Perioperative Cardiovascular Evaluation and Care for Noncardiac Surgery

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 2002 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery)

Tzong-Luen Wang,
MD, PhD, JM, FESC, FACC, FSPAC
103.04.15

Goldman Criteria

- Age > 70 yrs (5)
- CAD: MI within 6 months (10)
- CHF: S3 or JVE (11)
- Rhythm:
  – other than NSR/PACs on most recent ECG (7);
  – > 5 PVCs/min any time preoperatively (7)
- Valvular Disease: important aortic stenosis (5)
- General Medical condition (5)
  – PaO2 <60 or PaCO2 >50, K <3.0, or HCO3 <20, BUN >50 or Cr >3.0, abnormal AST, signs of chronic liver disease, bedridden from noncardic causes
- Surgery: intraperitoneal, thoracic, aortic surgery (3) emergent surgery (4)

Goldman Criteria

Class	Total Score	No or Minor Complications	Life Threatening	Cardiac Deaths
I	0-5	99%	0.7%	0.2%
II	6-12	93%	5%	2%
III	13-25	86%	11%	2%
IV	>25	22%	22%	56%

Revised Goldman Criteria

- High risk type of surgery
- History of ischemic heart disease
- History of heart failure
- History of CVA
- Preoperative treatment with insulin
- Preoperative serum creatinine $\geq$ 2.0 mg/dL

Rates: *0.4% with no risk; 0.9% with 1 risk; 7% with 2 risks; 11% with 3 or more risks*

Detsky Criteria

- Age > 70 yrs (5)
- CAD:
  – MI within 6 months (10)
  – MI >6 months (5)
  – CCS angina class III (10)
  – CCS angina class IV (20)
  – Unstable angina past 3 months (10)
- CHF:
  – Pulmonary edema within 1 week (10)
  – Pulmonary edema, ever (5)
- Rhythm:
  – other than NSR/PACs on last preop ECG (5);
  – > 5 PVCs/min any time preoperatively (5)
- Valvular Disease: suspected critical aortic stenosis (5)
- General Medical condition (5)
  – PaO2 <60 or PaCO2 >50, K <3.0, or HCO3 <20, BUN >50 or Cr >3.0, abnormal AST, signs of chronic liver disease, bedridden from noncardic causes
- Surgery: emergent surgery (10)

Revised Detsky Criteria

- High risk type of surgery
- History of ischemic heart disease
- History of heart failure
- History of CVA
- Preoperative treatment with insulin
- Preoperative serum creatinine $\geq$ 2.0 mg/dL
- unstable angina within 3 months of surgery or stable angina occurring with minimal exertion or recent pulmonary edema (HIGH RISK)
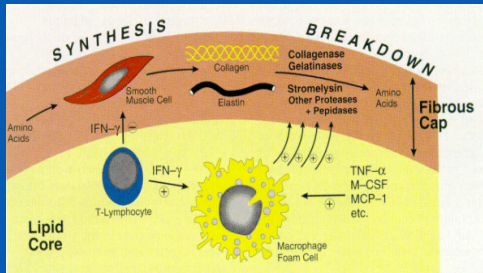
Rates: *0.4% with no risk; 0.9% with 1 risk; 7% with 2 risks; 11% with 3 or more risks or HIGH RISK*

Slide 1: Goldman and Detsky Criteria

- **May UNDERESTIMATE the Cardiac Risk in Vascular Patients …**

Slide 2: Eagle Criteria

- **Access 5 significant clinical predictors**
  1. Q waves on EKG
  2. History of angina
  3. History of ventricular ectopy requiring treatment
  4. Diabetes mellitus requiring therapy other than diet
  5. Age > 70

- *Rate of postoperative ischemic events: 3.1% if no predictors, 15% if 1-2 predictors and up to 50% if 3 or more predictors.*

