Indications (partial list)

- Angina + LMCA stenosis
- Left main stenosis > 70%
- Proximal LAD stenosis with 1 or 2-vessel disease
- Proximal LAD > 70% + proximal Cx
- Triple vessel, EF < 50%
- Angina + 2-vessel disease, LAD stenosis, EF < 50%
- Ruptured papillary muscle, VSD, LV rupture
- Failed PCI w/ hemodynamic instability


Access surgery online
http://www.accesssurgery.com/Content.aspx?searchStr=Coronary+Artery+Bypass+Graft&aid=5029227#5029243

Conduits

- Saphenous vein
  - Poor lung function
  - Occluded subclavian artery
  - Hx chest radiation
  - Hx bilateral mastectomy

- Internal mammary artery
  - Diabetes
  - Obesity
  - RCA or LAD lesion
  - Saphenous unavailable
  - Atherosclerotic aorta
Cardiopulmonary Bypass

- Hypothermia
  - Systemic cooling (28°C to 30°C)
  - Topical cooling
  - Infusion of chilled cardioplegia
  - Reduced metabolic and oxygen demands → organ preservation
- Cardioplegia
  - Contains an ingredient (usually K⁺) to depolarize cell membrane → arrests heart during diastole
  - Myocardial preservation
- Hemodilution
  - Crystalloid solution
  - Decrease blood viscosity → improved blood flow
  - Decrease hemolysis
  - Usually to Hct of 25% to 30%
- Anticoagulation
  - Heparin (antidote is Protamine)
  - Prevents clot formation

Conduits: Patency

<table>
<thead>
<tr>
<th>Venous Conduits</th>
<th>Internal mammary artery</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 90% at 1 year</td>
<td>• 95% at 1 year</td>
</tr>
<tr>
<td>• 50-60% at 10 years</td>
<td>• 90% at 10 years</td>
</tr>
<tr>
<td>• 20% at 20 years</td>
<td>• 90% at 20 years</td>
</tr>
<tr>
<td>• 80% at 10 years with SV to LAD</td>
<td></td>
</tr>
</tbody>
</table>

Effects of Cardiopulmonary Bypass

- Hemolysis
  - Platelets, RBCs, WBCs & plasma proteins
  - Damaged in pump circuit
- Coagulopathy
  - Activation of clotting factors
- Electrolyte imbalance
  - Pump priming solutions, fluid shifts, IV fluids
- Hyperglycemia
  - Stress Response
- Edema
  - Inflammatory response → ↑ capillary permeability
- Neurologic dysfunction
  - Inadequate cerebral perfusion, micro emboli to brain (air, plaque, blood)
CABG: Proven Strategies to Prevent Perioperative Mortality/Morbidity

• Preoperative
  – Carotid screening

• Perioperative
  – Prophylactic antimicrobial therapy
  – Antiarrhythmics (beta blockers)

• Postop
  – Antiplatelet therapy (aspirin)
  – Lipid-lowering therapy (statins)
  – Smoking cessation

Valvular Heart Disease

Valvular Heart Disease: Etiologies

• Congenital
  – Malformation (e.g. bicuspid aortic valve)
  – Connective Tissue Disorders
    – Marfan’s syndrome
    – Ehlers-Danlos syndrome
    – Barlow’s Syndrome (mitral valve prolapse)
Valvular Heart Disease: Etiologies

- Acquired
  - Rheumatic Heart Disease
  - Group A Streptococcal
  - Endocarditis (bacterial, viral, fungal)
  - Myocardial Infarction
  - Aortic dissection/aneurysm
  - Cardiomyopathies
  - Heart Failure
  - Blunt/penetrating Trauma
  - Degeneration (calcification, fibrosis)

Valvular Heart Disease: Terminology

- Stenosis- impeded forward flow through an opened valve
- Regurgitation- backward leaking of blood through a closed valve
- Vegetation- abnormal growth/lesions on diseased heart valves (e.g. endocarditis), comprised of fibrin, platelets, RBCs, necrotic tissue, and bacteria
- Calcification- build-up of calcium deposits on valve leaflets, causing narrowing of opening (e.g. stenosis)

Chest Examination Points

- Aortic: 2 ICS, RSB
- Pulmonic: 2 ICS, LSB
- Tricuspid: 5 ICS, LSB
- Mitral (apical): 5 ICS, MCL
- Erb’s Point: 3 ICS, LSB
- Epigastric: over xiphoid process
Murmurs

