

Extubation

- May leave pt intubated if concerns for resp failure and hypoxia.

Adjuvants

- Combination of appropriate intravascular volume replacement and vasodilators (nitroglycerin) for pulm Htn

Postoperative Period

- Delayed hypoxia from pulm injury common and can cause pulm Htn leading to hypotension if RV is severely contused

Anticipated Problems/Concerns

- Variable diagnostic criteria, total CK-MB >50 U/L and ≥5% total CK.

- Possible higher risk of cardiac complications with increased CK-MB.
- Almost any arrhythmia may be reported, especially conduction delays; more severe contusion associated with increased malignant ventricular arrhythmia.
- Watch for RV failure leading to increased LV pressure but decreased LV diastolic filling.

Myocardial Ischemia

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Risk

- Incidence in USA: 1.5 million/y develop acute MI; about 50% are silent (without enough symptoms to cause a medical visit); decreased rate of death in the United States balanced by increased population has kept MI numbers constant since 1970 despite increased population; worldwide, the incidence of MI is 9 million/y.
- Some 12 million individuals in USA have narrowing of 70% or more of one or more coronary arteries; among unselected pts over age 40 years, 1.4% have MIs; cardiac death occurs in 1.7%.
- Risk is higher among those of European, Indian, and African American heritage than among Japanese, but the environment of North America equalizes risks.
- Risk is highest in pts with known other atherosclerotic disease (including prior MI): smokers (3.5-fold increase); hypertensives (threefold increase); diabetics (4-fold increase); hypercoagulable or chronic inflammatory diseases (threefold increase); stressed, divorced, or unstable marriage (2.5-fold increase); with wt gain since age 20 years (1.5-fold increase for each 5-kg increase); increased LDL cholesterol in those who do not exercise (0.5% increase for each 1% increase above 100 mg/dL); who do not drink or take vitamin D or aspirin; whose parent died of CAD at <40 y of age (1.4- to 2.5-fold increase); age (threefold increase per decade over 50), family Hx (1.1-fold to 2.4-fold increase)

Perioperative Risks

- Periop CV complication (MI, CHF, RHF, arrhythmia requiring Rx) increases the risk ninefold.
- 2-y survival: Rate in high-risk pt with periop MIsch is 25% versus 85% for those without periop MIsch.
- Inadequate coronary perfusion (1–6% reinfarction rate with general surgery; higher with vascular/thoracic/upper abd surgery); lower with cataract/prostate/peripheral surgery with single-limb anesthesia only.
- Can lead to increased left or right ventricular compliance and CHF and dysrhythmias.
- Can lead to inadequate perfusion of other organs and their insufficient function (brain, kidney, liver, gut).

Worry About

- Postop period if stressed by perturbations that increase demand (pain, sepsis, fever, hypovolemia and hypovolemia, and tachycardia), or limit supply (thrombosis, hyperviscosity states, diseases limiting pulm function and gas exchange [restrictive, obstructive, parenchymal], Hct <28%)

Overview

- Condition of inadequate supply of O₂ and nutrients to myocardial cells relative to need associated with the increased stress of periop period,
- Treatment and prophylaxis of this and related disorders consume 10–20% of total health expenditures. Periop CV complications double with MIsch, with threefold reduction in 2-year survival and threefold increase in periop costs for major surgery.

- Major foci of clinical and basic studies are to decrease incidence and risks from concern over risk-benefit ratio and cost-effectiveness, identifying high-risk pts prior to surgery and segregating them for prior therapy (smoking cessation, control of Htn, hypercholesterol states, hypercoagulable states, PTCA, CABG) or increased periop vigilance and care (PA lines, TEE, ICU care, prophylactic pain therapy).

Etiology

- Known atherosclerotic risks (genetic predisposition, smoking, Htn, diabetes, divorced or unstable marriage, inflammation, hypercoagulable states, increase LDL or decrease HDL cholesterol, weight gain)
- Known conditions that increase periop demands on heart (tachycardia; 2-fold greater for HR >90, 11-fold greater for HR >110); or limit supply (vasospastic states; PaCO₂ <25; Hct <28%; hyperviscosity and hypercoagulable states; inadequate O₂ exchange)