Slide 3: Applying Classification of Recommendations and Level of Evidence

Class I	Class IIa	Class IIb	Class III
Benefit >>> Risk	*Benefit >> Risk* *Additional studies with focused objectives needed*	*Benefit ≥ Risk* *Additional studies with broad objectives needed; Additional registry data would be helpful*	*Risk ≥ Benefit* *No additional studies needed*
Procedure/ Treatment **SHOULD** be performed/ administered	**IT IS REASONABLE** to perform procedure/administer treatment	Procedure/Treatment **MAY BE CONSIDERED**	Procedure/Treatment should **NOT** be performed/administered **SINCE IT IS NOT HELPFUL AND MAY BE HARMFUL**
should is recommended is indicated is useful/effective/ beneficial	is reasonable can be useful/effective/ beneficial is probably recommended or indicated	may/might be considered may/might be reasonable usefulness/effectiveness is unknown /unclear/uncertain or not well established	is not recommended is not indicated should not is not useful/effective/beneficial may be harmful

---

Slide 4: Applying Classification of Recommendations and Level of Evidence

Level A	Class I	Class IIa	Class IIb	Class III
Multiple (3-5) population risk strata evaluated *General consistency of direction and magnitude of effect*	• Recommendation that procedure or treatment is useful/ effective • Sufficient evidence from multiple randomized trials or meta-analyses	• Recommendation in favor of treatment or procedure being useful/ effective • Some conflicting evidence from multiple randomized trials or meta-analyses	• Recommendation's usefulness/ efficacy less well established • Greater conflicting evidence from multiple randomized trials or meta-analyses	• Recommendation that procedure or treatment not useful/effective and may be harmful • Sufficient evidence from multiple randomized trials or meta-analyses

---

Slide 5: Applying Classification of Recommendations and Level of Evidence

Level B	Class I	Class IIa	Class IIb	Class III
Limited (2-3) population risk strata evaluated	• Recommendation that procedure or treatment is useful/effective • Limited evidence from single randomized trial or non-randomized studies	• Recommendation in favor of treatment or procedure being useful/ effective • Some conflicting evidence from single randomized trial or non-randomized studies	• Recommendation's usefulness/ efficacy less well established • Greater conflicting evidence from single randomized trial or non-randomized studies	• Recommendation that procedure or treatment not useful/effective and may be harmful • Limited evidence from single randomized trial or non-randomized studies

---

Slide 6: Applying Classification of Recommendations and Level of Evidence

Level C	Class I	Class IIa	Class IIb	Class III
Very limited (1-2) population risk strata evaluated	• Recommendation that procedure or treatment is useful/ effective • Only expert opinion, case studies, or standard-of-care	• Recommendation in favor of treatment or procedure being useful/effective • Only diverging expert opinion, case studies, or standard-of-care	• Recommendation's usefulness/ efficacy less well established • Only diverging expert opinion, case studies, or standard-of-care	• Recommendation that procedure or treatment not useful/effective and may be harmful • Only expert opinion, case studies, or standard-of-care

Slide 1

Active Cardiac Conditions for Which the Patient Should Undergo Evaluation and Treatment Before Noncardiac Surgery

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 > 100 bpm 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 cm2, or symptomatic) ▪ Symptomatic mitral stenosis (progressive dyspnea on exertion, exertional presyncope, or HF)

CCS indicates Canadian Cardiovascular Society; HF, heart failure; HR, heart rate; MI, myocardial infarction; NYHA, New York Heart Association. *According to Campeau.10 †May include stable angina in patients who are unusually sedentary. ‡The ACC National Database Library defines recent MI as more than 7 days but within 30 days)

Slide 2

Estimated Energy Requirements for Various Activities

	Can You…			Can You…
1 Met	Take care of yourself?		4 Mets	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?			Do heavy work around the house like scrubbing floors or lifting or moving heavy furniture?
	Walk a block or 2 on level ground at 2 to 3 mph (3.2 to 4.8 kph)?			Participate in moderate recreational activities like golf, bowling, dancing, doubles tennis, or throwing a baseball or football?
4 Mets	Do light work around the house like dusting or washing dishes?		≥ 10 Mets	Participate in strenuous sports like swimming, singles tennis, football, basketball, or skiing?

