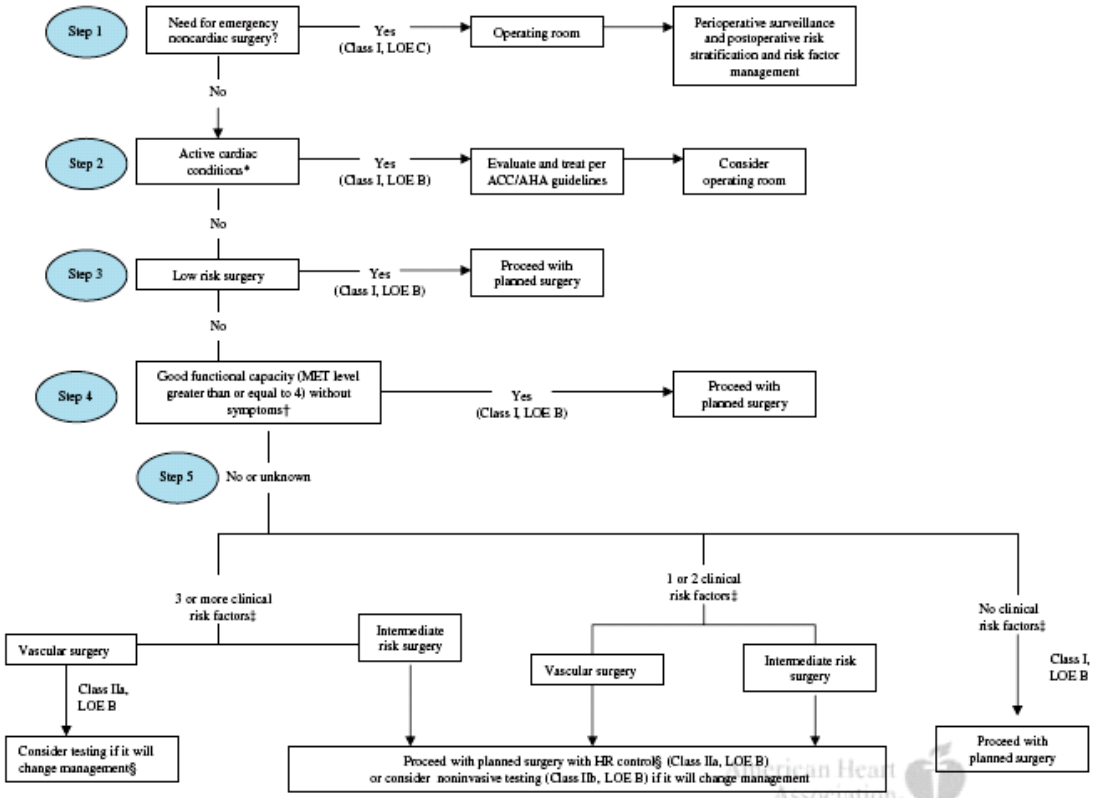


Figure 1. Cardiac evaluation and care algorithm for noncardiac surgery based on active clinical conditions, known cardiovascular disease, or cardiac risk factors for patients 50 years of age or greater. *See Table 2 for active clinical conditions. †See Table 3 for estimated MET level equivalent. ‡Clinical risk factors include ischemic heart disease, compensated or prior HF, diabetes mellitus, renal insufficiency, and cerebrovascular disease. §Consider perioperative beta blockade (see Table 11) for populations in which this has been shown to reduce cardiac morbidity/mortality. ACC/AHA indicates American College of Cardiology/American Heart Association; HR, heart rate; LOE, level of evidence; and MET, metabolic equivalent.

Risk mitigation and noncardiac surgery:

Beta-blockers

a. ACC/AHA 2009 focused update on perioperative cardiovascular evaluation for noncardiac surgery: focused update on perioperative beta-blocker therapy.[11]

1. Beta-blockers should be continued in patients undergoing surgery who are receiving beta-blockers to treat angina, symptomatic arrhythmias, hypertension, or other ACC/AHA Class I guideline indications. (Evidence: Class I, Level C)
2. Beta-blockers titrated to heart rate and blood pressure are probably recommended for patients undergoing vascular surgery who are at high risk owing to coronary artery disease or the finding of cardiac ischemia on preoperative testing. (Evidence: Class IIa, Level B)
3. Beta-blockers titrated to heart rate and blood pressure are reasonable for patients in whom preoperative assessment for vascular surgery identifies high cardiac risk, as defined by the presence of more than 1 clinical risk factor. (Evidence: Class IIa, Level C)
4. Beta-blockers titrated to heart rate and blood pressure are reasonable for patients in whom preoperative assessment identifies coronary artery disease or high cardiac risk, as defined by the presence of more than 1 clinical risk factor, who are undergoing intermediate-risk surgery. (Evidence: Class IIa, Level B)
5. The usefulness of beta blockers is uncertain for patients who are undergoing either intermediate-risk procedures or vascular surgery in whom preoperative assessment identifies a single clinical risk factor in the absence of coronary artery disease. (Evidence: Class IIb, Level C)
6. The usefulness of beta blockers is uncertain for patients who are undergoing vascular surgery with no clinical risk factors who are not currently taking beta blockers. (Evidence: Class IIb, Level B)
7. Beta-blockers should not be given to patients undergoing surgery who have absolute contraindications to beta-blockade. (Evidence: Class III, Level C)
8. Routine administration of high-dose beta-blockers in the absence of dose titration is not useful and may be harmful to patients not currently taking beta blockers who are undergoing noncardiac surgery. (Evidence: Class III, Level B)

b. From the ESC/ESA guidelines[12]:

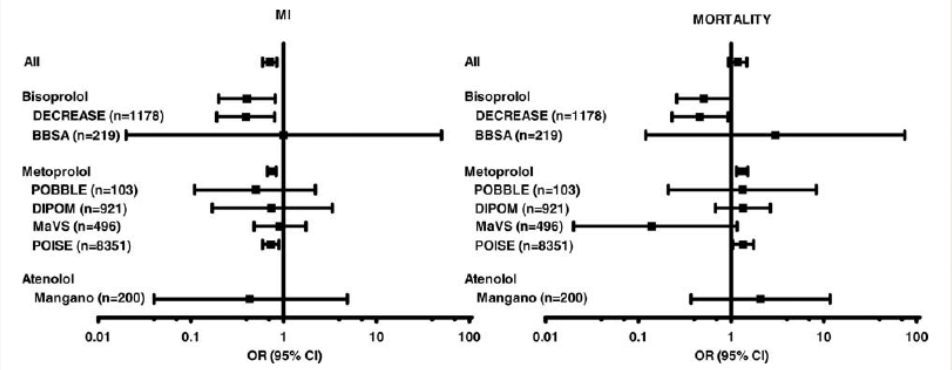


Figure 2 Effect of β-blockers on 30-day rates of non-fatal MI and all-cause mortality as assessed from the seven randomized trials. Note: in the trial by Mangano *et al.*, mortality was assessed at 6 months.

c. POISE (**P**eri**O**perative **IS**chemic **E**valuation) Trial.[13]

Randomized, controlled, multicenter (190 hospitals in 23 countries) trial that compared metoprolol (target dose 200 mg daily) versus placebo in a range of intermediate or high risk surgeries (41% vascular, 22% intraperitoneal, 21% orthopedic, 16% other). Primary outcome: cardiovascular death+non-fatal MI+non-fatal cardiac arrest at 30 days after randomization.