Usual Treatment

- Decrease atherogenic risk factors.
- Decrease periop demands on the heart.
- Consider preop segregation for statin or aspirin (162.5mg) and nitrate therapies, antispasmodic and sympatholytic therapies, PTCA or CABG considerations, or stepped up postop care of increased monitoring, intensive normalization of hemodynamics, more prophylactic pain therapies. See the algorithm in second Key Reference below the Assessment Points.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Plaques in other areas	Risk factor search: Smoking stain, hypercholesterolemic lesions	McArdle earlobe	
CV	Decreased left or right ventricular compliance Decreased pump function arrhythmias Autonomic pain	SOB, DOE, angina, reduced exercise tolerance, palpitations, PND	HR/BP prior to and after two-stair climb; S ₃ ; rales; JVD; use character and rhythm	ECG, CXR, stress ECHO or dipyridamole thallium or ambulatory Holter, troponins, and myeloperoxidase tests
RESP		Nocturnal cough, orthopnea		
RENAL	Perfusion insufficiency	Nocturia Erectile dysfunction (male) Loss of ability to achieve orgasm (female)		BUN/Cr
CNS	Autonomic pain syndromes Other atherosclerotic syndromes	Pain in neck or left arm History of stroke or TIA	CNS and cranial nerve exam	Carotid Doppler, testing of ANS

Key References: Jeremias A, Kaul S, Rosengart TK, et al.: The impact of revascularization on mortality in patients with nonacute coronary artery disease, *Am J Med* 122(2):152–161, 2009; Fleisher LA, Fleischmann KE, Auerbach AD, et al.: 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines, *Circulation* 130(24):2215–2245, 2014; Practice advisory for the perioperative management of patients with cardiac rhythm management devices: pacemakers and implantable cardioverter–defibrillators, *Anesthesiology* 103(1):186–198, 2005.

Perioperative Implications**Preoperative Preparation**

- Consider segregation procedures and prophylactic regimens (see [Usual Treatment](#)); continue concurrent aspirin, adrenergic, and antilipidemic therapies; optimize blood sugar control.

Monitoring

- ST-T waves of area of myocardium identified as at risk (or II and V₅) (II especially for CNS surgery); ST-segment trend analysis.
- Consider TEE and arterial line and approaches to intensive normalization of hemodynamics.
- Management of arrhythmia control devices.

Airway

- Routine

Induction

- Without hemodynamic disturbance and especially with control of HR

Maintenance

- Tachycardia or hypovolemia and Hct <28 can precipitate ischemia.
- No agent with demonstrated outcome superiority.
- Intensively normalize hemodynamics and HR.

Extubation

- In nonstressful fashion for pt without compromising supply of O₂ to myocardium
- Aggressive stepped pain therapy recommended; alpha₂-adrenergic agonist recommended by some

Adjuvants

- CHF decreases liver blood flow and clearance of drugs requiring hepatic metabolism (such as lidocaine).
- β-adrenergic receptor antagonists and nitrates can be associated with profound hemodynamic disturbances if there are drug interactions or sudden preload, afterload, or contractility perturbations (such as rapid onset of spinal anesthesia).

Anticipated Problems/Concerns

- Preop and postop periods at least as great a cause of morbidity as intraop period.
- Restart antianginal and antiplaque therapies (i.e., statins, CO Q10, aspirin, DHA) and physical activity rehab program as soon as possible postop if D/C preop.
- Consider compassionate anxiety-relieving yet aggressive preop consultation and intensive stepped pain prophylaxis consultations postop.

Myocarditis

Ronak Shah

Risk

- Incidence of idiopathic or viral myocarditis in the general population is unknown.
- Infectious and noninfectious causes; viruses are the most common.
- Pts with autoimmune diseases are at increased risk.

Perioperative Risks

- If pt develops DCM: EF <35% increased risk of MACE.
- Atrial arrhythmia if significant mitral regurgitation is present.
- Postop respiratory failure secondary to pulm edema.

Worry About

- Acute cardiovascular decompensation.
- New-onset atrial or ventricular arrhythmias, complete heart block, or an acute MI-like syndrome.
- Worsening of chronic HF.
- Chest pain in acute myocarditis can result from an associated pericarditis or occasionally from coronary artery spasm.
- Sudden death occurs in ~12%.

Overview

- Inflammatory infiltrative process targeting the myocardium.
- Usually due to viral infection and/or a postviral immune-mediated response.
- Virus or infectious agent enters myocytes.
- Viral replication and cell necrosis initiate a response from host's immune system.
- Immune response declines with elimination of virus and ventricular function recovers.
- However, the autoimmune processes persist independently of detection of the virus genome in the myocardium, leading to the chronic phase, characterized by myocardial remodeling and development of DCM.
- DCM is enlargement of RV and LV with hypertrophied muscle fibers but no increase in size of the free wall of the septum; this gives the heart a spherical shape.
- The heart is 2–3 times larger than normal and systolic function is impaired.