MET indicates metabolic equivalent; mph, miles per hour; kph, kilometers per hour. *Modified from Hlatky et al,11 copyright 1989, with permission from Elsevier, and adapted from Fletcher et al.12

Slide 3

Cardiac Risk Stratification for Noncardiac Surgical Procedures

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

Slide 4

Recommendations for Preoperative Noninvasive Evaluation of LV Function

- Class I (none)
- Class IIa
  - It is reasonable for patients with dyspnea of unknown origin to undergo preoperative evaluation of LV function. (C)
  - It is reasonable for patients with current or prior HF with worsening dyspnea or other change in clinical status to undergo preoperative evaluation of LV function if not performed within 12 months. (C)
- Class IIb
  - Reassessment of LV function in clinically stable patients with previously documented cardiomyopathy is not well established. (C)
- Class III
  - Routine perioperative evaluation of LV function in patients is not recommended. (B)

Slide 5

Recommendations for Preoperative Resting 12-Lead ECG

- Class I: Preoperative resting 12-lead ECG is recommended for pts with:
  - At least 1 clinical risk factor* who are undergoing vascular surgical procedures. (B)
  - Known CHD, peripheral arterial disease, or cerebrovascular disease who are undergoing intermediate-risk surgical procedures. (C)
- Class IIa: Preoperative resting 12-lead ECG is reasonable in persons with no clinical risk factors who are undergoing vascular surgical procedures. (B)
- Class IIb: Preoperative resting 12-lead ECG may be reasonable in patients with at least 1 clinical risk factor who are undergoing intermediate-risk operative procedures. (B)
- Class III: Preoperative and postoperative resting 12-lead ECGs are not indicated in asymptomatic persons undergoing low-risk surgical procedures. (B)

*Clinical risk factors include history of ischemic heart disease, history of compensated or prior HF, history of cerebrovascular disease, DM, and renal insufficiency.

Slide 6

Evaluation

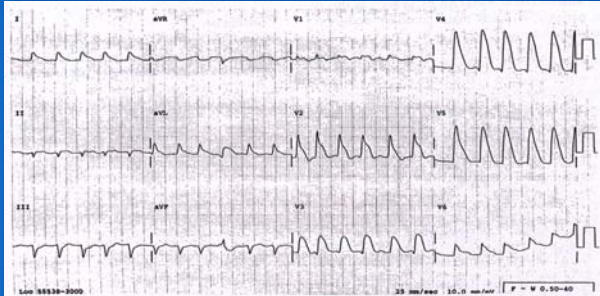### High Risk 12-Lead ECG

High Risk 12-Lead ECG

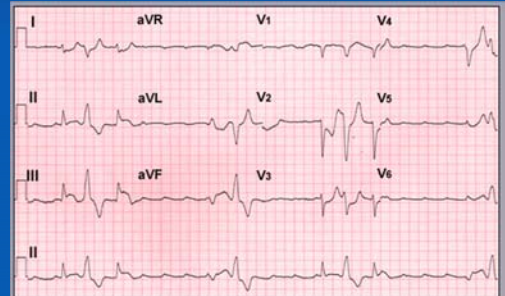**Extensive Antero-lateral MI**

High Risk 12-Lead ECG

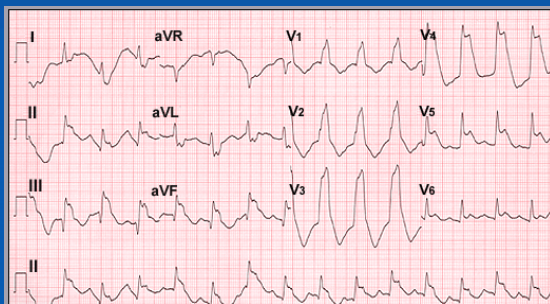**Inferior MI, high grade AV block and PVC**

High Risk 12-Lead ECG

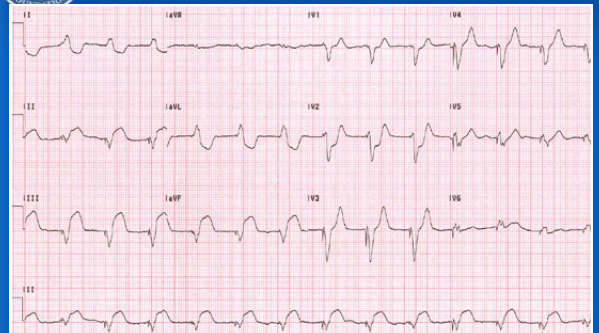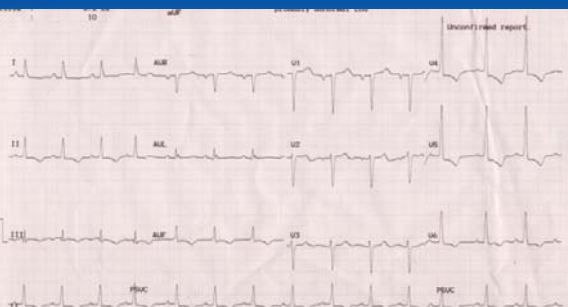**AMI (inferio-lateral?) With RBBB**