Data:

	Metoprolol group (n=4174)	Placebo group (n=4177)	Hazard ratio	p value
Cardiovascular death, non-fatal myocardial infarction, or non-fatal cardiac arrest*	244 (5·8%)	290 (6·9%)	0·84 (0·70–0·99)	0·0399
Cardiovascular death	75 (1·8%)	58 (1·4%)	1·30 (0·92–1·83)	0·1368
Non-fatal myocardial infarction	152 (3·6%)	215 (5·1%)	0·70 (0·57–0·86)	0·0008
Non-fatal cardiac arrest	21 (0·5%)	19 (0·5%)	1·11 (0·60–2·06)	0·7436
Total mortality	129 (3·1%)	97 (2·3%)	1·33 (1·03–1·74)	0·0317
Myocardial infarction	176 (4·2%)	239 (5·7%)	0·73 (0·60–0·89)	0·0017
Cardiac revascularisation†	11 (0·3%)	27 (0·6%)	0·41 (0·20–0·82)	0·0123
Stroke	41 (1·0%)	19 (0·5%)	2·17 (1·26–3·74)	0·0053
Non-fatal stroke	27 (0·6%)	14 (0·3%)	1·94 (1·01–3·69)	0·0450
Congestive heart failure†	132 (3·2%)	116 (2·8%)	1·14 (0·89–1·46)	0·3005
New clinically significant atrial fibrillation†	91 (2·2%)	120 (2·9%)	0·76 (0·58–0·99)	0·0435
Clinically significant hypotension†	625 (15·0%)	404 (9·7%)	1·55 (1·38–1·74)	<0·0001
Clinically significant bradycardia†	277 (6·6%)	101 (2·4%)	2·74 (2·19–3·43)	<0·0001
Non-cardiovascular death	54 (1·3%)	39 (0·9%)	1·39 (0·92–2·10)	0·1169

Data are n (%) or hazard ratio or relative risk (95% CI). *Some patients had more than one event. †Relative risks presented, rather than hazard ratios, since we did not collect the actual date patients experienced these events.

Table 3: **Effects of study treatment on primary and secondary outcomes at 30 days**

It is not clear how this trial should affect individualized decision-making regarding beta-blockers around the time of surgery, although it is clear that starting with a hefty 200 mg daily dose of metoprolol is probably not the right way to approach this. The trial should result in less overall use of beta-blockers for perioperative risk mitigation. As the editorialists pointed out, post-operative tachycardia should be carefully evaluated and underlying causes addressed before pushing β-blockers.[14]

d. DECREASE-IV Study[15]

Prospective, randomized, controlled, open-label, 2 by 2 trial of bisoprolol, fluvastatin, both, none in noncardiac surgery patients with an estimated cardiovascular risk of between 1 and 6%. Started study drugs a median of 34 days before surgery, allowing time for titration, and continued until 30 days after surgery. Titrated bisoprolol from 2.5 mg daily up to as much as 10 mg daily for a target heart rate of 50-70. Screened 45,000 patients, of whom 6460 patients met inclusion criteria, but 78% of these patients were already taking beta-blockers. This left only 1066 patients for the study that was ended early because of slow enrollment.

Data:

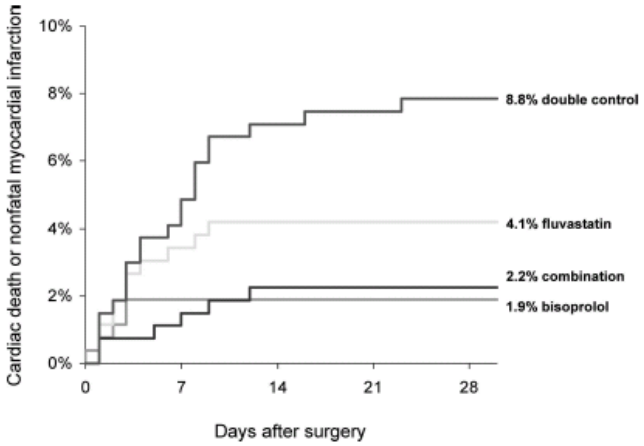


FIGURE 1. Incidence of primary study end point by treatment group: double control (red); fluvastatin (yellow); combination therapy (blue); and bisoprolol (green).

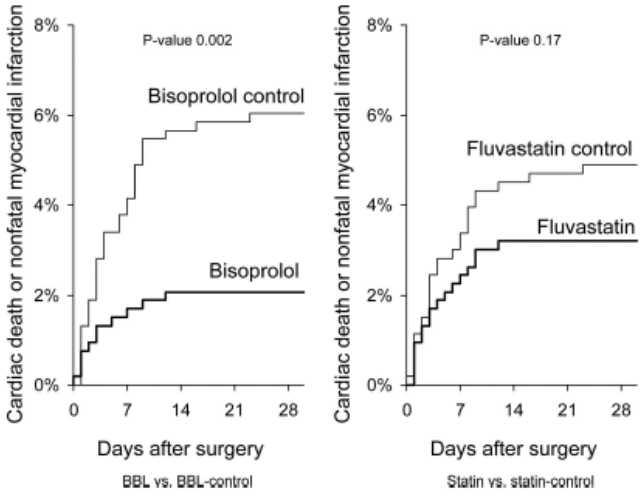


FIGURE 2. Incidence of primary study end point for each individual treatment versus control.

Bisoprolol resulted in a statistically significant reduction in cardiac death and nonfatal MI at 30 days after surgery, while fluvastatin appeared to reduce risk but did not achieve statistical significance.

