Assessing and minimising perioperative cardiac risk

Ian Scott
Director of Internal Medicine
Princess Alexandra Hospital
Assoc Professor of Medicine
University of Queensland
Brisbane

RACP College Lecture Series
April 3, 2008

Queensland Government
Queensland Health

The University Of Queensland
AUSTRALIA

Questions

- How prevalent are perioperative cardiac events?
- Is the underlying pathophysiology different from that of de novo events?
- What's their prognosis?
- Are there strategies for accurately stratifying risk?
- Are there care options which will predictably alter outcomes in patients according to different levels of risk?
- Are any harms associated with testing?

Prevalence

Retrospective review
177533 elective surgery patients Victoria 2000-01
Non-obstetric patients >15 years

- Cardiac arrest 0.2%
- AMI 0.5%
- Cardiac arrhythmias 7.4%
- Other cardiac events 4.3%

Moje et al Aust Health Rev 2006

Prevalence

Prospective audit
1102 consecutive patients
70 years or older
Elective (73%), non-elective (27%) non-cardiac surgery
3 Melbourne teaching hospitals 2004

- AMI 2.0%
- Cardiac arrest <0.1%
- Acute pulmonary oedema 4.0%

McNicol et al Med J Aust 2007

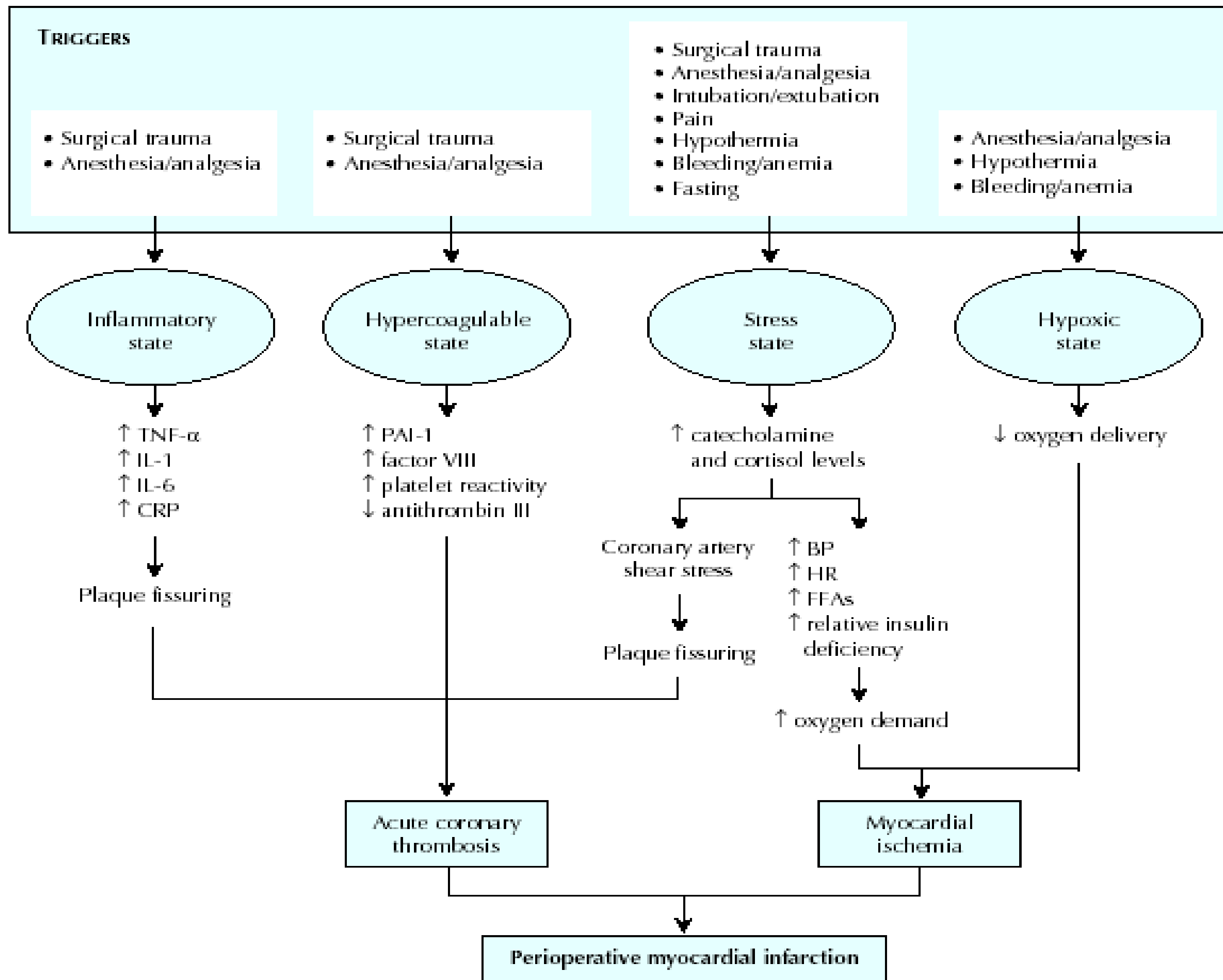
Prevalence

Most studies do not include, or contain small numbers of, emergency cases

Likely to rise as:

- Patients with CAD living longer and developing other conditions that require surgical intervention
- Shift in practice patterns toward advanced care for elderly patients
- Surgical and anaesthetic technique have become less invasive

Pathophysiology



Pathophysiology

- Most periop MIs occur during first 3 days of surgery
- Many are 'silent' because of perioperative analgesia
- Most are of NSTEMI type
- Underdiagnosed because of non-classical presentation, interpretability of ECG, elevated biomarkers due to surgery
- Studies of fatal MI[1,2]
  - 2/3 have left main or 3-V disease
  - Non-culprit plaque fissuring is common
  - 1/3 had intracoronary thrombus

1.Dawood Int J Cardiol 1996
2. Cohen Cardiovasc Pathol 1999

Prognosis

Perioperative MI

- In-hospital mortality rate 15%-30%[1,2,3]
  - 18 fold increase in cardiac death/MI at 6 months[4]

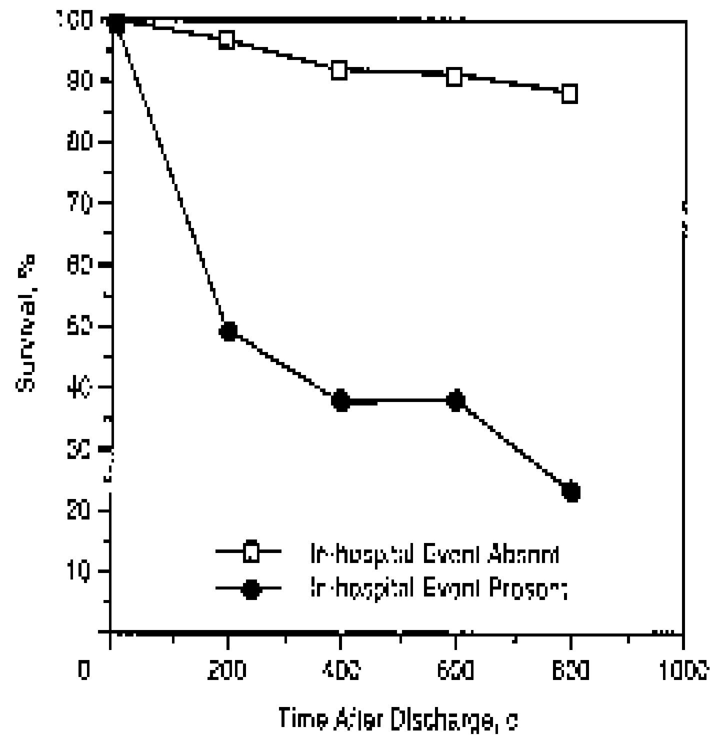
Cardiac arrest 66%[3]