High Risk 12-Lead ECG

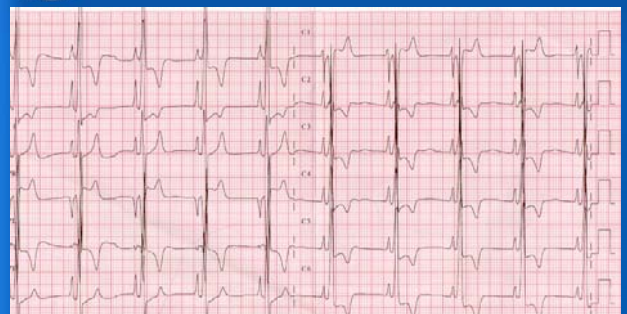**Pacemaker rhythm with AMI (inferior)**

High Risk 12-Lead ECG

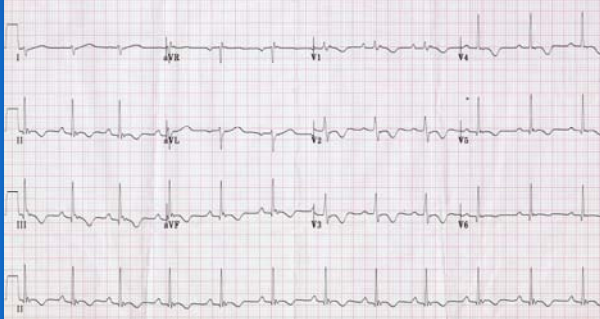**Aortic Valve Stenosis**

High Risk 12-Lead ECG

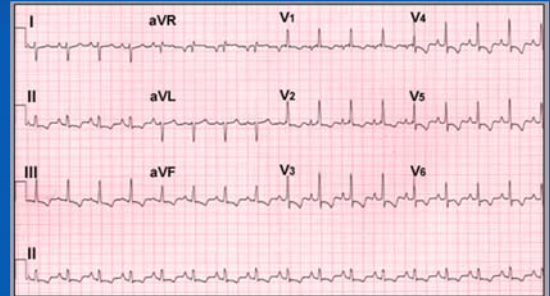**HOCM**

High Risk 12-Lead ECG — Evaluation
Arrhythmogenic RV dysplasia

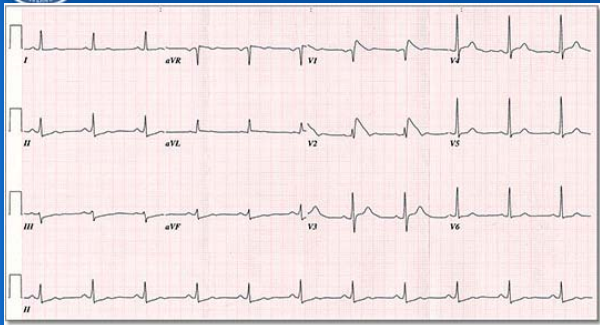**High Risk 12-Lead ECG** — Evaluation
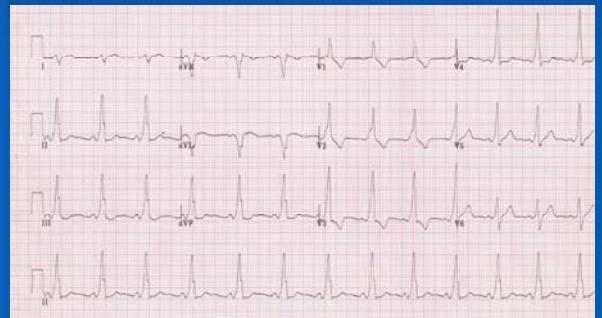RVH (PPH)

High Risk 12-Lead ECG — Evaluation
Brugada Syndrome?
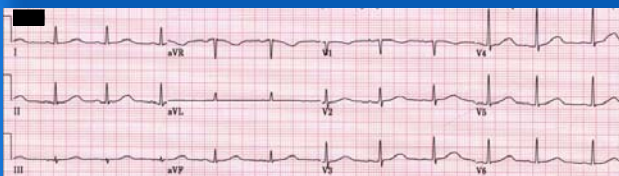

High Risk 12-Lead ECG — Evaluation
WPW Syndrome?