Current thinking (same as last year):

For patients with 0-1 risk factors by Lee Revised Cardiac Risk Index, beta-blockers are not beneficial as perioperative risk mitigation and may be harmful. For patients with two or more risk indicators, beta-blockers are probably beneficial, but ideally should be started well before surgery and titrated to a heart rate of 50-70. Acute use of beta-blockers, particularly high dose, is not a good strategy.

Statins and surgery

DECREASE III[16]

Double-blind, placebo-controlled trial of fluvastatin 80 mg daily versus placebo in patients already on bisoprolol, about to undergo vascular surgery. Study drug started a median of 37 days prior to surgery.

Table 1. Baseline Characteristics of the Patients, According to Study Group.*

Characteristic	Fluvastatin (N= 250)	Placebo (N= 247)
Demographic Characteristics		
Age — yr	66.0±10.5	65.8±11.5
Male sex — no. (%)	194 (77.6)	178 (72.1)
Risk factors		
Myocardial infarction — no. (%)	73 (29.2)	66 (26.7)
Angina pectoris — no. (%)	52 (20.8)	59 (23.9)
Congestive heart failure — no. (%)	13 (5.2)	19 (7.7)
Diabetes mellitus — no. (%)	55 (22.0)	42 (17.0)
Stroke or TIA — no. (%)	75 (30.0)	66 (26.7)
Renal insufficiency — no. (%)	23 (9.2)	31 (12.6)
Hypertension — no. (%)	142 (56.8)	143 (57.9)
COPD — no. (%)	74 (29.6)	71 (28.7)
Medication use		
Beta-blocker — no. (%)	250 (100.0)	247 (100.0)
Antiplatelet — no. (%)	160 (64.0)	146 (59.1)
Anticoagulant — no. (%)	62 (24.8)	73 (29.6)
ACE inhibitor — no. (%)	76 (30.4)	73 (29.6)
Calcium antagonist — no. (%)	56 (22.4)	59 (23.9)
Angiotensin II–receptor antagonist — no. (%)	40 (16.0)	37 (15.0)
Nitrate — no. (%)	20 (8.0)	23 (9.3)
Diuretic — no. (%)	64 (25.6)	78 (31.6)
Surgery		
Carotid artery — no. (%)	37 (14.8)	32 (13.0)
Abdominal aortic — no. (%)	121 (48.4)	115 (46.6)
Open — no. (%)	58 (23.2)	54 (21.9)
Endovascular — no. (%)	63 (25.2)	61 (24.7)
Lower-limb arterial — no. (%)	92 (36.8)	100 (40.5)

* Plus–minus values are means ±SD. ACE denotes angiotensin-converting enzyme, COPD chronic obstructive pulmonary disease, and TIA transient ischemic attack.

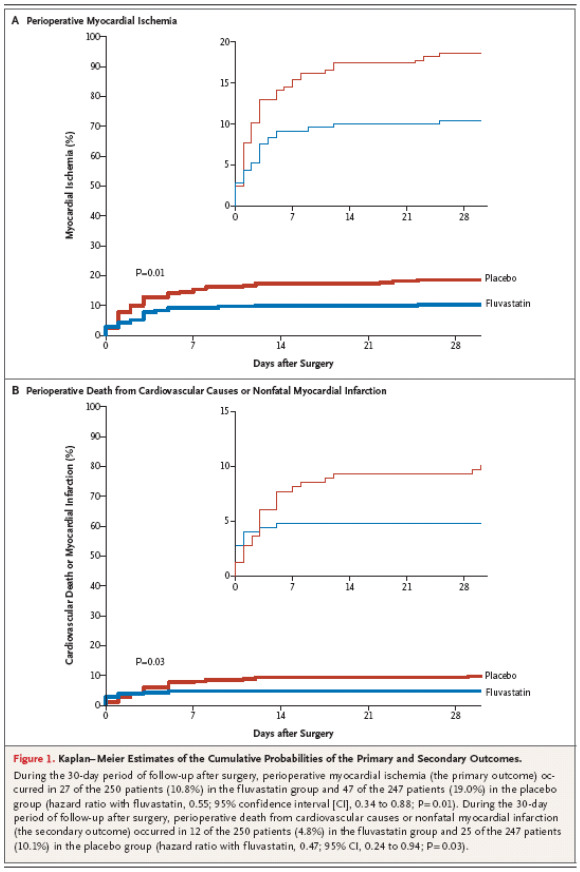
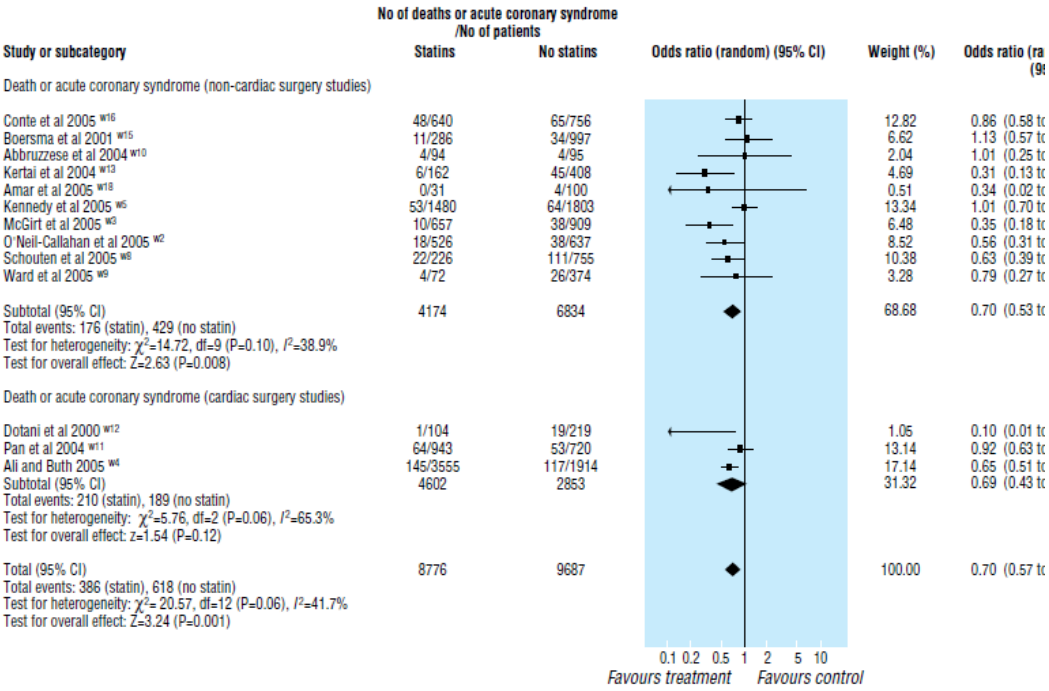
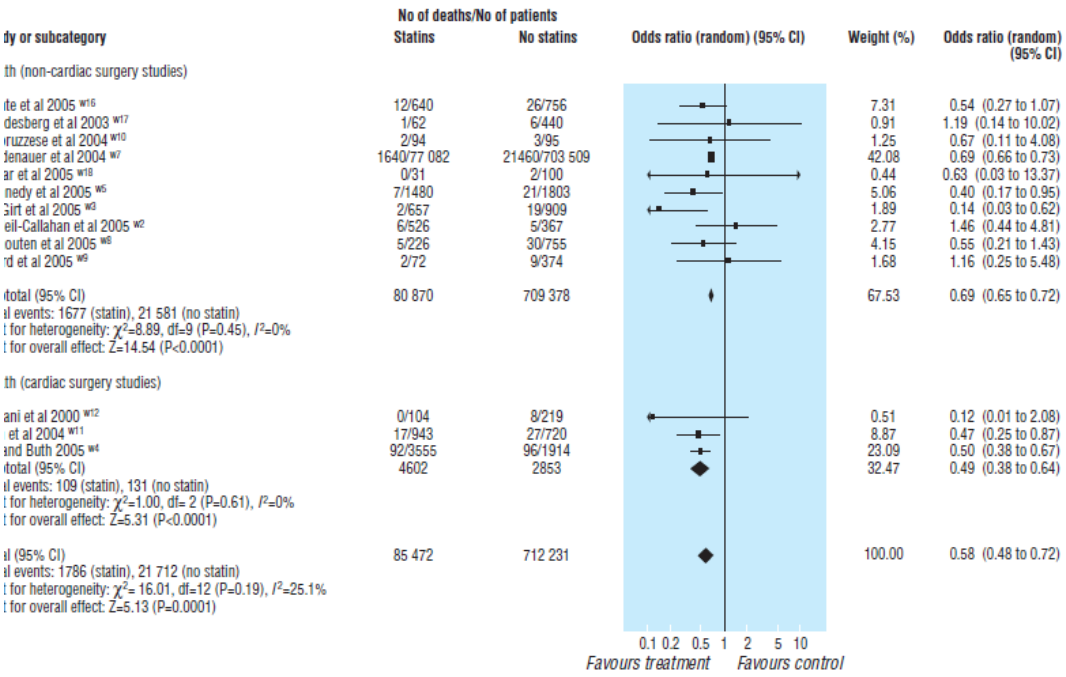


