

The Consultant's Job...

I KEEP PAYING YOU FOR CONSULTING, BUT YOU NEVER MAKE ANY RECOMMENDATIONS.

I'M WHAT YOU CALL A "FEEL GOOD."



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MY JOB IS TO MAKE YOU FEEL SECURE IN THE KNOWLEDGE THAT SOMEONE BRILLIANT IS SHAPING YOUR STRATEGIES.



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THIS IS WEIRD; I HATE YOU, BUT AT THE SAME TIME I FEEL GOOD.

YOU'RE WELCOME.



Cardiac Pre-Operative Evaluation

ACC 2007 Guidelines

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October 15, 2009



Objectives of Conference

- Understand “Cardiac Clearance” for noncardiac surgery
 - Apply Guidelines for pre-operative evaluation
 - Who needs a stress test?
 - Who needs a cath?
 - Who can go to surgery?
-

Pre-Op Cardiac Evaluation

Potentially many facets

- Coronary atherosclerosis
 - Myocardial ischemia
 - Heart failure
 - Systolic
 - Diastolic
 - Arrhythmia
 - Chronic
 - Pacemaker/ICD
 - Peri-operative
 - Valvular disease
 - Anticoagulation & Antiplatelet issues
 - Congenital heart disease
-

Why assess patients pre-operatively?

- Identify patients at risk for cardiac complications peri-operatively
 - Myocardial infarction
 - Arrhythmia
 - CHF
- Intervene to reduce the cardiac risk
- Pre-op evaluation in US is estimated to cost \$3.7 billion/year



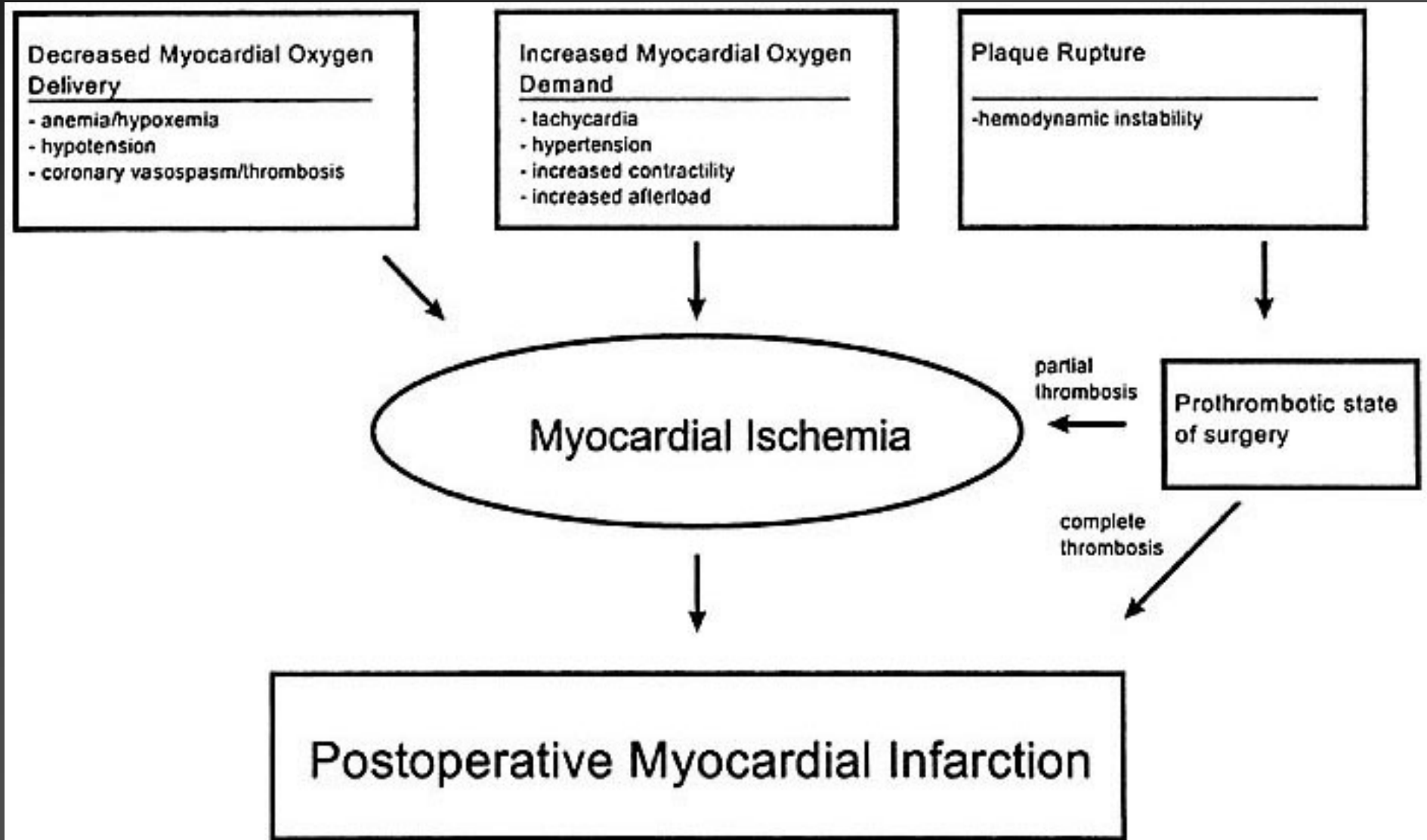
CONSULTING

IF YOU'RE NOT A PART OF THE SOLUTION,
THERE'S GOOD MONEY TO BE MADE IN PROLONGING THE PROBLEM.