High Risk 12-Lead ECG — Evaluation
Long QT Syndrome?

Recommendations for **Noninvasive Stress Testing** Before Noncardiac Surgery

- Class I: Patients with active cardiac conditions in whom noncardiac surgery is planned should be evaluated and treated per ACC/AHA guidelines before noncardiac surgery. (B)
- Class IIa: Noninvasive stress testing of patients with 3 or more clinical risk factors and poor functional capacity (less than 4 METs) who require vascular surgery is reasonable if it will change management. (B)
- Class IIb: Noninvasive stress testing may be considered for patients:
  - With at least 1 to 2 clinical risk factors and poor functional capacity (less than 4 METs) who require intermediate-risk noncardiac surgery if it will change management. (B)
  - With at least 1 to 2 clinical risk factors and good functional capacity (greater than or equal to 4 METs) who are undergoing vascular surgery. (B)
- Class III: Noninvasive testing is not useful for patients:
  - With no clinical risk factors undergoing intermediate-risk noncardiac surgery. (C)
  - Undergoing low-risk noncardiac surgery. (C)

Slide 1

Prognostic Gradient of Ischemic Responses During an ECG-Monitored Exercise Test in Patients With Suspected or Proven CAD

High Risk Ischemic Response

Ischemia induced by low-level exercise* (less than 4 METs or heart rate < 100 bpm or < 70% of age-predicted heart rate) manifested by 1 or more of the following:

- Horizontal or downsloping ST depression > 0.1 mV
- ST-segment elevation > 0.1 mV in noninfarct lead
- Five or more abnormal leads
- Persistent ischemic response >3 minutes after exertion
- Typical angina
- Exercise-induced decrease in systolic BP by 10 mm Hg

Slide 2

Prognostic Gradient of Ischemic Responses During an ECG-Monitored Exercise Test in Patients With Suspected or Proven CAD

Intermediate:
Ischemia induced by moderate-level exercise (4 to 6 METs or HR 100 to 130 bpm (70% to 85% of age-predicted heart rate)) manifested by ≥ 1 of the following:

- Horizontal or downsloping ST depression > 0.1 mV
- Persistent ischemic response greater than 1 to 3 minutes after exertion
- Three to 4 abnormal leads

Low
No ischemia or ischemia induced at high-level exercise (> 7 METs or HR > 130 bpm (greater than 85% of age-predicted heart rate)) manifested by:

- Horizontal or downsloping ST depression > 0.1 mV
- One or 2 abnormal leads

Inadequate test
Inability to reach adequate target workload or heart rate response for age without an ischemic response. For patients undergoing noncardiac surgery, the inability to exercise to at least the intermediate-risk level without ischemia should be considered an inadequate test.
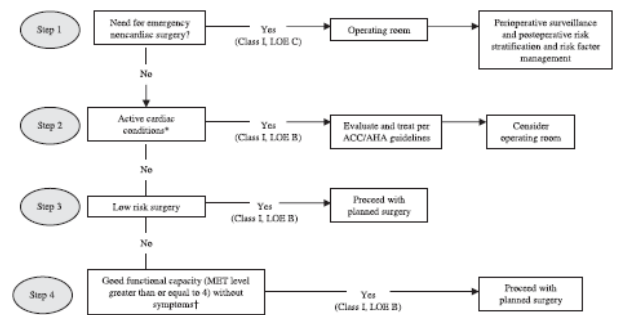
Slide 3

