Perioperative Care of the Cardiac Surgery Patient

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Learning Objectives

- Identify, evaluate, and treat cardiac risk patients
- Minimize intraoperative risk for these patients
- Address postoperative care problems in an EBM manner to reduce mortality and morbidity
Challenge in Care Plans

Preoperative
- Evaluation and risk assessment

Intraoperative
- Prevention of acceleration of disease state
- Managing interactions between anesthetic and surgical requirements, primary disease and co-morbidities

Postoperative
- Prevention and treatment of adverse events following surgery
Goals of Preoperative Evaluation

- Assess surgical disease
- Assess functional status
- Review associated comorbidities
- Explain procedure and postoperative expectations, including pain management
- Explain expected outcome
- Discuss directives in case of complications
- Instruct about preoperative medication, fasting, and pain treatment
- Minimize risk factors
- Full physical examination
- Collect and evaluate cardiac, pulmonary, and/or vascular examinations
- Review medications and laboratory results
- Prevent adverse events during intra- and postoperative period
Preoperative Evaluation

- Physical, cardiac, and pulmonary functional status.
  - Use a functional classification scale like NYHA
  - ECG, echo and stress testing
  - ABG, CXR, and PFTs

- History of previous surgeries and adverse events

- Allergies

- Previous or ongoing medication with
  - antiplatelet therapy
  - clot lysing agents
  - Aprotinin within last 6 months*
  - β-blockers
  - nitroglycerin
  - ACE-inhibitors
  - digitalis
  - diuretics
  - Ca-channel blockers
  - lipid lowering agents
  - anti hyperglycemic drugs

* see next slide
Aprotinin

A serine protease inhibitor, decreases inflammatory response and inhibits plasmin mediated fibrinolysis.

Prior exposure increases risk of allergic response with peak within the first 6 months post exposure.
Cardiovascular Risk Assessment

**Major**
- Unstable coronary syndrome
  - Acute or recent MI
  - Unstable/sever angina
- Decompensated HF
- Significant arrhythmias
  - High-grade AV block
  - Symptomatic ventricular arrhythmias with concomitant heart disease
  - Supraventricular arrhythmias with uncontrolled ventricular rate
- Severe valvular disease

**Intermediate**
- Mild angina pectoris
- Previous MI or Q waves
- Compensated/previous heart failure
- DM (esp. IDDM)
- Renal insufficiency
Cardiovascular Risk Assessment (cont)

Minor
- Advanced age
- Abnormal ECG
- Rhythm other than SR
- Low functional capacity
- Previous stroke
- Uncontrolled hypertension

These risk factors are predictors for myocardial infarction, heart failure, and death and should be weighed against surgical risk (see next slide).
High-risk Surgeries

- Aortic and major vascular surgery
- Cardiac surgery
- Emergency surgical procedures
- Prolonged surgery with massive fluid shifts or bleeding
Comorbidities

- Diabetes mellitus
- Hematological disease
- Pulmonary disease
- Renal disease
- Smoking
Preoperative Medical Treatments with Effect on Outcome of Surgery

**Diabetes**
- Poorly regulated blood glucose levels intra- and postop shown to negatively affect outcome possibly through effect on neutrophil activity.
- Silent ischemia also more likely in diabetic patients.

**Hypertension**
- Considered risk factor for CAD
- Uncontrolled HTN (stage 3) indication for postponing surgery if possible

**Arrhythmias**
- Preoperative β-blockers recommended by ACC/AHA for supraventricular arrhythmias before cardiac surgery and non-cardiac surgery
- Amiodarone reduces AF after bypass surgery.
Preoperative Medical Treatments with Effect on Outcome of Surgery

Hyperlipidemia
- Statins reduce perioperative cardiac complications undergoing vascular surgery (StaRRS study)

Smoking cessation
- Quitting smoking is associated with a 36% risk reduction of all-cause mortality among patients with CHD, timeline unclear.
Extended Workup of the Cardiac Patient

Exercise stress test
- If ECG abnormalities, do exercise echo or exercise myocardial perfusion imaging

Non-exercise stress test
- Dobutamine, not for arrhythmic or severely hypo/hypertensive patients
- Dipyridamole, not for patients with obstructive pulmonary or carotid disease
- Myocardial perfusion study

Coronary angiogram
- For high-risk patients
**Premedication**

- **Opioids**
  - Sedation, risk of respiratory depression and hypoxia

- **Benzodiazepines**
  - Low risk of respiratory depression, good anxiolytic effect, and sedation