- Stenosis: occurs when valves are supposed to be open
  - Diastole: mitral, tricuspid
  - Systole: aortic, pulmonic
- Regurgitation: occurs when valves are supposed to be closed
  - Diastole: aortic, pulmonic
  - Systole: mitral, tricuspid

Causes of Murmurs

- High rate of blood flow through a normal structure
- Normal blood flow through a narrowed structure
- Back flow of blood through an incompetent structure
- Turbulent blood flow in an enlarged, dilated structure

Valvular Heart Disease: Murmurs

**Systolic Murmur**
- Mitral
- Regurgitation
- Prolapse/pansystolic
- Aortic
- Systolic

**Diastolic Murmur**
- Mitral
- Systolic
- Aortic
- Regurgitation
- Diastolic

*Note: Ventricular septal rupture (VSD) → Holo(pan)systolic murmur

Valvular Heart Disease: Signs and Symptoms

- Decreased cardiac output:
  - Fatigue
  - Palpitations
  - Dizziness
- Pulmonary congestion
  - Shortness of breath/dyspnea
- Murmur
- Extra heart sounds (S3 and/or S4)
- S/S of heart failure
- Dysrhythmias
- Elevated filling pressures (CVP, PAP, PAOP)
- Angina/chest discomfort
Management of Valve Disease

- Oxygenation
- Hemodynamic stability
  - Decrease preload
  - Decrease afterload
  - Increase contractility
- Treat dysrhythmias
- Anticoagulation
- Antibiotic prophylaxis prior to invasive/dental procedure
- Balloon valvuloplasty
- Cardiac rehab
- Surgical repair/replacement

Valve surgery: repair vs. replace

Valvular Heart Disease – Types of Surgery:

1) Reconstructive
   a) Open commissurotomy
   b) Valvuloplasty
   c) Annuloplasty

2) Valve replacement
   a) Mechanical
   b) Biological tissue (pigs - porcine, cows - bovine, human cadaver homographs)

Valve Replacement

- Mechanical
  - Tilting disc
  - Bileaflet
- Biologic
  - Porcine
  - Bovine
  - Allograft (cadaver)
Mechanical Prosthetic Valves:

**Advantages:**
- Durability
- Good hemodynamics

**Disadvantages:**
- Lifetime anticoagulation
- Audible click
- Mechanical failure
- Infections are harder to treat

Biological Tissue Valves:

**Advantages:**
- Non-thrombogenic
- No long-term anti-coagulation
- Good hemodynamics
- Quiet
- Infections are easier to treat

**Disadvantages:**
- Prone to deterioration
- Frequent replacement is required (average of 10 years)

Valve Replacement

- Complications
  - Inadequate seating
  - Thromboembolism
  - Endocarditis

Post Open Heart Surgery-Complications

- Bleeding
- Infection
- Hemodynamic instability
- Stroke
- Dysrhythmias
- VAP, pleural effusion
- Graft occlusion/stenosis
- Cardiac Tamponade/ Cardiogenic Shock
Post Open Heart Surgery-Complications

Cardiac Tamponade

• Occurs when fluid (blood, effusion fluid, pus) accumulates in the pericardial space compromising cardiac filling and cardiac output
• Pericardium typically has 20-50cc of blood

Clinical Signs of Cardiac Tamponade

• Beck’s Triad
  – Hypotension
  – Distended neck vein (JVD)
  – Muffled heart sounds
• Narrowed pulse pressure
• Tachycardia (usually) but may be PEA
• Dyspnea
• Peripheral pulses weak or absent
• Signs of shock (cool/clammy extremities, cyanosis)

Hemodynamics of Cardiac Tamponade

• Increased CVP, PAD, PAOP
• Equalization of CVP, PAD, PAOP
• Decreased CO/CI
• Pulsus paradoxus

Management of Cardiac Tamponade

• Post open heart surgery: reopen chest
• Identify and treat cause
• Oxygenation (avoid high levels of peep)
• Volume expansion with blood, saline or plasma to maintain intravascular volume
• Inotropic therapy (e.g. dobutamine)
• Bed rest with leg elevation (may ↑ venous return)
• Pericardial effusion→pericardiocentesis, pericardial window
Post Open Heart Surgery—Complications

**Cardiogenic shock**
- Loss of myocardial contractile function to the extent that blood to the tissues to maintain aerobic metabolism becomes inadequate

Clinical Signs of Cardiogenic Shock
- Restless and/or confused
- Cool, moist skin
- Hypothermia
- Rapid pulse
- Low BP
- UO<20 cc
- Rales
- Pulmonary edema

Hemodynamics of Cardiogenic Shock
- Low CO syndrome
- SBP<90
- CVP>9
- PAWP>18
- CI<2.0
- SVR>2000

Management of Cardiogenic Shock
- Oxygen
- Optimize CO/CI
  - Reduce afterload (vasodilators, ACE-I)
  - Improve contractility (inotropic agents—dobutamine, milrinone)
  - Decrease preload (diuretics, vasodilators)
- IABP Therapy
- Ventricular assist device
IABP Indications

- Failure to wean from cardiopulmonary bypass
- Cardiogenic shock
- Heart failure
- Acute heart attack
- Support during high-risk PCI

Trivia Question!!