Figure 1. Kaplan–Meier Estimates of the Cumulative Probabilities of the Primary and Secondary Outcomes.
During the 30-day period of follow-up after surgery, perioperative myocardial ischemia (the primary outcome) occurred in 27 of the 250 patients (10.8%) in the fluvastatin group and 47 of the 247 patients (19.0%) in the placebo group (hazard ratio with fluvastatin, 0.55; 95% confidence interval [CI], 0.34 to 0.88; P=0.01). During the 30-day period of follow-up after surgery, perioperative death from cardiovascular causes or nonfatal myocardial infarction (the secondary outcome) occurred in 12 of the 250 patients (4.8%) in the fluvastatin group and 25 of the 247 patients (10.1%) in the placebo group (hazard ratio with fluvastatin, 0.47; 95% CI, 0.24 to 0.94; P=0.03).

Meta-analysis from 2006[17] included 18 studies (2 RCT, 15 cohort studies, 1 case control) with 12 of the studies being conducted in vascular surgery patients:



2 Perioperative death or acute coronary syndrome event rates in cohort studies



3 Perioperative death rates in cohort studies

A more recent systematic review and meta-analysis summarizes data from 15 randomized, controlled trials, 11 of which were in CABG.[18] Patients were "statin-naïve" entering these trials, so this gives a better sense of perioperative effect.

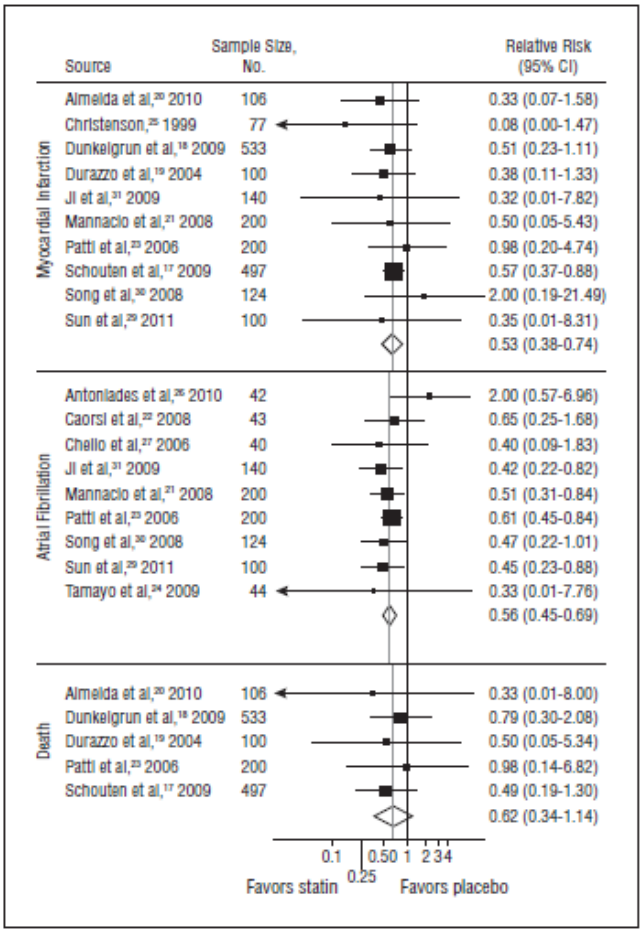


Figure 2. Effect of perioperative statins on myocardial infarction, atrial fibrillation, and death.

Results argue for starting statins if not already prescribed for patients who are undergoing cardiac and vascular surgery, but it seems premature to extend use to patients at lower risk for cardiac events.

Clonidine and noncardiac surgery

Meta-analyses have suggested benefit in vascular surgery but have not confirmed benefit in nonvascular surgery.[19] The PeriOperative Ischemia Evaluation-2 (POISE-2) trial is enrolling 10,000 patients in a 2-by-2 design to assess the effect of aspirin and clonidine in noncardiac surgery patients at risk for cardiovascular events. The results are expected in 2014. Stay tuned.