Preoperative Coronary Revascularization With CABG or Percutaneous Coronary Intervention
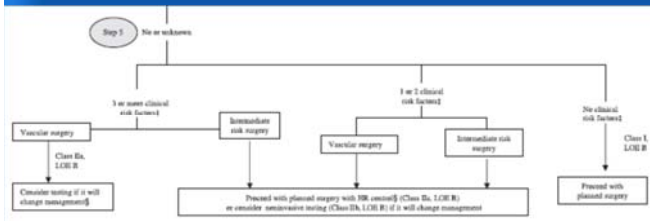
- Class I: Patients with active cardiac conditions in whom noncardiac surgery is planned should be evaluated and treated per ACC/AHA guidelines before noncardiac surgery. (B)
- Class IIa: Noninvasive stress testing of patients with 3 or more clinical risk factors and poor functional capacity (less than 4 METs) who require vascular surgery is reasonable if it will change management. (B)
- Class IIb: Noninvasive stress testing may be considered for patients:
  - With at least 1 to 2 clinical risk factors and poor functional capacity (less than 4 METs) who require intermediate-risk noncardiac surgery if it will change management. (B)
  - With at least 1 to 2 clinical risk factors and good functional capacity (greater than or equal to 4 METs) who are undergoing vascular surgery. (B)
- Class III: Noninvasive testing is not useful for patients:
  - With no clinical risk factors undergoing intermediate-risk noncardiac surgery. (C)
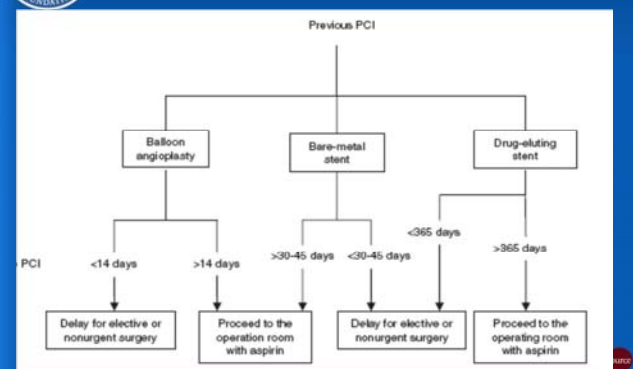 - Undergoing low-risk noncardiac surgery. (C)

Slide 4

Cardiac evaluation and care algorithm for noncardiac surgery (1)

Slide 5

Cardiac evaluation and care algorithm for noncardiac surgery (2)
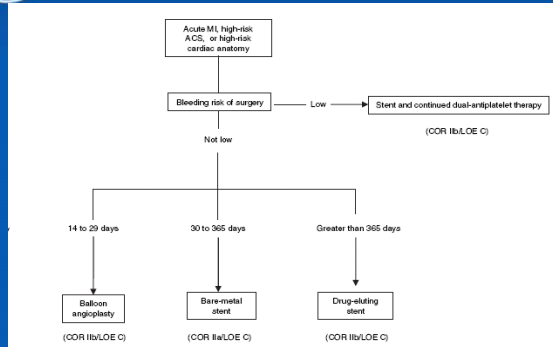

Slide 6

Proposed approach to the management of patients with previous PCI who require noncardiac surgery

Slide 1: Treatment for patients requiring PCI who need subsequent surgery

- Acute MI, high-risk ACS, or high-risk cardiac anatomy
- Bleeding risk of surgery
  - Low → Stent and continued dual-antiplatelet therapy (COR IIb/LOE C)
  - Not low
    - 14 to 29 days → Balloon angioplasty (COR IIb/LOE C)
    - 30 to 365 days → Bare-metal stent (COR IIa/LOE C)
    - Greater than 365 days → Drug-eluting stent (COR IIb/LOE C)

Slide 2: Drug Eluting Stents (DES) and Stent Thrombosis

- A 2007 AHA/ACC/SCAI/ACS/ADA science advisory report concludes that premature discontinuation of dual antiplatelet therapy markedly increases the risk of catastrophic stent thrombosis and death or MI.
- To eliminate the premature discontinuation of thienopyridine therapy, the advisory group recommends the following:

1. Before implantation of a stent, the physician should discuss the need for dual-antiplatelet therapy. In patients not expected to comply with 12 months of thienopyridine therapy, whether for economic or other reasons, strong consideration should be given to avoiding a DES.

2. In patients who are undergoing preparation for PCI and who are likely to require invasive or surgical procedures within the next 12 months, consideration should be given to implantation of a baremetal stent or performance of balloon angioplasty with provisional stent implantation instead of the routine use of a DES.

Grines CL, et al. *Circulation.* 2007;115:813-818.

Slide 3: Drug Eluting Stents (DES) and Stent Thrombosis

3. A greater effort by healthcare professionals must be made before patient discharge to ensure that patients are properly and thoroughly educated about the reasons they are prescribed thienopyridines and the significant risks associated with prematurely discontinuing such therapy.