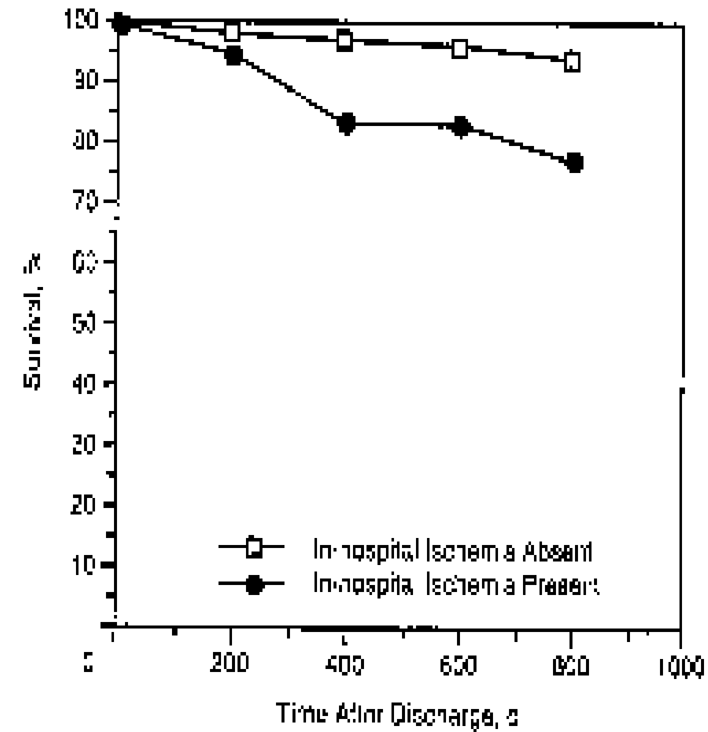
Acute pulmonary oedema 15%[3]

Cardiac complications prolong hospital stays by mean of 11 days[5]

1. Anaesthesiology 1998; 2. JGIM 2001 3. McNicol MJA 2007
4. Mangano JAMA 1992 5. Fleischmann Am J Med 2003

Prognosis

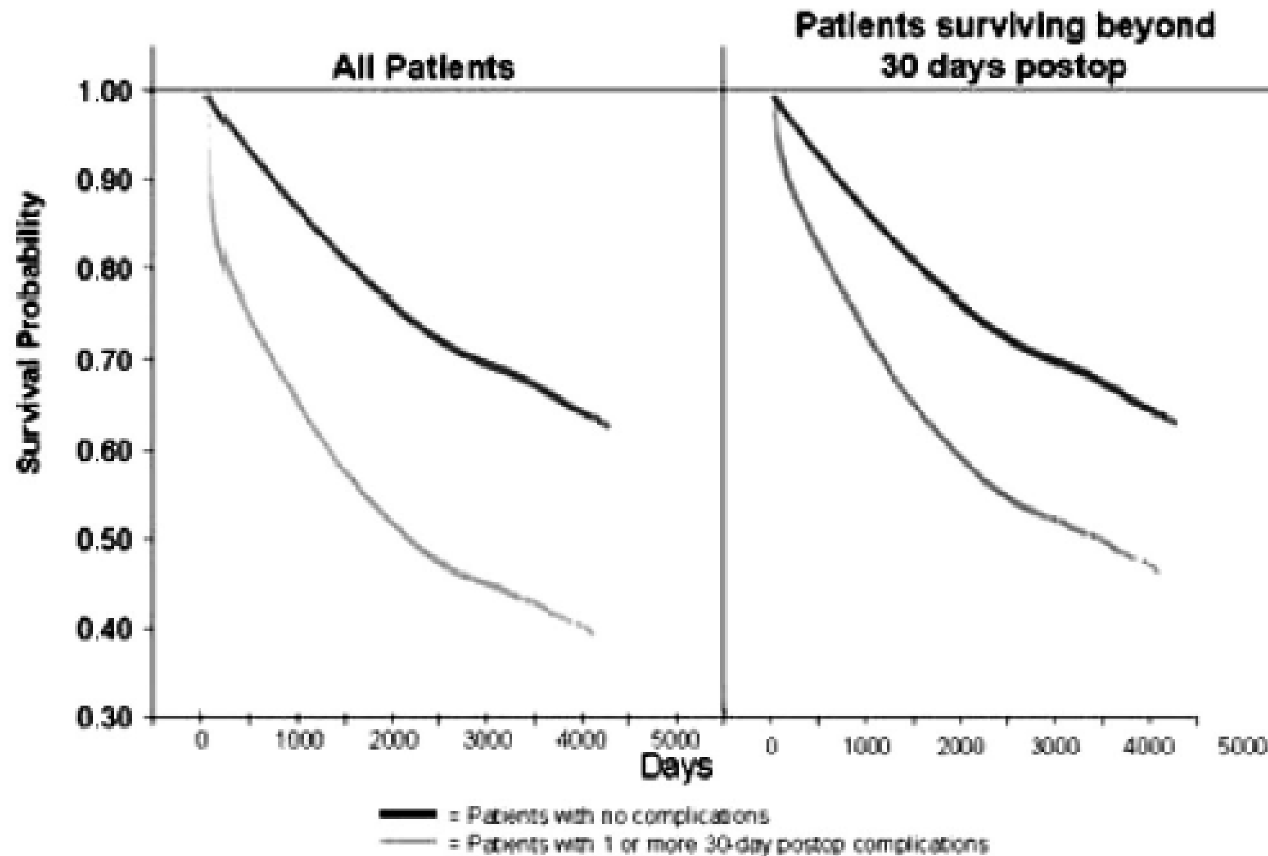




2.8 year F/U

Mangano et al JAMA 1992; 268: 233-39

Prognosis



11 years F/U

National Surgical Quality Improvement Program 1991-9
Khuri et al Ann Surg 2005

Consequences of assessing perioperative cardiac risk

- Cancel or change planned surgery
  - Less invasive surgery
  - Neuraxial blockade vs GA

- Consider preoperative coronary revascularisation

- Administer medical prophylaxis
  - β-blockers
  - A-blockers
  - Ca antagonists
  - Statins

Case 1

- 60 yr old male undergoing elective laparoscopic cholecystectomy
- PMH mild hypertension; hypercholesterolaemia
- No history angina, AMI
- Nonsmoker
- BP 130/75
- On ACE-I, statin
- Resting ECG and CXR normal
- Normal FBC, MBA
- TC 4.0, LDL-C 2.1, TC-HDL 2.1

What do you estimate his perioperative cardiac risk to be?

What further investigations, if any, would you undertake in assessing cardiac risk?

How would the results change your perioperative management?

Case 2

- 70 year old male undergoing elective colon resection for Ca
- PMH
  - Type 2 diabetes for 10 years
  - Uncomplicated inferior infarct 2004
- No angina
- BP 140/80
- On glyclazide, lantus insulin, aspirin, statin
- Resting ECG shows inferior Q waves; CXR normal
- FBC, MBA: renal insufficiency Cr 210; TC 3.7, LDL-C 2.0

What do you estimate his perioperative cardiac risk to be?

What further investigations, if any, would you undertake in assessing cardiac risk?

How would the results change your perioperative management?

Risk assessment

Clinical indices –
Revised Cardiac Risk Index

Lee et al Circulation 1999

4315 pts – elective, major non-cardiac procedures, ≥50 yrs

Risk factor	*Criteria*
High risk surgery	AAA repair, thoracic, abdominal
IHD	AMI, Q waves, angina, nitrates, EST+
CCF	History, examination, CXR
Cerebrovascular	Stroke, TIA
Pre-op insulin	Diabetes
Serum Cr >200	

C-index=0.81

No. of factors	*Proportion of pop^n*	*Cardiac risk**
0	36%	0.4%
1	39%	0.9%
2	18%	6.6%
3 or more	7%	11.0%

*MI, pulmonary oedema, VF or cardiac arrest, complete heart block

Clinical indices – Eagle criteria

Eagle et al Ann Intern Med 1989
200 patients, elective vascular surgery

- Advanced age (>75 years)
- Angina
- Diabetes
- Ventricular ectopy
- Q waves on ECG

No risk factor	<5%
1-2 risk factors	15%
≥3 risk factors	50%

Cardiac death or non-fatal MI

Case 1

- 60 yr old male undergoing elective laparoscopic cholecystectomy
- PMH mild hypertension; hypercholesterolaemia
- No history angina, AMI
- Nonsmoker
- BP 130/75
- On ACE-I, statin
- Resting ECG and CXR normal
- Normal FBC, MBA
- TC 4.0, LDL-C 2.1, TC-HDL 2.1

RCRI=0

What do you estimate his perioperative cardiac risk to be?