- **Antiemetics**
  - Sedative, anticholinergic, and antiemetic properties

- **Alpha-2 agonists**
  - Decreases stress response, lowers BP, amplifies opioid effect
Goals of Intraoperative Management

- Protect brain, heart, lung, and kidney function by maintaining organ perfusion
- Reduce level of stress hormones
- Reduce cardiac oxygen consumption
- Reduce risk for arrhythmias
- Maintain euglycemia, start insulin infusion early!
- Implement plan for postoperative pain management
- Plan for postoperative organ support if needed
- Adjust anesthetic plan for postoperative care
Organ Protection

- Maintain tissue perfusion by regulating volume status, anesthesia depth, and cardiac function through procedure.
- Use Swan-Ganz catheter (not shown to change outcome), CVP, invasive BP, urine output measurements, and ABGs to reach your preset goals.
- Use β-blockers intraoperatively to reduce HR (reducing oxygen consumption and increasing coronary perfusion time), catecholamine response, and minimize risk for AF.
Methods for Intraoperative Cardiac Function Measurements

- ECG with ST-monitoring
- Arterial line
- CVP
- PA-catheter
- TEE
- Esophageal Doppler
- Partial CO$_2$ rebreathing (NICO) for CO measurement
Goals for Cardiac Optimization

Optimize coronary blood flow by keeping a high arterial diastolic pressure, low LV diastolic pressure, and a relative bradycardia, and decrease coronary vascular resistance (pertinent for CAD but less so for some valvular lesions like AI):

- Nitrates: vasodilates coronaries, slight to no decrease of diastole, decrease in preload and afterload
- Ca-blockers: dilates coronaries, increases diastolic time, minimal to light reduction of preload and reduces afterload
- ß-blockers: increases diastolic time, slightly increase pre- and afterload (probably not of clinical importance), decreases contractility and HR, reduces collateral coronary blood flow (metoprolol)
Anesthetics Effect on Cardiac Function

**Opioid**
- No myocardial depression
- Stable hemodynamics

**Volatile agents**
- Protects ischemic myocardium
- Preconditioning
- Suppresses sympathetic response
- Myocardial depression
- Systemic depression and vascular relaxation

**Propofol**
- Vasodilator
- Rapid recovery, can be used for postoperative sedation
Regional anesthesia

• Epidural: if high (T1-T5), results in cardiac sympathectomy, decreases oxygen consumption, increases coronary blood flow, and increases LV function
• Gives excellent analgesia, reduces postoperative stress response, and facilitates pulmonary function recovery with reduction in mechanical ventilation and earlier extubation

Benzodiazepines

• Midazolam: decreases myocardial oxygen consumption and coronary sinus blood flow
• Diazepam: decrease in LVEDP, reduction in oxygen consumption, increased myocardial blood flow
Isoflurane, sevoflurane, and desflurane all cause coronary vasodilatation

- A hypothesis of “coronary steal” was postulated: Flow change in coronaries when dilated from normal would reduce flow to poststenotic dilated poorly perfused areas more than areas with good perfusion causing aggravated myocardial ischemia. Shown in animal studies, not a factor in humans if good hemodynamic control is maintained.
Intraoperative Drug Support

Vasopressors

- Dopamine
  - $\alpha$, $\beta$- and dopamine receptor agonist; vasodilator at low doses, impairs NE release and vasoconstrictor at higher doses
  - Increased risk of AF after cardiac surgery
  - NO renal protective effect of low-dose dopamine

- Epinephrine
  - $\alpha$- and $\beta$- receptor activity; inotropic and chronotropic effect with increase in afterload, also dromotropic and lusitropic effects (with appropriate use the effect on afterload is minimal)
  - $\beta$-adrenergic activity, increases contractility and HR, reduces systemic and pulmonary vascular resistance

- Norepinephrine
  - $\alpha$- and $\beta_1$ receptor activity; potent $\alpha$-effect with increase in vascular resistance
Intraoperative Drug Support

- Vasopressin
  - $V_1$ and $V_2$ (and $V_3$) receptor effect; induces coronary vasodilatation at low doses followed by vasoconstriction at higher doses, promotes platelet aggregation, releases factor VIII and vWf, increases hepatic glycogenolysis, induces mesenteric vasoconstriction, and decreases CO.
  - The combined effect of NE and vasopressin infusion on catecholamine refractory dilatory shock post CABG seems to be advantageous.
Intraoperative Drug Support