4. Patients should be specifically instructed before hospital discharge to contact their treating cardiologist before stopping any antiplatelet therapy, even if instructed to stop such therapy by another healthcare provider.

5. Healthcare providers who perform invasive or surgical procedures and who are concerned about periprocedural and postprocedural bleeding must be made aware of the potentially catastrophic risks of premature discontinuation of thienopyridine therapy. Such professionals who perform these procedures should contact the patient's cardiologist if issues regarding the patient's antiplatelet therapy are unclear, to discuss optimal patient management strategy.

Grines CL, et al. *Circulation.* 2007;115:813-818.

Slide 4: Drug Eluting Stents (DES) and Stent Thrombosis

6. Elective procedures for which there is significant risk of perioperative or postoperative bleeding should be deferred until patients have completed an appropriate course of thienopyridine therapy (12 months after DES implantation if they are not at high risk of bleeding and a minimum of 1 month for bare-metal stent implantation).

7. For patients treated with DES who are to undergo subsequent procedures that mandate discontinuation of thienopyridine therapy, aspirin should be continued if at all possible and the thienopyridine restarted as soon as possible after the procedure because of concerns about late stent thrombosis.

Grines CL, et al. *Circulation.* 2007;115:813-818.

Slide 5: Recommendations for Beta-Blocker Medical Therapy

CLASS I

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. (*C*)
2. 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. (*B*)

CLASS IIa

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

Slide 6: Recommendations for Beta-Blocker Medical Therapy

CLASS IIb

1. 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.* (*C*)

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

CLASS III

1. Beta blockers should not be given to patients undergoing surgery who have absolute contraindications to beta blockade. (*C*)

Recommendations for Perioperative Beta-Blocker Therapy

Surgery	No Clinical Risk Factors	1 or More Clinical Risk Factors	CHD or High Cardiac Risk	Patients Currently Taking Beta Blockers
Vascular	Class IIb, Level of Evidence: B	Class IIa, Level of Evidence: B	Patients found to have myocardial ischemia on preoperative testing: Class I, Level of Evidence: B* Patients without ischemia or no previous test: Class IIa, Level of Evidence: B	Class I, Level of Evidence: B
Intermediate risk	...	Class IIb, Level of Evidence: C	Class IIa, Level of Evidence: B	Class I, Level of Evidence: C
Low risk	...	...	...	Class I, Level of Evidence: C

Recommendations for Statin Therapy

CLASS I
1. For patients currently taking statins and scheduled for noncardiac surgery, statins should be continued. (B)

CLASS IIa
1. For patients undergoing vascular surgery with or without clinical risk factors, statin use is reasonable. (B)

CLASS IIb
1. For patients with at least 1 clinical risk factor who are undergoing intermediate-risk procedures, statins may be considered. (C)

Recommendations for Alpha-2 Antagonists and TE Echo

CLASS IIb
1. 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. (B)

CLASS III
1. Alpha-2 agonists should not be given to patients undergoing surgery who have contraindications to this medication. (C)

CLASS IIa
1. The emergency use of intraoperative or perioperative TEE is reasonable to determine the cause of an acute, persistent, and life-threatening hemodynamic abnormality. (Level of Evidence: C)

Recommendations for PA Catheters and IV Nitro

CLASS IIb
1. Preoperative intensive care monitoring with a pulmonary artery catheter for optimization of hemodynamic status might be considered; however, it is rarely required and should be restricted to a very small number of highly selected patients whose presentation is unstable and complex and who have multiple comorbid conditions. (B)

2. 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

Intraoperative and Postoperative Use of ST-Segment Monitoring

CLASS IIa
- 1. 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. (B)

CLASS IIb
- 1. Intraoperative and postoperative ST-segment monitoring may be considered in patients with single or multiple risk factors for CAD who are undergoing noncardiac surgery. (B)

Surveillance for Perioperative MI

CLASS I
- 1. Postoperative troponin measurement is recommended in patients with ECG changes or chest pain typical of acute coronary syndrome. (C)

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

CLASS III
- 1. Postoperative troponin measurement is not recommended in asymptomatic stable patients who have undergone low-risk surgery. (C)