What further investigations, if any, would you undertake in assessing cardiac risk?

How would the results change your perioperative management?

Case 2

- 70 year old male undergoing elective colon resection for Ca
- PMH
  - Type 2 diabetes for 10 years
  - Uncomplicated inferior infarct 2004

RCRI=4

- No angina
- BP 140/80
- On glyclazide, lantus insulin, aspirin, statin
- Resting ECG shows inferior Q waves; CXR normal
- FBC, MBA: renal insufficiency Cr 210; TC 3.7, LDL-C 2.0

What do you estimate his perioperative cardiac risk to be?

What further investigations, if any, would you undertake in assessing cardiac risk?

How would the results change your perioperative management?

Limitations of simple clinical indices

- Do not predict risk as continuous variable, esp high-risk patients
- Better performance by adding assessment of
  - Surgery-specific risk
  - Functional capacity
    - Exercise tolerance
    - Stress testing

Surgery-specific risk

Eagle et al Circulation 1997
3368 elective operations

TABLE 3. Cardiac Risk* Stratification for Noncardiac Surgical Procedures

High (Reported cardiac risk often greater than 5%)

- Emergent major operations, particularly in the elderly
- Aortic and other major vascular surgery
- Peripheral vascular surgery
- Anticipated prolonged surgical procedures associated with large fluid shifts and/or blood loss

Intermediate (Reported cardiac risk generally less than 5%)

- Carotid endarterectomy
- Head and neck surgery
- Intraperitoneal and intrathoracic surgery
- Orthopedic surgery
- Prostate surgery

Low (Reported cardiac risk generally less than 1%)

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

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

Clinical history

High risk (>30%); surgery contra-indicated unless emergency

- Acute coronary syndrome <4 months
- Decompensated CHF
- High-grade AV block, symptomatic ventricular arrhythmias, supraventricular arrhythmias with uncontrolled ventricular rate
- Severe valvular disease

Is OSA an independent risk factor?

Complications	Group 1 (OSAS) (n=101) 1A (n=36)	1B (n=65)	Group 2 (control) (n=101)	*P* value
General				
Reintubation	2 (5.5)	0 (0.0)	0 (0)	.16
Acute hypercapnia	2 (5.5)	5 (7.7)	2 (2)	.41
Episodic hypoxemia	9 (25.0)	12 (18.5)	8 (8)	.08
Myocardial infarction	1 (2.7)	0 (0.0)	1 (1)	.47
Myocardial ischemia	5 (13.8)	4 (6.2)	3 (3)	.56
Arrhythmia	3 (8.3)	3 (4.6)	5 (5)	.76
Delirium	5 (13.8)	5 (7.7)	3 (3)	.07
Unplanned ICU transfer	12 (33.3)	8 (12.3)	6 (6)	<.001
Planned ICU transfer	2 (5.5)	0 (0.0)	2 (2)	...
Total	41	36	30	<.001

Gupta et al Mayo Clinic Proc 2001
1A=undiagnosed; 1B=diagnosed

Risk stratification strategies

- Ideally should integrate patient characteristics, type and urgency of surgery, and ?anaesthetic technique
- Must be accurate, influence decision-making and outcome beyond usual care, and not induce harm

Possible strategies

- Non-invasive testing
- Composite clinical-test algorithms

Why the need for further non-invasive functional testing

- Most patients undergoing major non-cardiac surgery cannot exercise
- History and ECG interpretation can be unreliable
- Cardiac imaging at rest is not predictive*

*Halm et al Ann Intern Med 1996

Predictive value of functional testing in vascular surgery

58 studies; 8119 patients; major vascular surgery

Results expressed as + or - test

Test	No. of studies	No. of patients	No. of events	Sensitivity, % (95% CI)	Specificity, % (95% CI)
Radionuclide ventriculography	8	532	54	50 (32–69)	91 (87–96)
Ambulatory electrocardiography	8	893	52	52 (21–84)	70 (57–83)
Exercise electrocardiography	7	685	25	74 (60–88)	69 (60–78)
Myocardial perfusion scintigraphy	23	3119	207	83 (77–89)	49 (41–57)
Dobutamine stress echocardiography	8	1877	82	85 (74–97)	70 (62–79)
Dipyridamole stress echocardiography	4	850	33	74 (53–94)	86 (80–93)

Kertai et al Heart 2003

Predictive value of non-invasive testing

- Negative predictive value: 98-100%
- Positive predictive value:
  - DSMPS 4-20%
  - DSE 14-24%

Multi-level thresholds in non-invasive testing: DSMPS

9 studies, 1179 vascular surgery patients, 82 events

Extent of reversibility of myocardial defects	Likelihood ratio (95% CI)	Post-test probability† of MI or cardiac death, % (95% CI)	% of scans with this result
No defects	0.42 (0.20–0.88)	3 (1–6)	30
Fixed defects only	0.51 (0.24–1.1)	4 (2–8)	30
Reversibility < 20%	1.3 (0.88–1.9)	9 (6–13)	17
Reversibility 20%–29%	1.6 (1.0–2.6)	11 (7–16)	11
Reversibility 30%–39%	2.9 (1.6–5.1)	18 (11–28)	6
Reversibility 40%–49%	2.9 (1.4–6.2)	18 (10–32)	3
Reversibility ≥ 50%	11 (5.8–20)	45 (30–60)	3

†Based on pre-test CAD prevalence 7%

Etchells et al J Vasc Surg 2002

Multi-level thresholds in non-invasive testing: DSE

302 vascular surgery patients, 27 events
Poldermans et al JACC 1995

- 72 patients had a positive DSE
- Semiquantitative assessment of severity and extent of ischaemia not predictive of short-term events
- HR at which ischaemia developed (ischaemic threshold):
  - Low threshold = 53%
  - High threshold = 21%

Composite thresholds in non-invasive testing: DSE

145 patients; non-cardiac surgery

Inducible ischaemia

Ischaemic threshold (HR at which Ischaemia develops)

Clinical risk variables (Eagle criteria)
Low score=1-2
High score=3-4

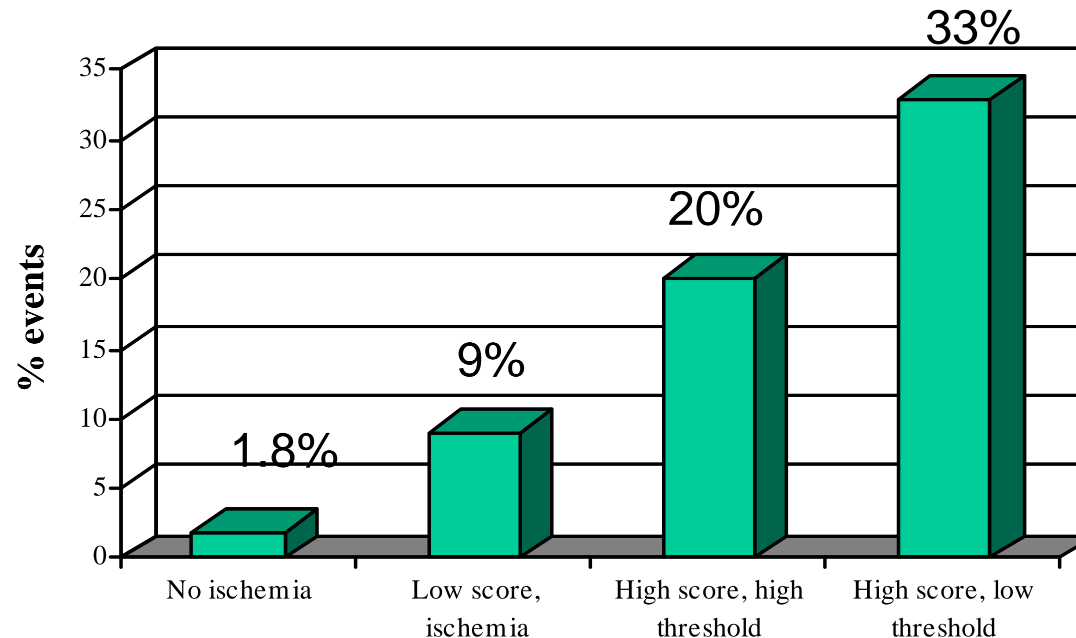


Fig 1. Stratification of "at risk"patients; low score = Eagle 1-2, low threshold = ischemia at <70% predicted maximum heart rate.