Some facts and figures

- 27 million patients undergo surgery annually in US
- 1 million of those will have peri-operative cardiac complication
 - \$20 billion/year in extra hospital/long term care costs
- Overall risk of post-op MI is <1%
 - However, it is about 6% if there is history of MI
 - Risk peaks within about 3 days post op, most MI's are detected within 24 hours

Surgical Stress on the Heart



The Old Ways of Pre-op Eval

- 1947 – Dripps; assigned physical class to patients prior to anesthesia
 - 1. A healthy patient.
 - 2. A patient with mild systemic disease.
 - 3. A patient with a severe systemic disease that limits activity, but is not incapacitating.
 - 4. A patient with an incapacitating systemic disease that is a constant threat to life.
 - 5. A moribund patient who is not expected to survive 24 hours with or without an operation.

- Note: In the event of an emergency operation, precede the number with an E.

1977 Goldman

Criterion	Points
History	
Age>70	5
MI in past 6 months	10
Physical Exam	
3 rd Heart sound or JVD	11
Important Aortic stenosis	3
EKG	
Rhythm other than sinus or PAC's	7
>5 PVC's per minute at any time	7
General status	
Hypoxia, renal failure, LFT abnormality	3
Operation	
Intraperitoneal, aortic, or intrathoracic	3
Emergency	4
Total	53

1986 Detsky

- Modified Goldman
 - Even more complicated than Goldman
-

ACC Guidelines

- 2002
 - Stepwise evaluation of patient
 - Simplified decision making
- 2007
 - Even simpler decision making

History & Physical

■ History

- What surgery?
- Cardiac history and risk factors

■ Physical

- Neck – JVD, carotid bruits
 - Heart - 3rd or 4th heart sound, rhythm
 - Lungs – crackles
 - Extremities – edema, pulses
-

Assessing Activity Level

Table 3. Estimated Energy Requirements for Various Activities

1 MET	Can you... Take care of yourself? Eat, dress, or use the toilet?	4 METs	Can you... Climb a flight of stairs or walk up a hill? 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.

*Modified from Hlatky et al. (10), copyright 1989, with permission from Elsevier, and adapted from Fletcher et al. (11).

Conditions requiring further investigation

Table 2. Active Cardiac Conditions for Which the Patient Should Undergo Evaluation and Treatment Before Noncardiac Surgery (Class I, Level of Evidence: B)

Condition	Examples
Unstable coronary syndromes	Unstable or severe angina* (CCS class III or IV)† Recent MI‡
Decompensated HF (NYHA functional class IV; worsening or new-onset HF)	
Significant arrhythmias	High-grade atrioventricular block Mobitz II atrioventricular block Third-degree atrioventricular heart block Symptomatic ventricular arrhythmias Supraventricular arrhythmias (including atrial fibrillation) with uncontrolled ventricular rate (HR greater than 100 beats per minute at rest) Symptomatic bradycardia Newly recognized ventricular tachycardia
Severe valvular disease	Severe aortic stenosis (mean pressure gradient greater than 40 mm Hg, aortic valve area less than 1.0 cm ² , or symptomatic) Symptomatic mitral stenosis (progressive dyspnea on exertion, exertional presyncope, or HF)

*According to Campeau (9).

†May include "stable" angina in patients who are unusually sedentary.

‡The American College of Cardiology National Database Library defines recent MI as more than 7 days but less than or equal to 1 month (within 30 days).

CCS indicates Canadian Cardiovascular Society; HF, heart failure; HR, heart rate; MI, myocardial infarction; NYHA, New York Heart Association.

Clinical Risk Factors

- History of heart disease
- History of compensated or prior heart failure
- History of cerebrovascular disease
- Diabetes mellitus
- Renal insufficiency

Risk of Surgical Procedure

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.

Routine Pre-op EKG?

- A routine pre-operative EKG is generally recommended (Class 1 or 2a) in pt with
 - No clinical risk factors for AAA repair
 - No clinical risk factors for cholecystectomy
 - 1 clinical risk factor for breast biopsy
 - Known CAD for thoracic surgery
 - History of Stroke for cataract surgery

Routine Pre-op EKG?

- A routine pre-operative EKG is generally recommended (Class 1 or 2a) in pt with
 - No clinical risk factors for AAA repair
 - No clinical risk factors for cholecystectomy
 - 1 clinical risk factor for breast biopsy
 - Known CAD for thoracic surgery
 - History of Stroke for cataract surgery

Routine Pre-op EKG

■ Class 1

- Preoperative resting 12-lead ECG is recommended for patients with at least 1 clinical risk factor* who are undergoing vascular surgical procedures. (*Level of Evidence: B*)
- Preoperative resting 12-lead ECG is recommended for patients with known coronary heart disease, peripheral arterial disease, or cerebrovascular disease who are undergoing intermediate-risk surgical procedures. (*Level of Evidence: C*)

Routine Pre-op EKG

■ Class 2A

- Preoperative resting 12-lead ECG is reasonable in persons with no clinical risk factors who are under-going vascular surgical procedures. (*Level of Evidence: B*)

■ Class 2B

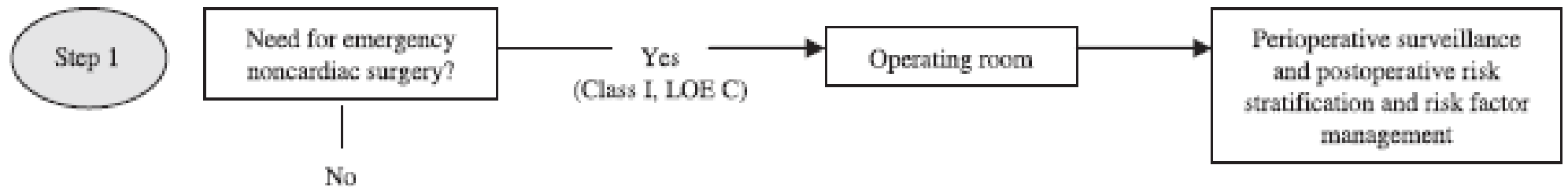
- Preoperative resting 12-lead ECG may be reasonable in patients with at least 1 clinical risk factor who are undergoing intermediate-risk operative procedures. (*Level of Evidence: B*)