**Inotropes**

- **Dobutamine**
  - “Selective” β agonist; positive inotropic effect, augments coronary blood flow, reduces afterload and preload more than dopamine
  - The increase in CI with dobutamine early after CPB is mostly heart rate, not SV
- **Milrinone (Amrinone)**
  - Phosphodiesterase III inhibitor; positive inotropic effect and dilates pulmonary and systemic vasculature
Anti-arrhythmic drugs

- Amiodarone
  - Minimal effect on LV function, decreases HR
- Magnesium
  - Intraoperative magnesium seems to contribute to myocardial recovery and lessen risk of ventricular arrhythmias postop and reduces AF after cardiac surgery
Antifibrinolytics - these seem to be clinically equal in effect on bleeding during CPB surgery, price and side effects differ

- Aprotinin
- Aminocapric acid
- Tranexamic acid
Level of care is dependent on present or anticipated problems.

- ICU
- Step-down unit
- Telemetry unit
- Ward
Admission

- Keyword: communication! Direct information from OR team/anesthesiologist/surgeon to intensivist team on arrival in the unit about:
  - Operation
  - Complications during op; bleeding, need for transfusion
  - Responsiveness to volume, inotropes, and drugs
  - Planned care and expected problems
Initial Review of the Postoperative Patient

- ABC
- Monitoring
- IV lines and sites
- Pumps and infusions
- Drain catheters and urinary catheter
- Temperature
- Physical examination
Postoperative Management

CABG patients info of importance for care:

- Time on CPB
- Clamp time
- Ventilation/oxygenation/airway management
- Pressor/inotropic support
- Surgical considerations for postop period
Postoperative Management

Ventilation
- CXR for ETT and chest tube placement, SG-catheter position, and pulmonary pathology
- ABG for ventilation assessment and support

Circulation
- Pressor needs? Inotropes?
- CO output and SVR/PVR review
- Peripheral perfusion
- Kidney function

Coagulation
- Output in chest tube/wound per time unit
- TEG/ACT/PT/APTT/platelet count for coagulation status
- Observe drug effects on platelet function (i.e., milrinone)
Risk Factors for Postoperative Pulmonary Dysfunction

- Age < 2 or > 60
- Amiodarone
- COPD
- Pulmonary hypertension
- Congenital pulmonary pathology
- Down’s syndrome

- Long CPB time
- Type of oxygenator
- Level of C3a activation in bypass circuit
- Use of ice for cardioplegia (damage to phrenic nerve)
Postoperative Medications

Aspirin
- Start within first 48 (24) h post op. Reduces risk of early occlusion of grafts

β-blocker
- Reduces risk of cardiovascular death and AF/arrhythmia

Ca-channel blocker
- Reduced mortality after cardiac surgery, although negative inotropic and chronotropic effect and platelet inhibitor

Lipid lowering therapy
- Aggressive treatment delays progression of atherosclerosis regardless of risk factors.
ACE-inhibitors/ARB

- Reduces risk of stroke, MI and death in diabetic and vascular patients, unclear effect after cardiac surgery except for quinapril which reduces risk for ischemic events in postop CAGB patients
Several therapies to maintain graft patency after CABG has been used, side effects and surgeon preference decide choice

- Nitroglycerin
- Ca²-channel antagonists
- Phosphodiesterase inhibitors
- α-adrenergic antagonists
Preventable Postoperative Complications

Arrhythmia
- Decreased organ perfusion
- Increased risk for MI or fatal arrhythmia
- Prolonged ICU care and hospital stay

Hyperglycemia
- Increased mortality and morbidity
- Impaired wound healing
- Decreased cardiac function

Hypertension
- Increased risk of stroke and MI
- Increased risk of surgical bleeding
Postoperative Complications

Bleeding
• Surgical?
• Coagulopathy? Lysis? Heparin effect?

Pain
• Secondary hypertension
• Reduced pulmonary function
• Hyperdynamic circulation
• Impaired wound healing
• Use multimodal approach: acetaminophen, NSAID, opioid and/or LA (PainBuster®) from the OR, add opioids in the unit
Postoperative Complications

- **Coronary ischemia**
  - Increased risk of MI/arrhythmias/circulatory arrest

- **Renal failure**
  - 1 - 2% of CPB patient, associated with high mortality especially if ARF is associated with dialysis
  - Fenoldopam, dopamine – 1 agonist, improves outcome in patients with low CO?