Torres et al Am J Cardiol 2002

Effectiveness of interventions for reducing perioperative cardiac risk

Coronary revascularisation

- 11 trials; 2950 patients with stable CAD
  - No benefit of PCI vs medical therapy

Katritsis & Ioannidis Circulation 2005

- COURAGE 2287 pts with stable multi-vessel CAD
  - No benefit of PCI vs medical therapy over 5 years

Boden et al N Engl J Med 2007

Coronary revascularisation

McFalls et al N Engl J Med 2004

- RCT 510 pts elective vascular surgery considered 'at risk'
  - Risk factors + positive stress imaging
  - Need for coronary angiography decided by treating cardiologist
  - Exclusions: unstable angina; prior revasculariation with no inducible ischaemia
  - Eligibility criteria for revascularisation: ≥1 major artery with ≥70% stenosis
- Randomised medical Rx or PCI/CABG
- No difference β-blockers, ACE-I, aspirin, statins
- 33% 3-VD or LMD; LVEF >40%

	Revasc	*No revasc*
• 30 days		
– Mortality	3%	3%
– AMI	12%	14%
• 2.7 years		
– Mortality	22%	23%

In 37 patients with ≥3 Eagle factors + extensive stress induced ischaemia:
Trend for long-term survival OR=4.0 (95%CI 0.8-19)

Coronary revascularisation in very high risk patients

Poldermans et al JACC 2007

- Screening of 1880 pts scheduled for major vascular surgery
- 101 pts high risk patients: ≥3 risk factors + ≥5 segment inducible ischaemia
- Randomised to:
  - coronary angiography + revascularisation OR
  - non-invasive approach followed by planned surgical procedure
- All patients receiving β-blocker (target PR 60-65), antiplatelet therapy
- Primary outcome: composite all-cause death/non-fatal MI between screening and 30 days after index surgery
- Feasibility study: 93% power to see 85% risk reduction (CASS registry)

	Revasc (n=49)	*No revasc (n=52)*
• Coronary angio	2-VD 24% 3-VD 67% LMD 8% LVEF (<35%) 43%	N/A
• Revascularisation	PCI 65% CABG 35%	N/A
• Median time to surgery	30 days	?<5 days

Coronary revascularisation in very high risk patients

Poldermans et al JACC 2007

	Revascularization n (%)	No Revascularization n (%)	HR (95% CI)	p Value
Number of patients	49	52		
Events before surgery				
All-cause mortality	2 (4.1)	0	—	0.23
Myocardial infarction	1 (2.1)	0	—	
Composite	3 (6.1)	0	—	0.11
Events up to 30 days after surgery				
All-cause mortality	11 (22.5)	6 (11.5)	2.2 (0.74–6.6)	0.14
Myocardial infarction	17 (34.7)	16 (30.8)	—	
Composite	21 (42.9)	17 (32.7)	1.4 (0.73–2.8)	0.30
Events up to 365 days after surgery				
All-cause mortality	13 (26.5)	12 (23.1)	1.3 (0.55–2.9)	0.58
Myocardial infarction	18 (36.7)	19 (36.5)		
Composite	24 (49.0)	23 (44.2)	1.2 (0.68–2.3)	0.48

CI = confidence interval; HR = hazard ratio.

Coronary revascularisation

- **Decision for revascularisation should rest on proven indications in non-operative setting**
  - **Reserve for ACS or refractory ischaemia**

Caution in patients with recent PCI and stent insertion

- Stent thrombosis in patients undergoing non-cardiac surgery
  - BMS
    - 3.9% death, MI, ST if surgery within 2 months (n=207)[1]
    - 7.1% if surgery within first 4-6 weeks[1]
    - 86% (6/7) vs 5% (1/20) mortality in pts ceasing vs continuing antiplatelet Rx within 3 weeks (n=27)[2]

1. Wilson et al JACC 2003
2. Sharma et al Catheter Cardiovasc Interv 2004

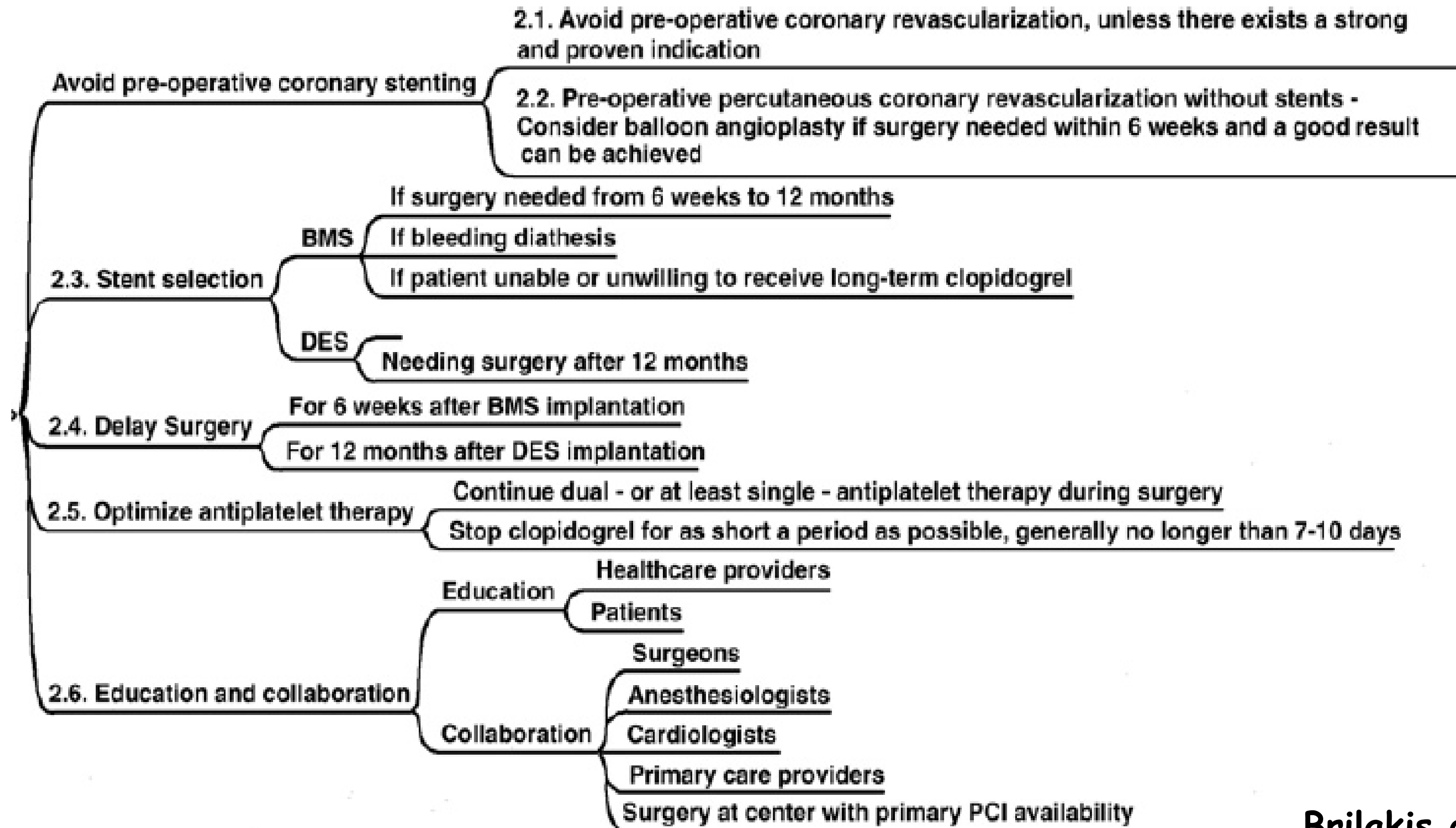
Caution in patients with recent PCI and DES insertion