■ Class 3

- Preoperative and postoperative resting 12-lead ECGs are not indicated in asymptomatic persons undergoing low-risk surgical procedures. (*Level of Evidence: B*)

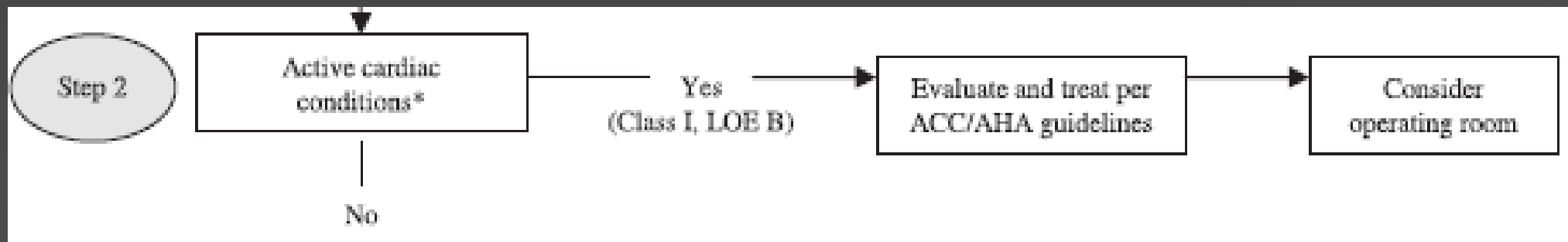
Step 1

- Is this emergency surgery?
 - If yes, go to the OR



Step 2

- Is there an active cardiac condition?
 - Unstable coronary syndromes
 - Decompensated HF (NYHA functional class IV, worsening or new-onset HF)
 - Significant arrhythmias
 - Severe valvular disease
- If so, evaluate per usual guidelines

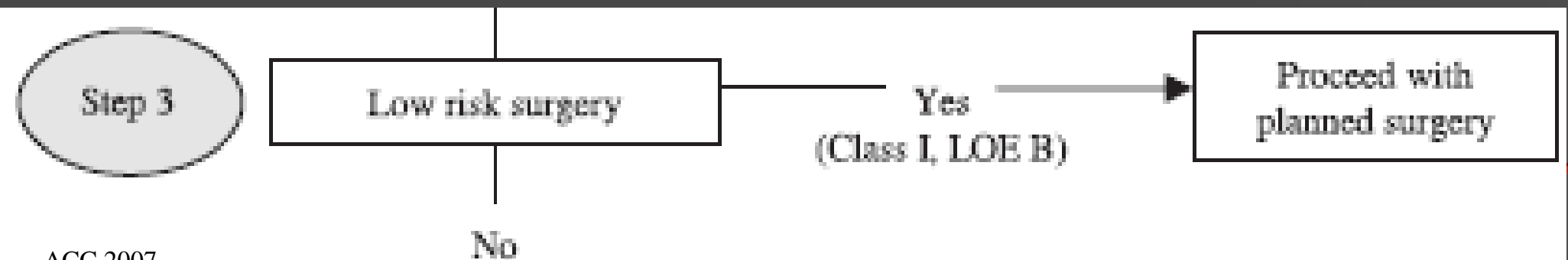


Step 3

■ Is this a low risk surgery?

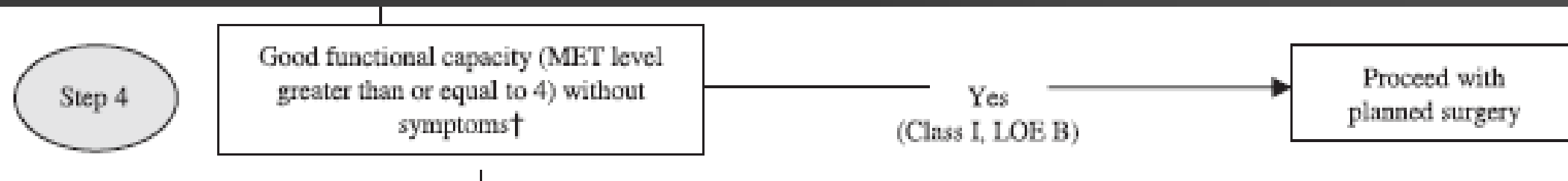
- Endoscopic procedures
- Superficial procedure
- Cataract surgery
- Breast surgery
- Ambulatory surgery