- **Prolonged ventilation**
  - Increased risk of VAP
Problem Directed Management

Hypertension

- Pain?
  - PCA, iv/po medications or epidural

- Postoperative stress response?
  - ß-blocker if tachycardia and good LV function
  - Nicardipine, does not decrease preload, other vasodilators if hypovolemia is excluded
  - Fenoldopam, for patient with renal insufficiency?
    - Tachycardia and pronounced hypotension, usefulness in ICU patients unclear
Problem Directed Management

Hyperglycemia

- Insulin infusion to maintain blood glucose < 110 mg/dl (< 6.1 mmol/l) has shown to decrease mortality/morbidity in postoperative ICU patients.
Arrhythmias

- Amiodarone has good prophylactic effect and shown good rhythm control on postoperative AF. Secondary effect is reduced morbidity and cost in the ICU
- β-blockers should be continued if started, but keep in mind the negative effect on a “stunned” myo-cardium.
Coagulopathy

Hypothermia?
  • Rewarm!

Residual heparin effect?
  • Give 50-mg protamine

Intraoperative major bleed?
  • Supply missing components – platelets, coagulation factors
  • Potentiate vWF and activate platelets with DDAVP
Special Cases

Pacemaker and/or ICD pre-, intra-, and postop.
  • Investigate type, function, possibility to turn off during and susceptibility to cauterization before surgery. Backup needed?

Mechanical support for failing heart postoperatively: IABP, VAD (L/R/Bi)
  • IABP improves coronary circulation during diastole and reduces LV afterload
  • VAD therapy: temporary measurement, bridge-to-transplant or bridge-to-destination
    • High complication risk of bleeding and/or infection
Special Cases

Postoperative vasodilatory shock
- Common post CBP and probably exacerbated by preoperative use of ACE-inhibitor and intraop milrinone.
- CPB appears to stimulate nitric oxide production thru an effect on the inducible NOS.
- Trend today to use vasopressin infusion, no randomized studies available comparing NE/E/vasopressin and outcome.

SIRS
- Use of low-dose steroids seems to attenuate cytokine response post bypass and improve outcome.
Pulmonary hypertension

- PVR increased or RV overload/failure? Use of milrinone, prostaglandin analogs, nicardipine, diuretics or sildenafil (or combinations) to improve RV function are treatment modalities currently used.


Practice Advisory for the Perioperative Management of Patients with Cardiac Rhythm Management Devices: Pacemakers and Implantable Cardioverter-Defibrillators. *Anesthesiology* 2005;103(1).


Medical Therapy for Pulmonary Arterial Hypertension, ACCP Evidence-Based Clinical Practice Guidelines. *Chest.* 2004;126:35S-62S.


Case 1

59-year-old male presents to emergency dept. with chest discomfort. Hx. of smoking, hypertension, and hyperlipidemia. Newly prescribed nitroglycerin for intermittent chest pain that started 3 months ago. Now chest pain during night that resolved after nitro. Meds: atenolol, ASA, lisinopril, lovastatin, and nitroglycerin. ECG: SR, 70 Hz, no ST/T changes. Troponin 0.02.

Admitted to Obs. Unit for follow up. Second ECG showed T-inversions in aVL, V4-5. Second troponin 0.02, no chest pain.

What next?
Case 1 (cont)


What now?

Cardiac cath lab: EF 45%, severe multivessel CAD, referred to CT surgeon for surgery

Which medications do you continue with or start?
Case 1 (cont)

- Patient started on heparin until surgery. ASA, metoprolol, lisinopril, and lovastatin cont’d.

- Day 2: CABG x 5, intraop CBG 98-177, started on insulin infusion. Anesthesia with isoflurane/fentanyl/pancuronium. CPB 109 minutes, clamp time 85 minutes. Postop sedation with dexmedetomidine.

- Admitted to ICU, initial review showed bibasilar atelectasis and minimal left pleural effusion on CXR, stable circulatory values, normal SVR/PVR and SvO₂ and ABG: 7.23, 56, 126, -5.3, 22. Good UO and temp 35.7º C.

- What do you do now?
Case 1 (cont)

Decision to “fast track” patient to extubation; patient extubated after 2 hours in ICU. ABG pre-extubation: 7.37/40/123/-1.6/23 after some volume replacement.

Minimal pain issues postop, continued on opioids and acetaminophen.


Day 5: Discharged home.