- Stent thrombosis secondary to withdrawal of dual antiplatelet therapy in DES
  - Risk of thrombosis at 6 weeks 29%[1]
  - 70% risk of AMI[1,2]
  - Mortality rate 31%-45%[1,2]

- Clopidogrel withdrawn; aspirin continued
  - 30 day cessation
    - Mortality at 12 months 7.5% vs 0.7% ($p<0.001$)[3]
  - 6 month cessation
    - Mortality + AMI at 24 months: 7.2% vs 3.1% (p,0.001)[4]

1. Iakovou et al JAMA 2005
2. Kuchulakanti et al Circulation 2006
3. Spertus et al Circulation 2006
4. Eisenstein et al JAMA 2007

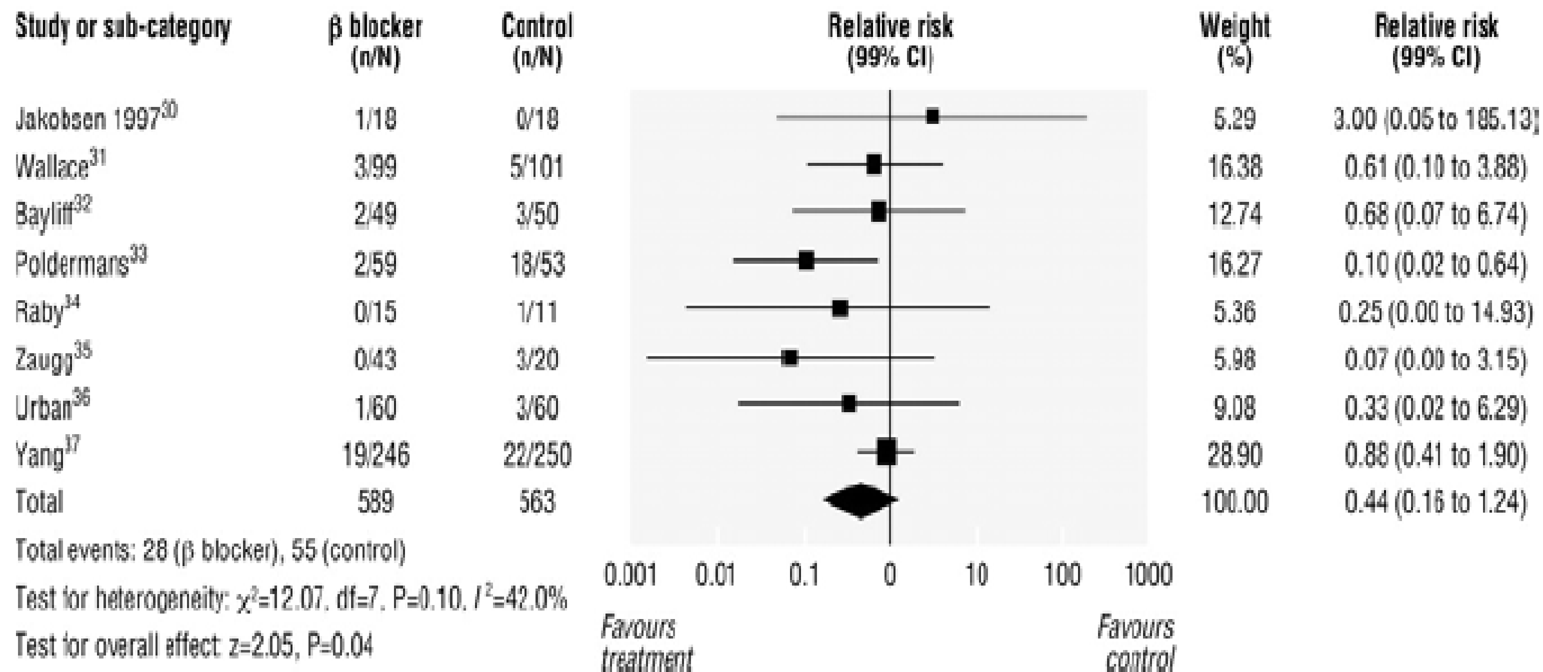
Suggested guidelines re stents



Brilakis et al
JACC 2007

Cardiac Prophylaxis
β-blockers

Systematic review (Devereaux et al BMJ 2005)



Study or sub-category	β blocker (n/N)	Control (n/N)	Weight (%)	Relative risk (99% CI)
Jakobsen 1997[30]	1/18	0/18	5.29	3.00 (0.05 to 185.13)
Wallace[31]	3/99	5/101	16.38	0.61 (0.10 to 3.88)
Bayliff[32]	2/49	3/50	12.74	0.68 (0.07 to 6.74)
Poldermans[33]	2/59	18/53	16.27	0.10 (0.02 to 0.64)
Raby[34]	0/15	1/11	5.36	0.25 (0.00 to 14.93)
Zaugg[35]	0/43	3/20	5.98	0.07 (0.00 to 3.15)
Urban[36]	1/60	3/60	9.08	0.33 (0.02 to 6.29)
Yang[37]	19/246	22/250	28.90	0.88 (0.41 to 1.90)
Total	589	563	100.00	0.44 (0.16 to 1.24)

Total events: 28 (β blocker), 55 (control)

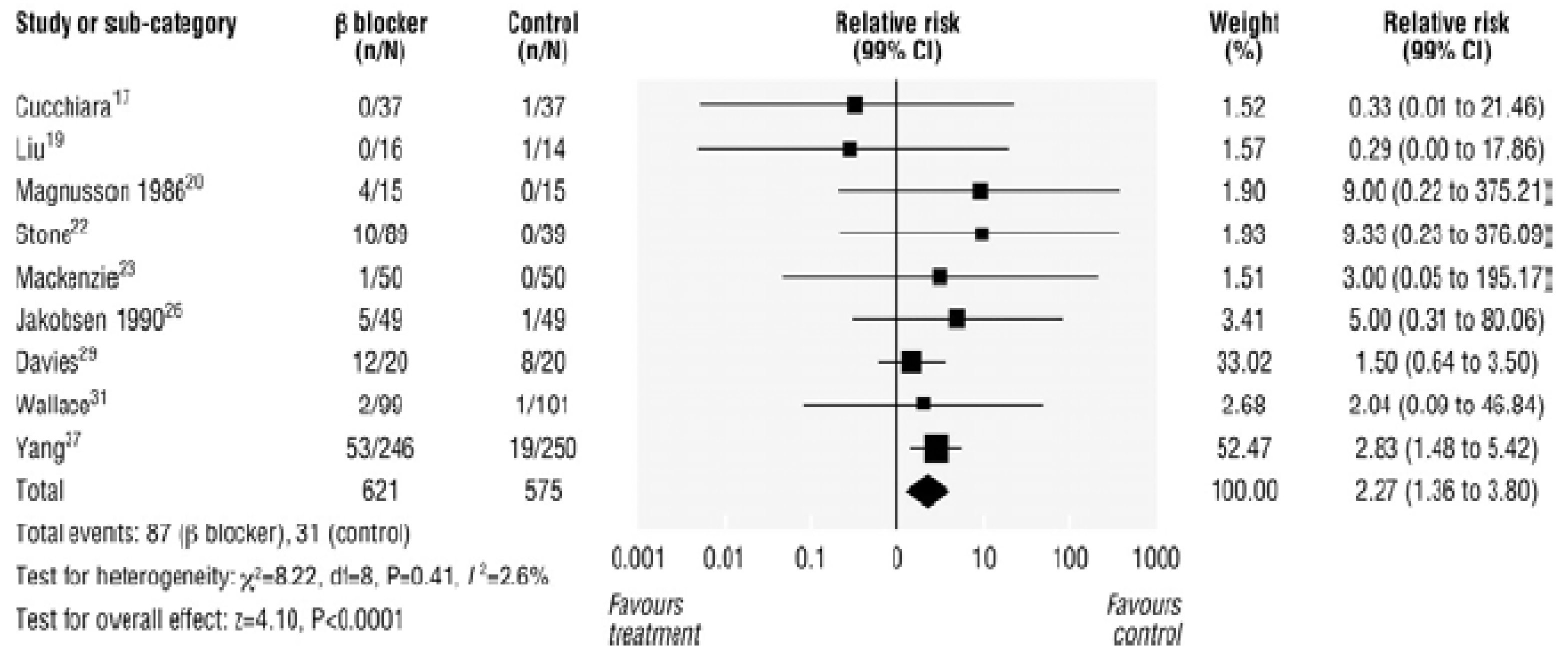
Test for heterogeneity: $\chi^2=12.07$, df=7, P=0.10, $I^2=42.0\%$