■ If so, go to OR



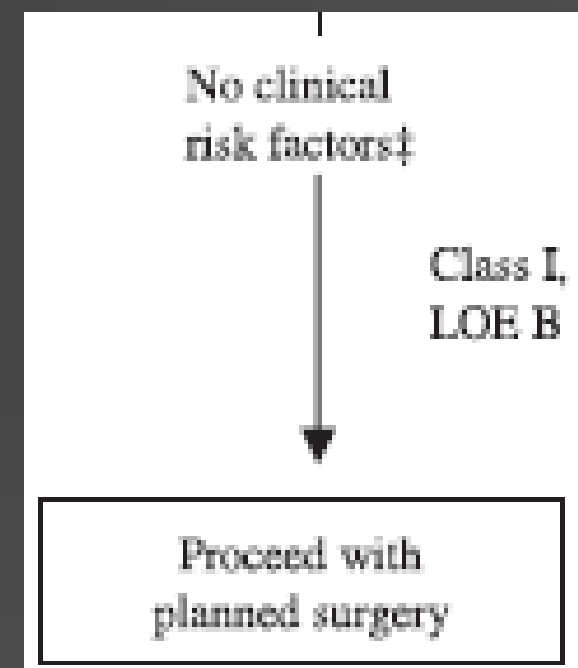
Step 4

- Is there a good functional status (>4 METS)
 - If so, go to OR



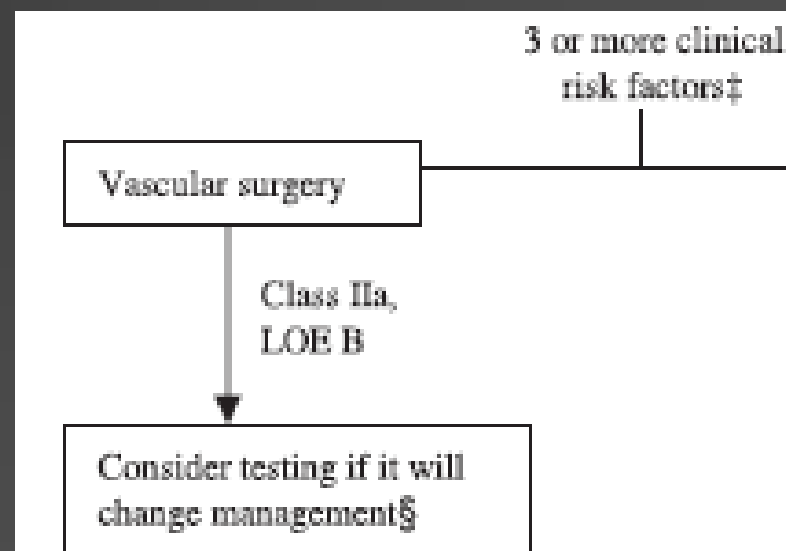
Step 5

- OK, you made it this far...
- Unable to achieve >4 METS, or unknown activity level
- No Clinical risk factors
 - History of heart disease
 - History of compensated or prior heart failure
 - History of cerebrovascular disease
 - Diabetes mellitus
 - Renal insufficiency
- Go to OR



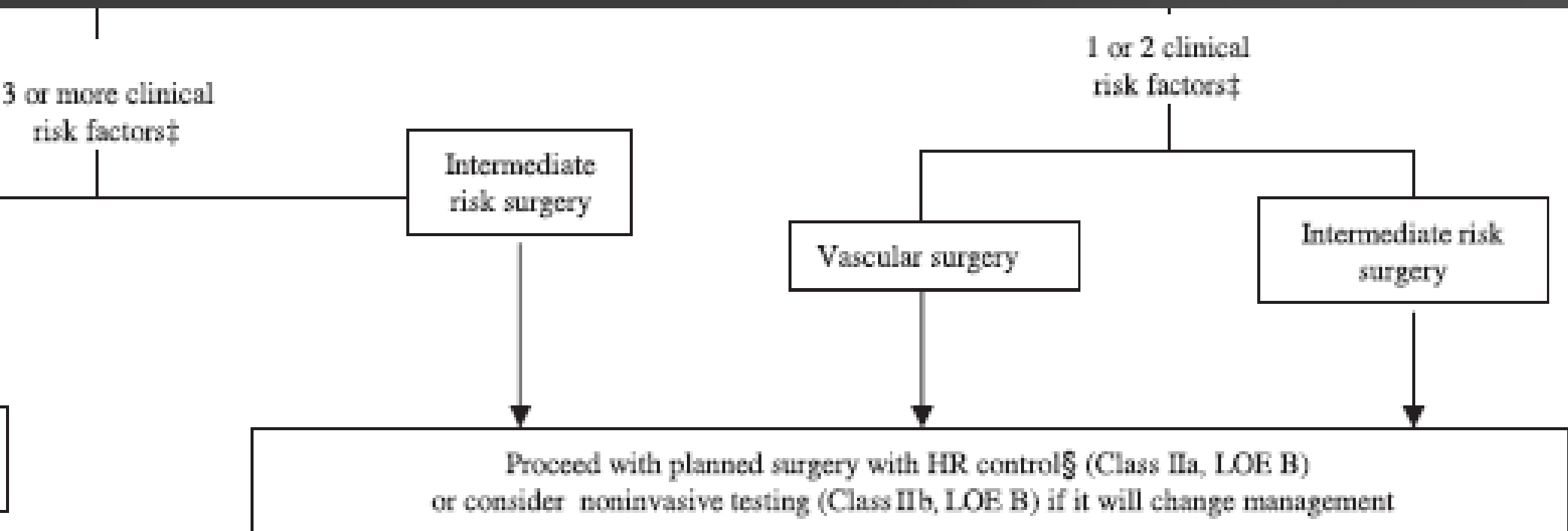
Step 5

- 3 or more clinical risk factors for vascular surgery
 - History of heart disease
 - History of compensated or prior heart failure
 - History of cerebrovascular disease
 - Diabetes mellitus
 - Renal insufficiency
- Consider stress test



Step 5

- 3 or more risk factors + vascular surgery
- 1-2 risk factors for at least intermediate risk surgery
- Consider stress test if it will change management



Who gets pre-operative revascularization?