Should we be routinely checking troponins after noncardiac surgery?

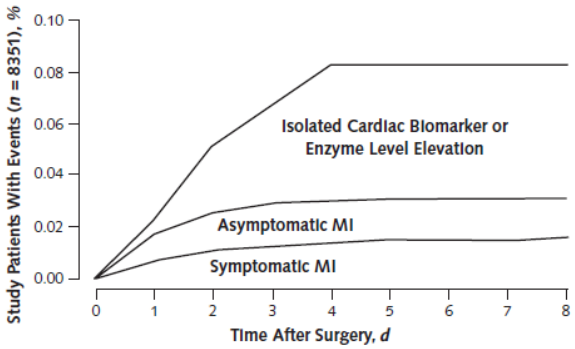
An offshoot from the POISE trial provides interesting insight into this question.[20] 8351 patients in this cohort study had cardiac troponins measured during the 3 days after surgery.

Perioperative MI defined as either autopsy findings of MI or elevated cardiac biomarker with at least one of the following defining features: ischemic symptoms, development of pathologic Q waves, ischemic changes on EKG, coronary artery intervention, or cardiac imaging evidence of MI.

30 day follow-up.

Data:

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



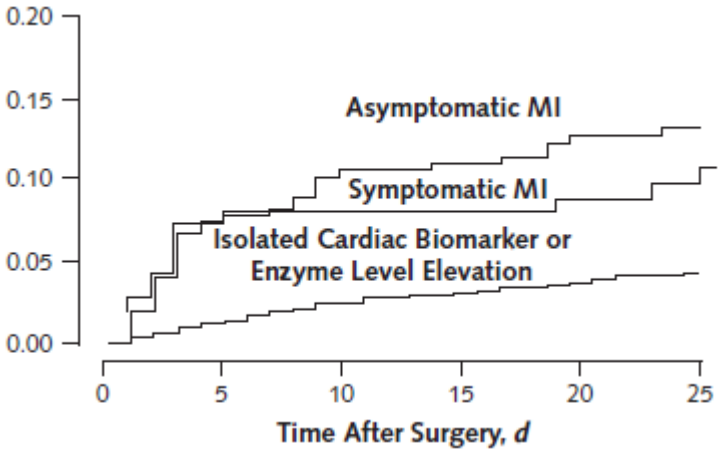
An isolated elevation refers to a patient who had elevated levels of a cardiac biomarker or an enzyme but did not fulfill our definition of MI. MI = myocardial infarction.

Table 1. Outcomes

Outcome	Patients With No Perioperative MI (*n* = 7936), *n* (%)	Perioperative MI With Ischemic Symptoms (*n* = 144)		Perioperative MI Without Ischemic Symptoms (*n* = 271)		No Perioperative MI But Elevated Cardiac Biomarker or Enzyme Levels (*n* = 697)	
		Patients, *n* (%)	Unadjusted Odds Ratio (95% CI)*	Patients, *n* (%)	Unadjusted Odds Ratio (95% CI)*	Patients, *n* (%)	Unadjusted Odds Ratio (95% CI)†
Nonfatal cardiac arrest	26 (0.3)	3 (2.1)	6.48 (1.94–21.64)	11 (4.1)	12.87 (6.29–26.33)	6 (0.9)	3.93 (1.51–10.27)
Congestive heart failure	171 (2.2)	35 (24.3)	14.58 (9.68–21.97)	42 (15.5)	8.33 (5.80–11.96)	22 (3.2)	1.55 (0.98–2.45)
Stroke	52 (0.7)	1 (0.7)	1.06 (0.15–7.72)	7 (2.6)	4.02 (1.81–8.94)	5 (0.7)	1.11 (0.44–2.82)
Coronary revascularization	5 (0.1)	19 (13.2)	241.09 (88.63–655.85)	14 (5.2)	86.41 (30.89–241.71)	2 (0.3)	9.14 (1.29–64.97)

MI = myocardial infarction.
* Compared with patients who did not have perioperative MI.
† Compared with patients who did not have either perioperative MI or an elevated cardiac biomarker or enzyme level.

Mortality



The period of greatest danger is during the 48-72 after a perioperative MI.

Perioperative MI was an independent predictor of 30 day mortality. Interestingly, patients with symptomatic MI had a 30 day mortality of 9.7% while those with asymptomatic MI had a higher (12.5%) mortality.

Impact: Not clear, as it is not clear how to intervene. However, for patients at high risk of perioperative MI, checking post-op troponins may identify patients who should be monitored more closely and who should have medical management maximized.

Case 2

77 y.o. patient with the following medical conditions:

1. Heart failure, managed with furosemide 40 mg BID, metoprolol 50 mg TID, digoxin 0.125 mg daily. Unclear why not on an ACE inhibitor or ARB.
2. Atrial fibrillation since 2007, rate controlled with metoprolol, digoxin. No history of embolic events. On Coumadin with INR consistently in the 2-3 range.
3. Coronary artery disease, manifested by myocardial infarction 15 years ago.
4. Deep venous thrombosis and pulmonary embolism, 2005.

No chest pain or shortness of breath. No peripheral edema.

No history of diabetes, stroke, or renal insufficiency. History of hypertension in the past, but blood pressure has been normal on current medications.

Exam: Heart rate 100-115, irreg. BP 126/66, Weight 65 kg
Lungs are clear. Cardiac: irreg, irreg rhythm, loud III/VI systolic murmur heard best at the RUSB with radiation to the carotids, also heard well at the apex.

Data: Creatinine 0.7; glucose 152; Hct 32.5 with MCV 77; platelets 346,000; INR 3.1

The patient is being considered for a right hemicolectomy for colon cancer discovered during evaluation of iron deficiency anemia.

The patient is seen in the office for pre-operative assessment and planning. Among many other issues to be addressed for this patient, anticoagulation is a major concern.

Anticoagulation

Key questions:

1. Bleeding risk of the anticipated procedure
2. Risk of thromboembolic events with interruption of anticoagulation
3. Risk of venous thromboembolism associated with the anticipated procedure.