Etiology

- Endomyocardial biopsies have implicated multiple viruses, such as coxsackievirus B, adenovirus, parvovirus B19, and even HCV.

- Bacterial causes include *Chlamydia trachomatis*, *Corynebacterium diphtheriae*, *Legionella pneumophila*, *Mycobacterium tuberculosis*, *Mycoplasma pneumoniae*, *Staphylococcus aureus*, *Streptococcus aureus*, and *Streptococcus pneumoniae*.
- Other noninfectious causes include hypersensitivity and toxic reactions to medications.
- Autoimmune diseases such as giant cell myocarditis, hypereosinophilic syndrome, Kawasaki disease, lupus erythematosus, lymphofollicular myocarditis, rheumatoid arthritis, sarcoidosis, scleroderma, and ulcerative colitis place pts at higher risk.

Usual Treatment

- For acute DCM, treatment focus is supportive therapy for LV dysfunction.
- Most pts will improve with a standard HF regimen that includes ACEIs pr ARBs, beta blockers, and diuretics.
- Complete heart block and bradycardia are treated with a temporary pacemaker.
- If etiology is autoimmune-related, treatment includes immunosuppression therapy specific for the disease.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Lymphadenopathy if caused by viral/bacterial infection and sarcoidosis	Hx of fever, chills, upper respiratory tract infections	Enlarged cervical lymph nodes if progressed to DCM, JVD	Blood and sputum cultures, immunologic assays for viral infections
RESP	Pulm edema if HF develops	Dyspnea, frothy sputum Exercise intolerance and fatigue	Tachypnea, rales on auscultation	CXR, ABG analysis
CV	LV dysfunction, with LV dilatation and subsequent RV overload with chronic HF Atrial and ventricular arrhythmias	Orthopnea, chest pain, peripheral edema, fatigue, palpitations, and hepatomegaly	Tachycardia or irregularly irregular S ₃ gallop Distant heart sounds Cardiomegaly (broad and displaced point of maximal impulse, RV heave)	Labs: Cardiac enzymes (troponin I or T) indicators for cardiac myonecrosis Viral antibody titers Rheumatologic screening ECHO to exclude other causes of HF and assess extent of cardiac dysfunction Coronary cath: rule out ischemic causes ECG: ST, QRS/QT prolongation, diffuse T-wave inversions, AV conduction defects and ventricular arrhythmias. Cardiac MRI Endomyocardial biopsy

Key References: Kaur H, Khetarpal R, Aggarwal S: Dilated cardiomyopathy: an anaesthetic challenge, *J Clin Diagn Res* 7(6):1174–1176, 2013; Daabiss MA, Hasanin A: Perioperative anesthetic management of a case with severe dilated cardiomyopathy, *Oman Med J* 25, 2010, doi:10.5001/omj.2010.20.

Perioperative Implications

Preoperative Preparation

- If acute cardiac decompensation presents with myocarditis, consider delaying surgery.
- Continue and optimize HF regimen (except for ACE inhibitors).
- Consider ECHO/CXR if there is a change in functional clinical status.
- If present, cardiac pacemaker should be evaluated.

Monitoring

- Consider invasive monitoring such as arterial line and pulm artery catheter, depending on type of surgery and condition of pt.
- Consider intraop TEE if significant hemodynamic changes occur.

Airway

- HF pts can present with frothy secretions resulting from pulm edema.

Preinduction/Induction

- Pts with DCM are extremely sensitive to cardiodepressants.
- Narcotic-based technique (EF <30%) is preferred to minimize cardiac depression.
- Also consider ketamine (<0.5 mg/kg) and etomidate.

Maintenance

- Conducted under general anesthesia.
- Fluid balance regulated to avoid hypervolemia and hypovolemia.
- Acute LV failure is more sensitive to the depressant effects of volatile agents.

- Afterload reduction in DCM is key as it will improve regional and global indices of ventricular relaxation and EF during anesthesia when myocardial depression is significant.

Adjuvants

- Hemodynamic instability can be treated with low-dose inotrope and vasodilator.

Anticipated Problems/Concerns

- Prolonged intubation secondary to pulm edema/hemodynamic instability.
- If LV function worsens despite optimal medical management, consider mechanical circulatory support, such as ventricular assist devices or ECMO, as a bridge to transplantation or recovery.