- Class 1
 - Coronary revascularization before noncardiac surgery is useful in patients with stable angina who have significant left main coronary artery stenosis. (*Level of Evidence: A*)
 - Coronary revascularization before noncardiac surgery is useful in patients with stable angina who have 3-vessel disease. (Survival benefit is greater when left ventricular ejection fraction is less than 0.50.) (*Level of Evidence: A*)
 - Coronary revascularization before noncardiac surgery is useful in patients with stable angina who have 2-vessel disease with significant proximal left anterior descending stenosis and either ejection fraction less than 0.50 or demonstrable ischemia on noninvasive testing. (*Level of Evidence: A*)
 - Coronary revascularization before noncardiac surgery is recommended for patients with high-risk unstable angina or non–ST segment elevation myocardial infarction (MI).§ (*Level of Evidence: A*)
 - Coronary revascularization before noncardiac surgery is recommended in patients with acute ST-elevation MI. (*Level of Evidence: A*)

How do I manage antiplatelets?

■ Class 2A

- In patients in whom coronary revascularization with percutaneous coronary intervention (PCI) is appropriate for mitigation of cardiac symptoms and who need elective noncardiac surgery in the subsequent 12 months, a strategy of balloon angioplasty or bare-metal stent placement followed by 4 to 6 weeks of dual antiplatelet therapy is probably indicated. *(Level of Evidence: B)*
- In patients who have received drug-eluting coronary stents and who must undergo urgent surgical procedures that mandate the discontinuation of thienopyridine therapy, it is reasonable to continue aspirin if at all possible and restart the thienopyridine as soon as possible. *(Level of Evidence: C)*

How do I interpret stress results?

■ Class 2B

- The usefulness of preoperative coronary revascularization is not well established in high-risk ischemic patients (eg, abnormal dobutamine stress echocardiogram with at least 5 segments of wall-motion abnormalities). (*Level of Evidence: C*)
- The usefulness of preoperative coronary revascularization is not well established for low-risk ischemic patients with an abnormal dobutamine stress echocardiogram (segments 1 to 4). (*Level of Evidence: B*)

What should I not do?

■ Class 3

- It is not recommended that routine prophylactic coronary revascularization be performed in patients with stable coronary artery disease (CAD) before noncardiac surgery. (*Level of Evidence: B*)
- Elective noncardiac surgery is not recommended within 4 to 6 weeks of bare-metal coronary stent implantation or within 12 months of drug-eluting coronary stent implantation in patients in whom thienopyridine therapy or aspirin and thienopyridine therapy will need to be discontinued perioperatively. (*Level of Evidence: B*)
- Elective noncardiac surgery is not recommended within 4 weeks of coronary revascularization with balloon angioplasty. (*Level of Evidence: B*)



INEPTITUDE

IF YOU CAN'T LEARN TO DO SOMETHING WELL,
LEARN TO ENJOY DOING IT POORLY.

Why stress and cath so few patients?

- CARP
 - Poldermans et al
-

CARP

Coronary Artery Revascularization Prophylaxis

- VA study of 510 patients undergoing vascular surgery
 - 33% Abdominal aortic aneurysm
 - 67% Lower extremity arterial occlusive disease
- Avg age 66 years, significant but stable CAD
 - Randomized to revascularization vs. medical management
 - 59% PCI; 41% CABG
- Surgery delayed 54 days (vs 18 days) for revascularization

Outcome	Revascularization	Medical Management
Postop MI	11.6%	14.3%
30-day mortality	3.1%	3.4%
2.7-year mortality	22%	23%

Should surgery be delayed for cardiac risk stratification?

- 1476 patients screened before elective Abdominal Aortic Aneurysm repair or lower extremity revascularization

Cardiac Risk Factors

- Age over 70 years
- Angina pectoris
- Prior myocardial infarction
 - History
 - Pathologic Q waves on electrocardiography
- Compensated congestive heart failure or a history of congestive heart failure
- Current treatment for diabetes mellitus
- Renal dysfunction (serum creatinine 1.8 mg/dl)
- Prior stroke or transient ischemic attack

Patient Selection and Risk Stratification

- 354 with 0 risk factors
- 352 with 3 or more risk factors
- 770 with 1 or 2 risk factors
 - 384 not tested
 - 386 had stress test (Dobutamine Echocardiography)
 - 287 without ischemia
 - 65 with mild ischemia (1-4 segments)
 - 34 with extensive ischemia (>4 segments)
 - 12 revascularized
 - 5 with 2 vessel disease
 - 6 with 3 vessel disease
 - 22 not revascularized

Surgical management

- Median time from screening to operation
 - 34 days without stress test
 - 53 days if stress test was performed
- Median HR decreased from 70 to 60 from screening to surgery
 - B-Blockers used liberally to control HR to <65
 - In patients with ischemia, target HR less than ischemic threshold

Outcomes

Composite myocardial infarction and cardiac death 30 days after surgery

- 30 Day composite
 - 0.3% Low risk group (0 risk factors)
 - 2.2% Intermediate risk group (1-2 RF's)
 - 8.5% High risk group (>2 RF's)
- Intermediate risk group
 - 2.3% in tested group
 - 1.8% in non-tested group

Tested group outcomes (Intermediate risk = 1-2 RF's)

- Composite outcomes of intermediate risk group based on results of stress test
 - 0% no ischemia
 - 6.2% limited ischemia
 - 14.7% extensive ischemia
- Extensive ischemia group (34 patients)
 - 25% event rate not revascularized
 - 9% in revascularized group (p=0.32)

Late outcomes

- 3 year composite nonfatal MI + cardiac death
 - 0.7% low risk
 - 3.7% intermediate risk
 - 14.8% high risk
- 2 year composite outcome in intermediate risk tested patients
 - 4.3% with testing
 - 3.1% without testing (p=0.30)

Summary of Poldermans et al.