Bleeding risk of procedures

No validated method for quantifying the bleeding risk of specific procedures. However, the following procedures are associated with high risk for bleeding or for the consequences of bleeding[21]:

Coronary artery bypass surgery
Heart valve replacement surgery
Intracranial or spinal surgery
Aortic aneurysm repair
Peripheral artery bypass
Major orthopedic surgery (hip or knee replacement)
Reconstructive plastic surgery
Major cancer surgery
Prostate and bladder surgery
Resection of colonic polyps > 2cm in diameter
Biopsy of the prostate or kidney
Cardiac pacemaker or defibrillator placement (separation of fascial layers, lack of cautery/suturing, lead to risk for pocket hematoma)

Perioperative risk of thromboembolic events[22]

Table 1 ACCP suggested risk stratification for perioperative thromboembolism

Risk category	Mechanical heart valve	Atrial fibrillation	Venous thromboembolism
High (>10%/year risk of ATE or >10%/month risk of VTE)	Any mechanical mitral valve Caged ball or tilting disc valve in mitrial/aortic position Recent (<6 months) stroke or TIA	$CHADS_2$ score of 5 or 6 Recent (<3 months) stroke or TIA Rheumatic valvular heart disease	Recent (<3 months) VTE Severe thrombophilia Deficiency of protein C, protein S or antithrombin Antiphospholipid antibodies Multiple thrombophilias
Moderate (4%–10%/year risk of ATE or 4%–10%/month risk of VTE)	Bileaflet AVR with major risk factors for stroke	$CHADS_2$ score of 3 or 4	VTE within past 3–12 months Recurrent VTE Nonsevere thrombophilia Active cancer
Low: (<4%/year risk of ATE or <2%/month risk of VTE)	Bileaflet AVR without major risk factors for stroke	$CHADS_2$ score of 0–2 (and no prior stroke or TIA)	VTE more than 12 months ago

ACCP, American College of Chest Physicians; ATE, arterial thromboembolism; AVR, aortic valve; TIA, transient ischemic attack; VTE, venous thromboembolism. Data from [3,4].

($CHADS_2$: 1 point each for CHF, hypertension, diabetes, age>75; 2 points for prior stroke or TIA)

Thromboembolism risk in surgical patients

Two possible approaches to risk reduction:

1. Consider the risk of VTE in each patient, based on the individual predisposing risk factors and the risk associated with their current illness or procedure.
2. Implement thromboprophylaxis routinely for all patients who belong to each of the major groups at risk.

The ACCP consensus conference supports the latter approach. The tables that follow are taken from the 2008 consensus statement.[23]

Table 4—*Approximate Risks of DVT in Hospitalized Patients (Section 1.2)

Patient Group	DVT Prevalence, %
Medical patients	10–20
General surgery	15–40
Major gynecologic surgery	15–40
Major urologic surgery	15–40
Neurosurgery	15–40
Stroke	20–50
Hip or knee arthroplasty, HFS	40–60
Major trauma	40–80
SCI	60–80
Critical care patients	10–80

*Rates based on objective diagnostic screening for asymptomatic DVT in patients not receiving thromboprophylaxis.

Table 5—*Levels of Thromboembolism Risk and Recommended Thromboprophylaxis in Hospital Patients (Section 1.3)

Levels of Risk	Approximate DVT Risk Without Thromboprophylaxis, %†	Suggested Thromboprophylaxis Options‡
Low risk		
Minor surgery in mobile patients	< 10	No specific thromboprophylaxis
Medical patients who are fully mobile		Early and "aggressive" ambulation
Moderate risk		
Most general, open gynecologic or urologic surgery patients	10–40	LMWH (at recommended doses), LDUH bid or tid, fondaparinux
Medical patients, bed rest or sick		
Moderate VTE risk plus high bleeding risk		Mechanical thromboprophylaxis§
High risk		
Hip or knee arthroplasty, HFS	40–80	LMWH (at recommended doses), fondaparinux,
Major trauma, SCI		oral vitamin K antagonist (INR 2–3)
High VTE risk plus high bleeding risk		Mechanical thromboprophylaxis§

*The descriptive terms are purposely left undefined to allow individual clinician interpretation.
†Rates based on objective diagnostic screening for asymptomatic DVT in patients not receiving thromboprophylaxis.
‡See relevant section in this chapter for specific recommendations.
§Mechanical thromboprophylaxis includes IPC or VFP and/or GCS; consider switch to anticoagulant thromboprophylaxis when high bleeding risk decreases.

IPC = intermittent pneumatic compression
VFP = venous foot pump
GCS = graded compression stockings

ACCP (2012) recommendations[24]:

1. In patients who require temporary interruption of a VKA (vitamin K antagonists, i.e. warfarin), we recommend stopping VKAs approximately 5 days before surgery instead of stopping VKAs a shorter time before surgery.
2. In patients who require temporary interruption of a VKA before surgery, we recommend resuming VKAs approximately 12-24 hours (the evening after or the next morning) after surgery and when there is adequate hemostasis instead of later resumption of VKAs.
3. In patients with a mechanical heart valve, atrial fibrillation, or VTE at high risk for thromboembolism, we suggest bridging anticoagulation with therapeutic-dose SC LMWH or IV unfractionated heparin (UFH) instead of no bridging during temporary interruption of VKA therapy.
4. In patients with a mechanical heart valve or atrial fibrillation or VTE at moderate risk for thromboembolism, the bridging or no bridging approach chosen is, as in the higher- and lower-risk patients, based on an assessment of individual patient- and surgery-related factors.
5. In patients with a mechanical heart valve or atrial fibrillation or VTE at low risk for thromboembolism, we suggest no bridging instead of bridging during interruption of VKA therapy.

6. Bridging specifics:

    In patients who are receiving bridging anticoagulation with therapeutic-dose IV unfractionated heparin, we suggest stopping UFH 4 to 6 hours before surgery instead of closer to surgery.

    In patients who are receiving bridging anticoagulation with therapeutic-dose SC LMWH, we suggest administering the last preoperative dose of LMWH approximately 24 hours before surgery instead of 12 hours before surgery.

    In patients who are receiving bridging anticoagulation with therapeutic-dose SC LMWH and are undergoing high-bleeding-risk surgery, we suggest resuming therapeutic dose LMWH 48 to 72 hours after surgery instead of resuming LMWH within 24 hours after surgery.

From the 8th Consensus Conference (these were modified in the formal recommendations in the 9th edition, but still seem reasonable):

Dental, dermatologic, or ophthalmologic procedures.

For minor dental procedures, continue warfarin around the time of procedure and administer an oral prohemostatic agent. For patients receiving aspirin, continue the aspirin around the time of the procedure.
For minor dermatologic procedures, continue warfarin around the time of the procedure. For patients receiving aspirin, continue aspirin.
For cataract removal, continue warfarin, continue aspirin.

Management of antithrombotic therapy in patients requiring urgent surgery or other invasive procedures.