Test for overall effect: z=2.05, P=0.04

Relative risks for major perioperative events (cardiovascular death, non-fatal myocardial infarction, or non-fatal cardiac arrest)

Cardiac Prophylaxis
β-blockers

Systematic review (Devereaux et al BMJ 2005)



Study or sub-category	β blocker (n/N)	Control (n/N)	Weight (%)	Relative risk (99% CI)
Cucchiara[17]	0/37	1/37	1.52	0.33 (0.01 to 21.46)
Liu[19]	0/16	1/14	1.57	0.29 (0.00 to 17.86)
Magnusson 1986[20]	4/15	0/15	1.90	9.00 (0.22 to 375.21)
Stone[22]	10/89	0/39	1.93	9.33 (0.23 to 376.09)
Mackenzie[23]	1/50	0/50	1.51	3.00 (0.05 to 195.17)
Jakobsen 1990[26]	5/49	1/49	3.41	5.00 (0.31 to 80.06)
Davies[29]	12/20	8/20	33.02	1.50 (0.64 to 3.50)
Wallace[31]	2/99	1/101	2.68	2.04 (0.09 to 46.84)
Yang[27]	53/246	19/250	52.47	2.83 (1.48 to 5.42)
Total	621	575	100.00	2.27 (1.36 to 3.80)

Total events: 87 (β blocker), 31 (control)

Test for heterogeneity: χ^2=8.22, df=8, P=0.41, I^2=2.6%

Test for overall effect: z=4.10, P<0.0001

Relative risks for bradycardia needing treatment

Cardiac Prophylaxis
β-blockers

- Trials in high-risk patients
  - 921 diabetic patients undergoing major non-cardiac surgery
    - Juul A et al and the DIPOM Trial Group. BMJ 2006
  - 103 patients undergoing infra-renal vascular surgery
    - POBBLE Trial Investigators. J Vasc Surg 2005

No effect on mortality or cardiovascular events despite high event rates (20% and 33% respectively)

Cardiac Prophylaxis
β-blockers

- Large trial (n=10,000) in progress (POISE)

- Preliminary data: initiating metoprolol therapy shortly prior to non-cardiac surgery increases the risk of hypotension, stroke and death, despite reducing the risk of myocardial infarction.

Cleland et al Eur J Heart Fail 2008

Cardiac Prophylaxis
β-blockers

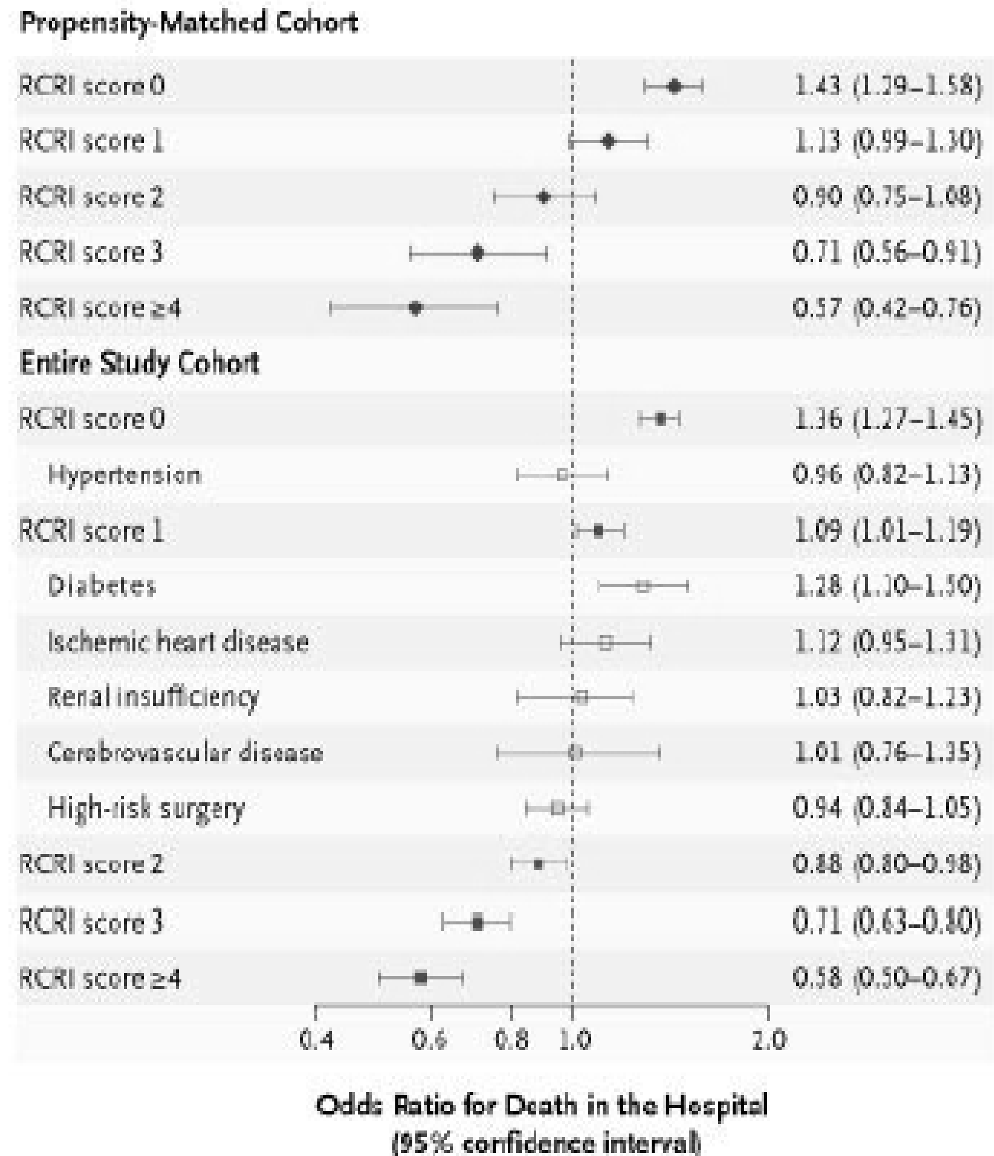
Retrospective cohort study
(Lindenauer et al. N Engl J Med 2005)

119,362 patients receiving peri-operative β-blocker

663,635 control patients

Analysis of benefit according to:

- *RCRI score*
- *type of surgery*
- *IHD/CCF*
- *CRF*



Cardiac Prophylaxis
β-blockers
Outstanding issues

?Dose: Titrate according to heart rate and BP
?Duration: not clear - 5-7 days post-op

Avoid in patients with clear C/I:
high-grade block, severe asthma

OK in COPD, PVD, mild-moderate asthma

Recommended in:
RSCI score ≥3
IHD
high risk surgery (vascular, thoracic)
age ≥70 years