- Initial clinical risk important to predict outcomes
- Intermediate risk patients could be further risk stratified by stress test results
- Trend toward more adverse events at 2 years with the testing strategy
- Testing patients delayed surgery
- Revascularization trended to improve cardiovascular outcomes
 - Small number of patients studied
 - 22 not revascularized vs 12 revascularized

How about other peri-operative management?

- Pre-operative statin
 - Pre-operative Beta Blocker
-

Pre-operative Statin?

- In which patients is a statin recommended (Class 1 or 2A) pre-operatively
 - Already taking a statin, for basal cell removal
 - Statin naïve, 1 clinical risk factor, for gallbladder
 - Statin naïve, for carotid endarterectomy
 - Statin naïve, no clinical risk factors, for colon resection

Pre-operative Statin?

- In which patients is a statin recommended (Class 1 or 2A) pre-operatively
 - Already taking a statin, for basal cell removal
 - Statin naïve, 1 clinical risk factor, for gallbladder (2B recommendation)
 - Statin naïve, for carotid endarterectomy
 - Statin naïve, no clinical risk factors, for coronary artery bypass grafting

Who gets a Statin?

■ Class 1

- For patients currently taking statins and scheduled for noncardiac surgery, statins should be continued. (*Level of Evidence: B*)

■ Class 2A

- For patients undergoing vascular surgery with or without clinical risk factors, statin use is reasonable. (*Level of Evidence: B*)

■ Class 2B

- For patients with at least 1 clinical risk factor who are undergoing intermediate-risk procedures, statins may be considered. (*Level of Evidence: C*)

Statins reduce cardiovascular complications in patients undergoing vascular surgery

- Retrospective analysis of 1163 patients undergoing vascular surgery
 - 31% Carotid
 - 15% Aortic
 - 54% Lower extremity
- 45% on statin

<i>N = number of patients with complication</i>	Receiving Statins (n =52)	Not Receiving Statins (n =105)
Death	6%	5%
Myocardial infarction	7	7
Other ischemia	5	26
CHF	21	50
VT	13	17

Who gets pre-operative Beta Blocker?

- Which is a Class 1 or 2A situation for pre-operative Beta Blocker?
 - On Beta-Blocker 2 clinical risk factors, for cataract
 - Beta-blocker naïve
 - No known CAD
 - 1 clinical risk factor for bariatric surgery
 - Complete heart block for appendectomy
 - B-blocker naïve, 1 clinical risk factor, for AAA
 - B-blocker naïve, 0 clinical risk factors, for AAA
 - B-blocker naïve, 2 clinical risk factors, for carotid endarterectomy
 - Known CAD (either ischemic or stable) for AAA
 - Known CAD (either ischemic or stable) for gallbladder

Who gets pre-operative Beta Blocker?

- Which is a Class 1 or 2A situation for pre-operative Beta Blocker?
 - On Beta-Blocker 2 clinical risk factors, for cataract
 - Beta-blocker naïve
 - No known CAD
 - 1 clinical risk factor for bariatric surgery (Class 2B)
 - Complete heart block for appendectomy (Class 3)
 - B-blocker naïve, 1 clinical risk factor, for AAA (Class 2B)
 - B-blocker naïve, 0 clinical risk factors, for AAA (Class 2B)
 - B-blocker naïve, 2 clinical risk factors, for carotid endarterectomy
 - Known CAD (either ischemic or stable) for AAA
 - Known CAD (either ischemic or stable) for gallbladder

Who gets pre-operative Beta Blocker?

■ Class 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. (*Level of Evidence: C*)
- Beta blockers should be given to patients undergoing vascular surgery who are at high cardiac risk owing to the finding of ischemia on preoperative testing. (*Level of Evidence: B*)

■ Class 2A

- Beta blockers are probably recommended for patients undergoing vascular surgery in whom preoperative assessment identifies coronary heart disease. (*Level of Evidence: B*)
- Beta blockers are probably recommended 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.* (*Level of Evidence: B*)
- Beta blockers are probably recommended for patients in whom preoperative assessment identifies coronary heart disease or high cardiac risk, as defined by the presence of more than 1 clinical risk factor,* who are undergoing intermediate-risk or vascular surgery. (*Level of Evidence: B*)

Who should not get a pre-operative Beta-Blocker?

■ Class 2B

- 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.* (*Level of Evidence: C*)
- The usefulness of beta blockers is uncertain in patients undergoing vascular surgery with no clinical risk factors who are not currently taking beta blockers. (*Level of Evidence: B*)