If reversal of warfarin is required for the procedure, ***recommend*** low-dose oral or IV vitamin K (2.5-5.0 mg).
For more immediate reversal of anticoagulant effect, ***suggest*** treatment with fresh-frozen plasma or another prothrombin concentrate in addition to low-dose oral or IV vitamin K.
For patients receiving aspirin or clopidogrel, or both, are undergoing surgery, and have excessive or life-threatening bleeding, ***suggest*** transfusion of platelets or administration of other prohemostatic agents.

So, what are we actually doing?

Multicenter, propective, observational study of periprocedural management of patients on warfarin various indications[25]

Event rates	No bridging (N=263)	Prophylactic dose heparin products (N=68)	Full-dose heparin product bridging (N=161)
Major bleeding	1.1%	2.9%	6.8%
Minor bleeding	1.5%	0	6.8%
Any bleeding event	2.6%	2.9%	13.6%
Thrombotic event	1.1%	1.5%	0
Death	0	0	0.6%

A strategy for full bridging proposed by Grant PJ, Brotman DJ, and Jaffer AK[26]:

Preoperatively

Ensure patient does not have any contraindications to LMWH bridging such as:
- allergy to LMWH
- history of HIT
- severe thrombocytopenia
- extremes of weight (severely underweight of overweight)
- creatinine clearance < 15 ml/min (weight-based dosing if 15-30 ml/min)
- poor patient reliability
- inability to administer injections

↓

Provide bridging instructions:
- stop warfarin 5 days before surgery (if INR 2-3)
- stop warfarin 6 days before surgery (if INR 3-4.5)
- start LMWH* 36 hours after last warfarin dose
- administer last dose of LMWH 24 hours prior to procedure†
- check INR on morning of surgery to ensure <1.5 and in some cases <1.2

↓

Postoperatively

- restart LMWH* approximately 24 hours post procedure or consider thromboprophylaxis dosing of LMWH on post-op day 1 if patient is at high risk for bleeding (discuss with surgeon)
- restart warfarin at patient's usual dose on the evening of the surgical day
- check INR daily until patient is discharged and periodically thereafter until INR is therapeutic
- check CBC on post-op days 3 and 7 to monitor platelets
- discontinue LMWH when INR is therapeutic for two consecutive days

Case 3

65 y.o. patient with the following medical problems:

1. Coronary artery disease. Underwent PCI 13 months ago, with drug-eluting stents to the RCA and LAD.
2. Hypertension
3. Dyslipidemia, on Lipitor
4. Diabetes mellitus, managed with diet alone, but known since 1998. Last HgB A1C: 8.7%

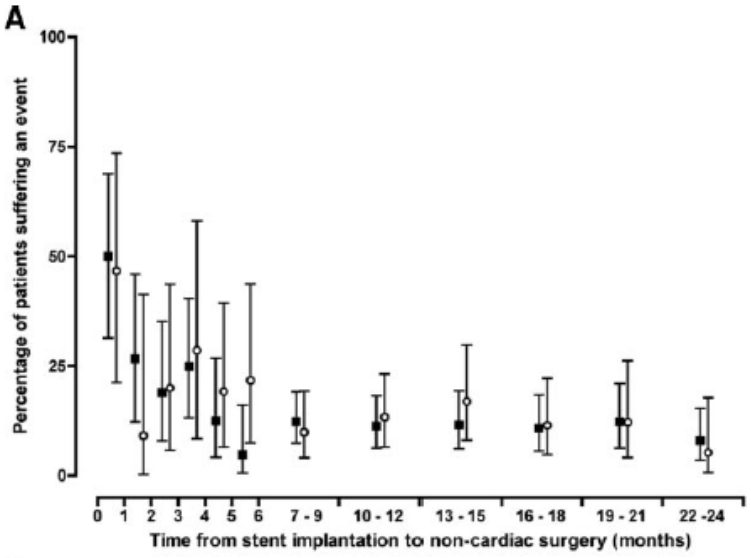
Meds: Aspirin 81 mg daily, clopidogrel 75 mg daily, Toprol XL 50 mg daily, amlodipine 10 mg daily, valsartan 160 mg daily, hydrochlorothizide 25 mg daily, atorvastatin 40 mg daily, omeprazole 20 mg daily, Imdur 30 mg daily.

Now being considered for left total hip replacement because of severe osteoarthritis.

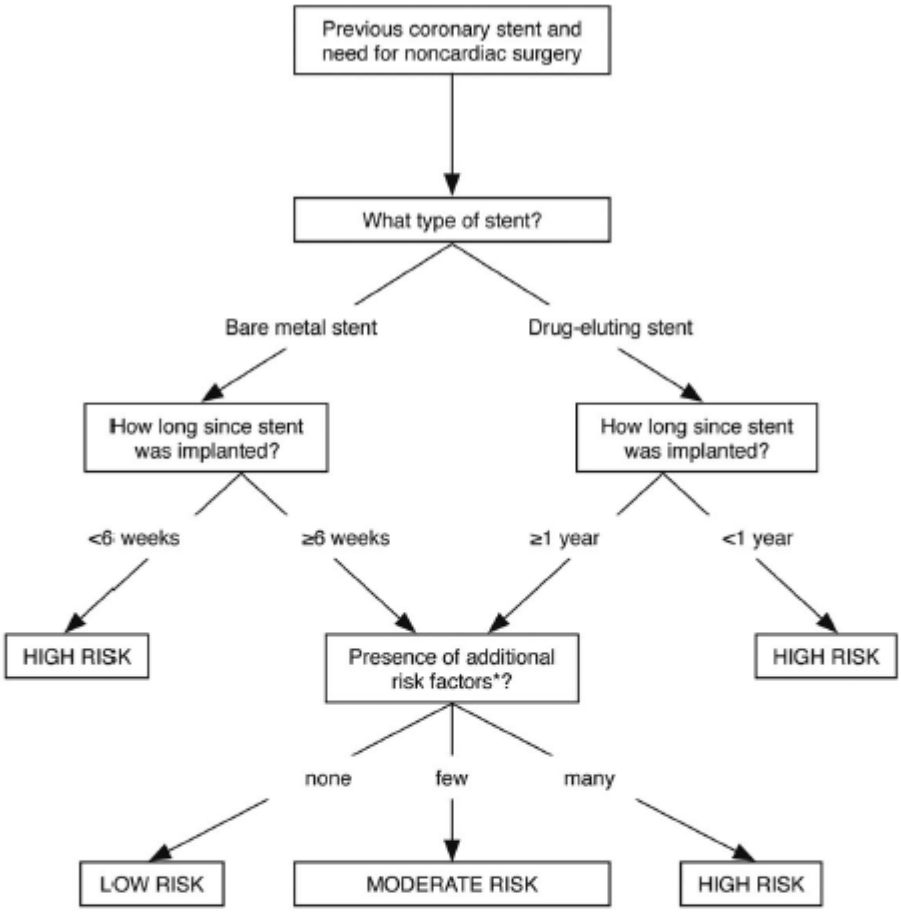
How should antithrombotic agents be managed for this patient around the time of surgery?