At what point in the cardiac cycle does the heart muscle receive its blood supply?

- A. During systole
- B. During diastole

Explain your answer

Diastole: IAB Inflation

- Increase myocardial oxygen supply
  - Balloon inflation in diastole (aortic valve closure)

Systole: IAB Deflation

- Afterload reduction:
  - Balloon deflation at end-diastole
  - Reduce myocardial oxygen demand in systole
IABP Therapy

Benefits
- Increases coronary artery perfusion!
- Decreases afterload (SVR)!
- Increases cardiac output
- Increases MAP

Types of Cardiomyopathies
- Dilated
- Hypertrophic
- Restrictive
- Ischemic
Dilated Cardiomyopathy

- Diffuse dilation of atrias and ventricles
- Unknown/various causes
- Systolic dysfunction = ↓ cardiac output
- S/S of heart failure: pulmonary/systemic congestion
- S/S: murmurs from MVR, TVR (systolic murmurs)

Hypertrophic Cardiomyopathy

- Asymmetrical hypertrophy of the LV with septal enlargement
- Creates diastolic stiffness/ impaired filling
- Inherited/idiopathic, neuromuscular disorders
- S/S: fainting, CP, lightheadedness during or after exercise, palpitations, dyspnea, SCD
- S/S: systolic murmur (AS, MR), S3/S4
Hypertrophic Cardiomyopathy

Treatment:
• Beta blockers, calcium channel blockers, volume, antiarrhythmics, anticoagulants, alcohol ablation, myectomy
• Avoid: Inotropes, nitrates, vasodilators, dehydration, strenuous exercise

Restrictive Cardiomyopathy

Treatment:
• Most commonly caused from amyloidosis or idiopathic myocardial fibrosis
• Fibrous tissue infiltrates layers of heart
• Heart becomes noncompliant: can’t relax or contract well
• Stiff ventricle: ↓ CO, pulmonary/systemic congestion
• S/S of right and left heart failure

Ischemic Cardiomyopathy

• Most common type of cardiomyopathy in the US
• Decreased pumping ability r/t coronary artery disease
  – Not enough oxygen and blood to heart
  – MI, angina, unstable angina
• S/S: Angina, pulmonary/systemic congestion, arrhythmias
Ischemic Cardiomyopathy

Treatment:
- Focused on symptom management of HF
- Pharmacologic: ACE Inhibitors, beta blockers, diuretics
- Non-pharmacologic: Na restriction diet, lifestyle changes
- May need CABG or angioplasty
- May need pacemaker/AICD

Practice Question

- An example of systolic murmur would be
  A. Tricuspid stenosis
  B. Tricuspid insufficiency (regurg)
  C. Mitral stenosis
  D. Pulmonic insufficiency (regurg)

Practice Question

- A patient in cardiogenic shock is in the ICU on vasopressor and intra-aortic balloon pump support. Which of the following assessment findings most reliably indicates that the current therapy is appropriate.
  A. HR 100, MAP 66, SVR 1200
  B. HR 117, MAP 53, SVR 1900
  C. HR 110, MAP 70, SVR 2800
  D. HR 117, MAP 53, SVR 2400

Practice Question

Which of the following indicates that a postoperative CABG patient requires return to the operating room?
  A. Chest tube output greater than 200ml/hr for two consecutive hours
  B. Map 65 mmHg for 2 hours despite norepineprine drip at 4mcg/min
  C. Cardiac Output 1.9 L/min
  D. Frequent PVCs
Practice Question

- Mr. Heart is s/p CABG x2. His hemodynamic profile upon arrival to the ICU is: HR-110b/min, MAP-50, CI-1.8, RAP/CVP-3, PAP- 18/10, PAOP-6, SVR- 1800. These findings are consistent with which of the following?
  A. Cardiac Tamponade
  B. Postoperative MI
  C. Septic Shock
  D. Hypovolemia