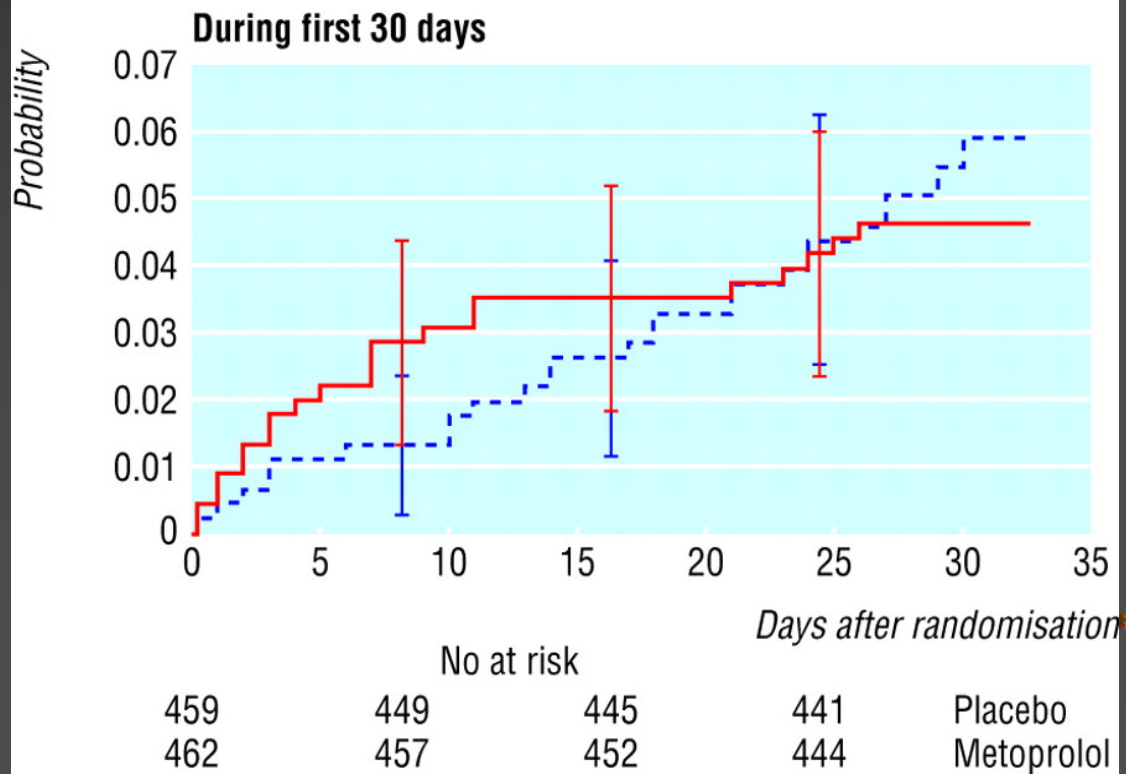
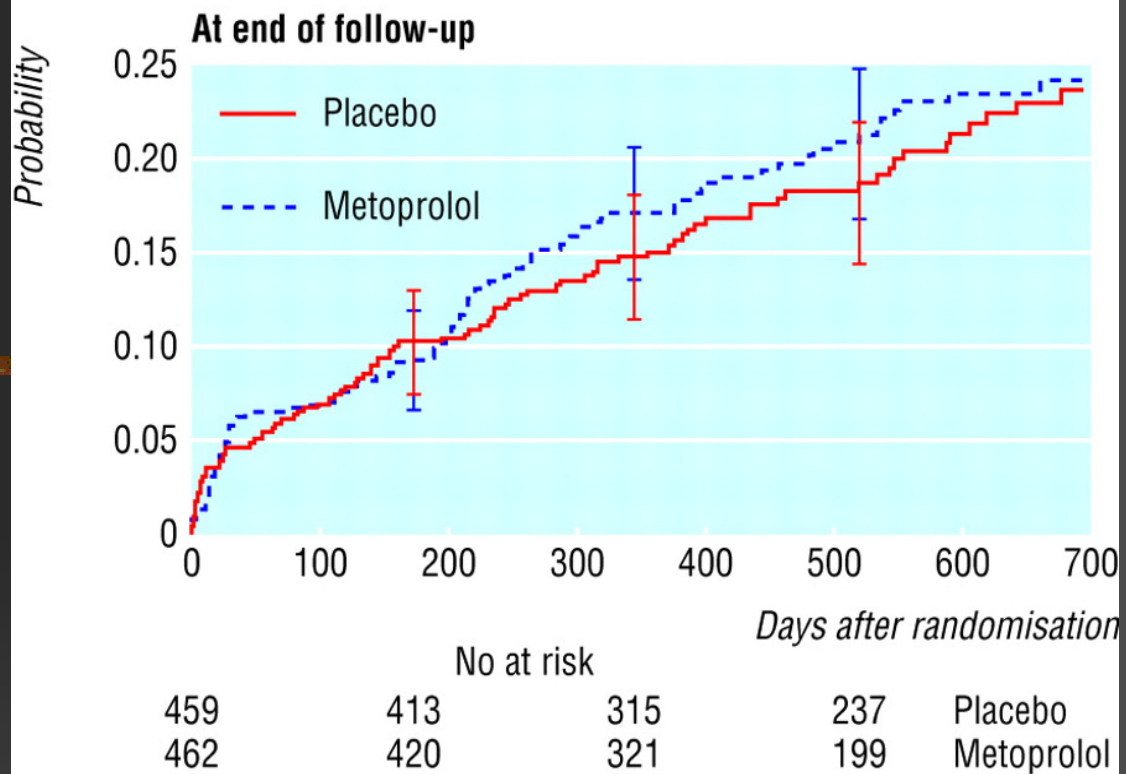
■ Class 3

- Beta blockers should not be given to patients undergoing surgery who have absolute contraindications to beta blockade. (*Level of Evidence: C*)

DIPOM - Routine perioperative Beta Blockade is not beneficial for diabetic patients

- 921 Beta blocker naïve diabetics undergoing noncardiac surgery given placebo vs metoprolol succinate (Toprol XL) 50mg day 1 then 100mg daily throughout hospitalization (up to 8 days)
- Surgery on day 2
- Composite outcome of all cause mortality, acute myocardial infarction, unstable angina, or congestive heart failure discovered or aggravated during admission to hospital

Juul AB, Wetterslev J, Gluud C, Kofoed-Enevoldsen A, Jensen G, Callesen T, Norgaard P, Fruergaard K, Bestle M, Vedelsdal R, Miran A, Jacobsen J, Roed J, Mortensen MB, Jorgensen L, Jorgensen J, Rovsing ML, Petersen PL, Pott F, Haas M, Albret R, Nielsen LL, Johansson G, Stjernholm P, Molgaard Y, Foss NB, Elkjaer J, Dehlie B, Boysen K, Zaric D, Munksgaard A, Madsen JB, Oberg B, Khanykin B, Blemmer T, Yndgaard S, Perko G, Wang LP, Winkel P, Hilden J, Jensen P, Salas N; DIPOM Trial Group. Effect of perioperative beta blockade in patients with diabetes undergoing major non-cardiac surgery: randomised placebo controlled, blinded multicentre trial. *BMJ*. 2006 Jun 24;332(7556):1482.