Anti-platelet agents in non-cardiac surgical patients with coronary stents

Major cardiac events and time after stent placement that patients undergo noncardiac surgery. Scottish registry study[27] of 1953 patients with stents (570 drug-eluting):



(Circles are drug-eluting, squares are bare metal)



*Additional risk factors for stent thrombosis		
Coronary anatomy Bifurcation stenting Ostial stenting Small (<3.0 m) stent diameter Long (>18mm) stent length Overlapping stents Multiple stents Suboptimal result	**Stent-Indication** Acute coronary syndrome	**Patient** Diabetes Renal impairment Advanced age Low ejection fraction Prior brachytherapy

From Hall R and Mazer CD[28]

Bleeding with anti-platelet agents:

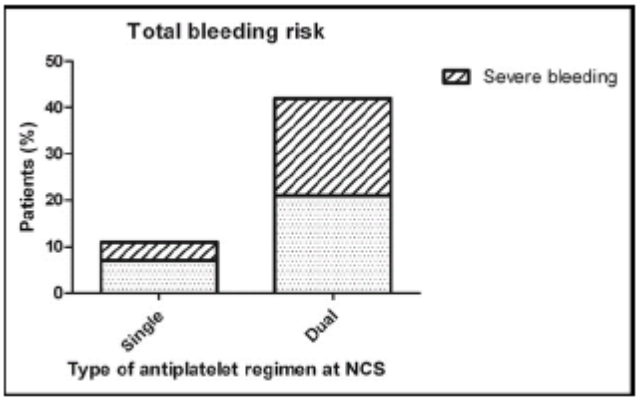


Figure 2. Bleeding risk according to antiplatelet regimen.

From van Kuijk et al.[29]

Recommendations[30,31]:

1. Elective non-cardiac surgery should be deferred for at least six weeks and ideally three months following PCI with bare metal stenting.
2. Elective non-cardiac surgery should be deferred for 12 months following insertion of a drug eluting stent.
3. Whenever possible, antiplatelet therapy should be continued in patients with coronary stents who are undergoing noncardiac surgery. The majority of patients should be able to continue aspirin at minimum.

   Exceptions are: spinal, intracranial, extraocular, TURP, major plastic reconstructive procedures. In these patients, antiplatelet therapy should be discontinued one week prior to the procedure.
4. Patients who must have antiplatelet therapy discontinued but are considered high risk for stent thrombosis should have their procedures done at facilities with immediate access to PCI.
5. In selected cases, "bridging" with heparin/tirofiban or heparin/eptifibide can be considered although there is limited data to support this and decisions require multidisciplinary input including the interventional cardiologist.

Recent European position paper[32]:

◆ extends also to patients on clopidogrel monotherapy

Minor Surgery: do not stop antiplatelet therapy.

Implement **mulitdisciplinary consult** in patients with (potential) bleeding complications.
Low molecular weight heparin: NOT a substitute for platelet inhibiting drugs.
Avoid plasmatic anticoagulation (LMWH, OAC) during surgery.

major surgery and	how to proceed	exception	how to proceed with exception
aspirin for primary prevention ◆	stop aspirin 5 days before surgery ◆		
aspirin in high-risk patients ◆ (diabetes, history of CV events, documented CV disease, increased global risk)	continue aspirin ◆	surgery in closed space, expected major bleeding complications	• stop aspirin 5 days before surgery ◆ • consider restarting within 24h ◆
aspirin **plus** clopidogrel in high risk patients	1. elective surgery: delay until no dual inhibition necessary 2. semi-urgent surgery: continue aspirin ± clopidogrel on a case by case basis 3. urgent surgery (within 24 h): continue aspirin and clopidogrel	surgery in closed space, expected major bleeding complications	*If delaying surgery not possible / semi-urgent surgery necessary:* • stop clopidogrel 5 days before surgery, consider bridging (short acting GPIIb/IIIa antagonist) • consider stopping also aspirin in particular patients • consider resuming dual antiplatelet therapy asap

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Figure 1: Summary of the expert group's recommendation.

Management of patients with coronary artery stents requires multidisciplinary approach with input from the consulting internist, the interventional cardiologist responsible for the stents, the anesthesiologist, and the surgeon.

New anticoagulants (dabigatran, rivaroxaban) and surgery. (From recent review by Schulman and Crowther[33])

Key points:

1. Shorter half-life than warfarin (requires less days interruption of drug to return to normal clotting).
2. Onset of anticoagulant effect is within 2 hours, provided intestinal absorption is normal. (important in deciding when to re-start).
3. Monitoring, to determine if anticoagulant effect due to drug is likely present:

Dabigatran: If thrombin clotting time (TCT) is normal, this rules out important levels of drug. However, TCT not routinely available. aPTT, accounting for time since last dose, should be elevated in the presence of dabigatran.

Rivaroxaban: PT (INR) shows linear dose-response to rivaroxaban, but is somewhat dependent on particular assay.

Summarizing: If the aPTT is normal in setting of dabigatran or the INR is normal in the setting of rivaroxaban, this suggests that hemostatic function is not impaired by drug.

Approach of Schulman and Crowther [33]

Table 4. Timing of interruption of dabigatran or rivaroxaban before surgery or invasive procedures

Calculated creatinine clearance, mL/min	Half-life, hours	Timing of last dose before surgery: Standard risk of bleeding*	Timing of last dose before surgery: High risk of bleeding†
Dabigatran			
> 80	13 (11-22)	24 h	2 d
> 50- ≤ 80	15 (12-34)	24 h	2 d
> 30- ≤ 50	18 (13-23)	2 d	4 d
≤ 30	27 (22-35)	4 d	6 d
Rivaroxaban			
> 30	12 (11-13)	24 h	2 d
< 30	Unknown	2 d	4 d

*Examples are cardiac catheterization, ablation therapy, colonoscopy without removal of large polyps, and uncomplicated laparoscopic procedures, such as cholecystectomy.

†Examples are major cardiac surgery, insertion of pacemakers or defibrillators (resulting from the risk for pocket hematoma), neurosurgery, large hernia surgery, and major cancer/urologic/vascular surgery.

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