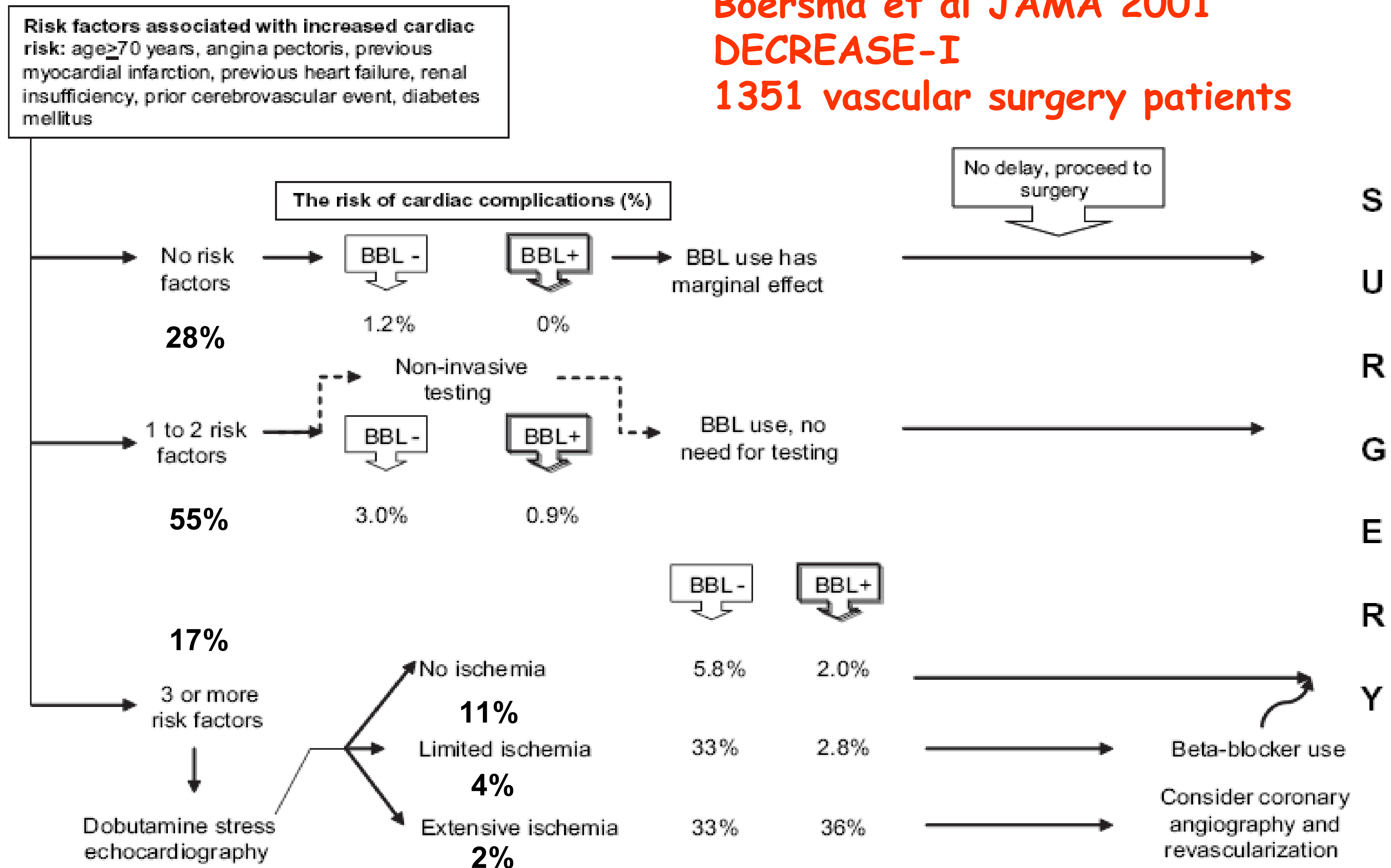
Await large-scale RCTs
POISE (10,000)
DECREASE IV (6,000)

Current state of play

Prescribe β-blockers, unless contra-indicated, in all patients with known coronary heart disease and/or RCRI scores ≥3 who are undergoing intermediate to high risk surgery with doses that maintain resting heart rate at 60 to 70 beats per minute

ACC/AHA 2006 guideline update on perioperative cardiovascular evaluation for noncardiac surgery: Focused update on perioperative beta-blocker therapy. J Am Coll Cardiol 2006

Clinical algorithm



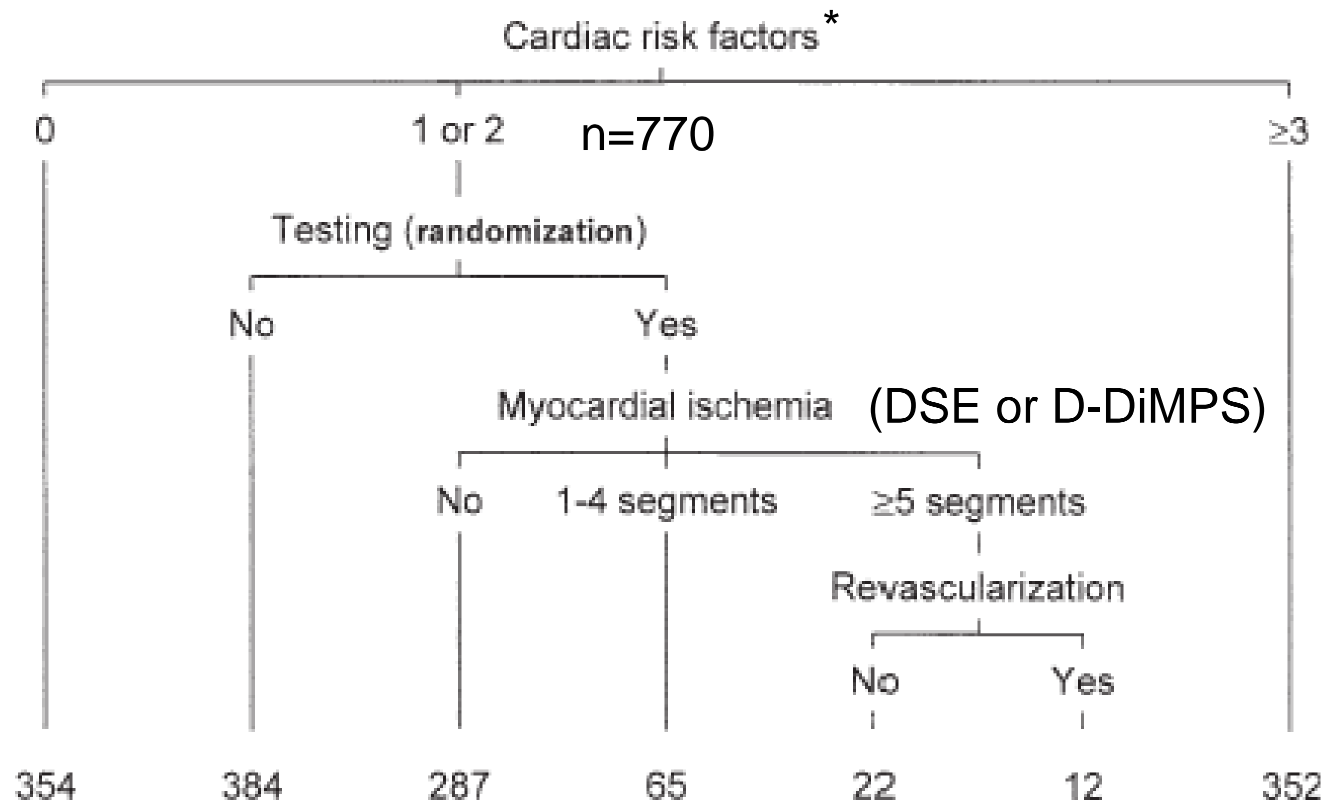
Integrated approach to management

- In low to intermediate risk patients undergoing vascular surgery and receiving β-blocker therapy titrated to achieve tight heart rate control, does pre-op cardiac testing and test-related changes in management alter cardiac outcomes?