POBBLE – Routine perioperative use of Beta blockers for infrarenal vascular surgery does not change cardiovascular outcomes at 30 days

* But they do reduce length of stay

- 103 patients undergoing infrarenal vascular surgery (38% AAA, 29% bypass)
- Placebo vs metoprolol tartrate 50mg bid for up to 7 days
- Composite MI, Unstable Angina, stroke, VT, death in 30 days 34% placebo vs 32% metoprolol
- Hospital stay median 10 days metoprolol vs 12 days placebo (P<0.02)

Summary of DIPOM and POBBLE

- Beta blockers not beneficial for routine use in all diabetic patients
- Hospital stay reduced by use of peri-operative beta blockers
- Both studies used brief courses of metoprolol (7-8 days)

Peri-operative Beta Blockade

NEJM, July 2005

- Large retrospective review of 782,969 patients
 - 663,635 (85 percent) had no recorded contraindications to beta-blockers
 - 122,338 (18 percent) received Beta blocker during the first two hospital days
 - 14% with RCRI of 0
 - 44% with RCRI of ≥ 4
 - RCRI 0 or 1, treatment of no benefit, possible harm
 - RCRI of 2, odds ratio of death in hospital 0.88
 - RCRI of 3, odds ratio of death in hospital 0.71
 - RCRI of ≥ 4 , odds ratio of death in hospital 0.58

Revised Cardiac Risk Index

(Circulation 1999; 100:1043-1049)

Each risk factor is assigned one point.

1. High-risk surgical procedures

- Intraoperative
- Intrathoracic
- Suprainguinal vascular

2. History of ischemic heart disease

- History of myocardial infarction
- History of positive exercise test
- Current complain of chest pain considered secondary to myocardial ischemia
- Use of nitrate therapy
- ECG with pathological Q waves

3. History of congestive heart failure

- History of congestive heart failure
- Pulmonary edema
- Paroxysmal nocturnal dyspnea
- Bilateral rales or S3 gallop
- Chest radiograph showing pulmonary vascular redistribution

4. History of cerebrovascular disease

- History of transient ischemic attack or stroke

5. Preoperative treatment with insulin

6. Preoperative serum creatinine > 2.0 mg/dL

RISK OF MAJOR CARDIAC EVENT

Points	Class	Risk
0	I	0.4%
1	II	0.9%
2	III	6.6%
3 or more	IV	11%

Peri-operative Beta Blockade

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CONSISTENCY

IT'S ONLY A VIRTUE IF YOU'RE NOT A SCREWUP.

Other Peri-operative measures

■ Nitroglycerin – Class 2B

- The usefulness of intraoperative nitroglycerin as a prophylactic agent to prevent myocardial ischemia and cardiac morbidity is unclear for high-risk patients undergoing noncardiac surgery, particularly those who have required nitrate therapy to control angina. The recommendation for prophylactic use of nitroglycerin must take into account the anesthetic plan and patient hemodynamics and must recognize that vasodilation and hypovolemia can readily occur during anesthesia and surgery. (*Level of Evidence: C*)

■ Swan-Ganz – Maybe not

- Class 2b – Use of a pulmonary artery catheter may be reasonable in patients at risk for major hemodynamic disturbances that are easily detected by a pulmonary artery catheter; however, the decision must be based on 3 parameters: patient disease, surgical procedure (ie, intraoperative and postoperative fluid shifts), and practice setting (experience in pulmonary artery catheter use and interpretation of results), because incorrect interpretation of the data from a pulmonary artery catheter may cause harm. (*Level of Evidence: B*)
- Class 3 – Routine use of a pulmonary artery catheter perioperatively, especially in patients at low risk of developing hemodynamic disturbances, is not recommended. (*Level of Evidence: A*)

Other Peri-operative measures

- Clonidine – Maybe? Maybe not?
 - Class 2b – Alpha-2 agonists for perioperative control of hypertension may be considered for patients with known CAD or at least 1 clinical risk factor who are undergoing surgery. (*Level of Evidence: B*)
 - Class 3 – Alpha-2 agonists should not be given to patients undergoing surgery who have contraindications to this medication. (*Level of Evidence: C*)

Intraoperative and Postoperative Monitoring

■ Class 2A

- Intraoperative and postoperative ST-segment monitoring can be useful to monitor patients with known CAD or those undergoing vascular surgery, with computerized ST-segment analysis, when available, used to detect myocardial ischemia during the perioperative period. (*Level of Evidence: B*)

■ Class 2B

- Intraoperative and postoperative ST-segment monitoring may be considered in patients with single or multiple risk factors for CAD who are undergoing noncardiac surgery. (*Level of Evidence: B*)

Surveillance of post-op MI

■ Class 1

- Postoperative troponin measurement is recommended in patients with ECG changes or chest pain typical of acute coronary syndrome. (*Level of Evidence: C*)

■ Class 2B

- The use of postoperative troponin measurement is not well established in patients who are clinically stable and have undergone vascular and intermediate-risk surgery. (*Level of Evidence: C*)

■ Class 3

- Postoperative troponin measurement is not recommended in asymptomatic stable patients who have undergone low-risk surgery. (*Level of Evidence: C*)

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