Integrated approach to management

1476 vascular surgery patients

Poldermans et al
DECREASE-II JACC 2006



*age>70, angina, prior MI, CHF, diabetes, renal dysfunction (Se Cr >160), CVA/TIA

Integrated approach to management

1476 vascular surgery patients

Poldermans et al
DECREASE-II JACC 2006

Primary end-point: CV death/MI at 30 days

- Testing 2.3%
- No testing 1.8% OR=0.78 (0.28-2.1)

- Strategy of no testing brought surgery forward by median 19 days

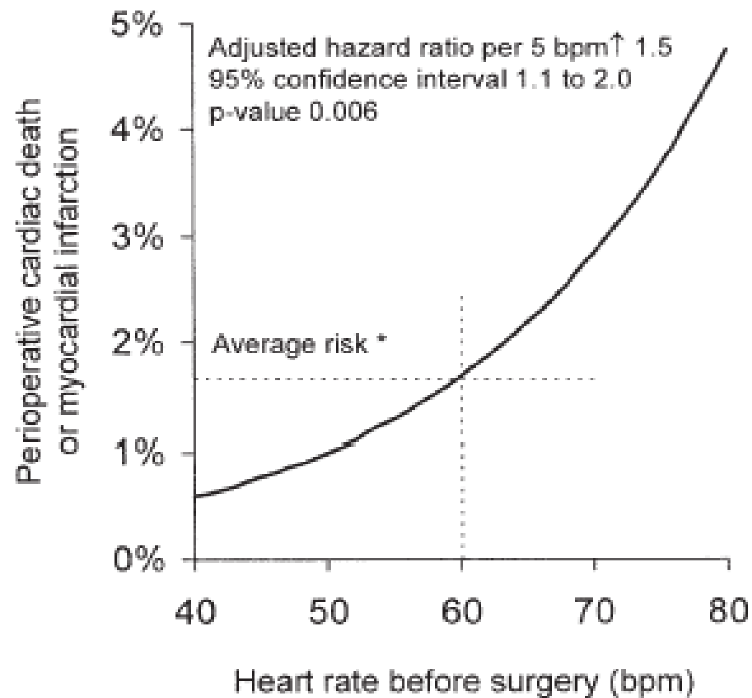
Prognostic value of testing

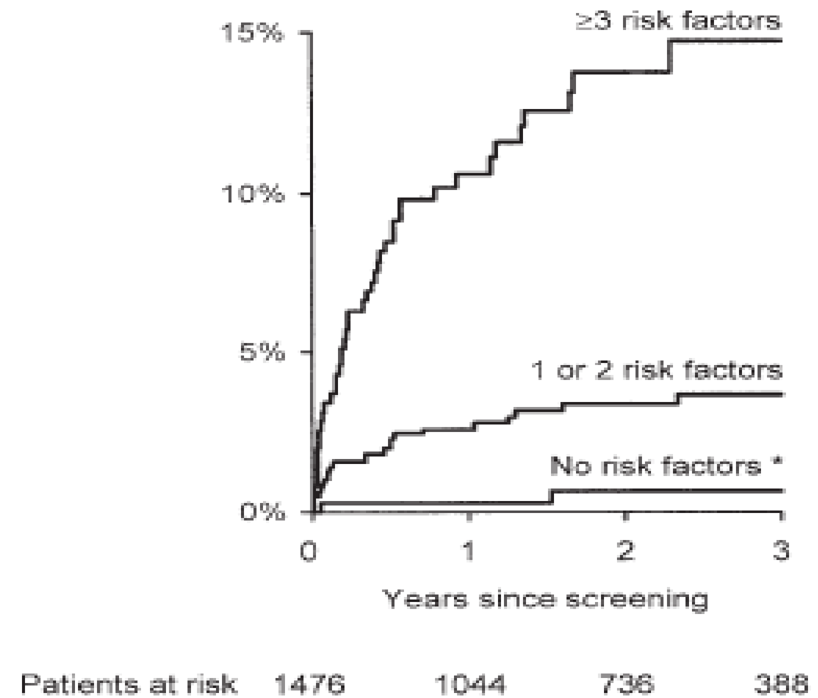
- No ischaemia: 0%
- 1-4 ischaemic segments: 6.2%
- ≥5 ischaemic segments: 14.7%

Integrated approach to management

1476 vascular surgery patients

Poldermans et al
DECREASE-II JACC 2006





Other adjuvant therapies

Calcium-channel blockers, α-adrenergic agonists and nitrates:

- Meta-analysis of 11 trials of calcium-channel blockers showed no statistically significant reduction in cardiac events
  (although total events (17 among 692 patients) were too few to draw conclusions) **Wijeysundera & Beattie Anesth Analg 2003**

- Meta-analysis of 12 trials of α-adrenergic agonists showed significant reductions in mortality and incidence of MI, but only in patients undergoing vascular surgery
  - RR=0.47 and 0.66 respectively

  (although single trial excluded 957 of 2854 randomised patients because of lower than expected event rates) **Wijeysundera et al Am J Med 2003**

- No studies evaluating the role of nitrates

Other adjuvant therapies

Statins

- Four risk-adjusted observational studies suggested increased cardioprotection from statins in patients undergoing high-risk surgery
  - One study: 29% fewer in-hospital deaths[1]
  - Other three: 48%, 45% and 76% fewer perioperative cardiac complications respectively in statin users compared to non-users with the greatest risk reduction of 85% in patients undergoing abdominal aneurysm repair who received both statins and β-blockers [2-4]
- Only randomised trial to date: 100 patients undergoing vascular surgery showed atorvostatin (20mg/day), administered for 45 days regardless of serum cholesterol level, markedly reduced cardiovascular events (absolute risk reduction [ARR]=18%)[5]
  - Low numbers of events (n=17), implausibly large effect size, and borderline statistical significance for a broad composite outcome

1.Lindenauer et al. JAMA 2004
2.O'Neil-Callahan et al JACC 2005
3. Kennedy et al. Stroke 2005
4. Kertai et al. Eur J Vasc Endovasc Surg 2004
5. Durazzo et al. J Vasc Surg 2004

Other adjuvant therapies

Antiplatelet agents

- Systematic review of 10 trials in patients undergoing infra-inguinal vascular surgery (6 involving aspirin)[1]
  - trend towards reduced vascular events (death, nonfatal MI, stroke) compared to placebo
- Pulmonary Embolism Prevention (PEP) trial[2]
  - increased risk of coronary events with aspirin in patients undergoing hip fracture surgery
  - 21% increase in postoperative bleeding episodes requiring transfusion (2.9% vs 2.4%)
- Almost 2-fold increase in bleeding risk (0.74% vs 0.39%) among 7606 surgical patients included in a large overview of randomised trials of antiplatelet therapy[3]
- Large definitive trial required in determining bleeding risk of antiplatelet therapy against the unproven cardiovascular benefits

1. **Robless et al Br J Surg 2001**
2. **PEP Investigators Lancet 2000**
3. **Antiplatelet Trialists' Collaboration BMJ 1994**

Current state of play

- No further testing necessary in patients who have:
  - undergone coronary revascularisation within past 5 years and have had no recurrent symptoms
  - had negative cardiac evaluation within past 2 years with no anginal symptoms
- In patients undergoing vascular surgery with RCRI or Eagle criteria ≤ 2, randomised evidence suggests that cardiac testing in those receiving β-blockers with tight HR control does not alter outcome and merely delays surgery
- In patients with RCRI or Eagle criteria ≥ 3 pre-operative testing is useful in identifying patients who, even with β-blockers, have a perioperative risk so high that cancellation of surgery +/- coronary revascularisation should be considered

Current state of play

- The role of cardiac testing in non-vascular, non-cardiac surgery remains ill-defined although the same approach as used in vascular surgery may apply
- Studies of cardiac testing have not assessed the impact of contemporary anaesthetic technique
- Utility of cardiac testing is subject to local availability and expertise
- Cardiac testing in general is predicated on the likelihood that it will lead to changes in clinical risk estimates large enough to materially alter decision-making
- Role of cardiac testing in patients who receive other cardioprotective agents in addition to β-blockers is uncertain

Post-operative risk stratification

3570 pts non-cardiac surgery
Prospective cohort
ECG in recovery room

Rinfret et al Am J Cardiol 2004

Variable	Class I/II (n = 2,554)	Class III/IV (n = 1,010)
Signs of ischemia on postoperative ECG	4/126 (3.2%)	14/142 (9.9%)
No signs of ischemia	16/2,428 (0.7%)	46/868 (5.3%)
OR (95% CI)†	4.9 (1.6–15)	2.0 (1.0–3.7)

Class=RCRI