PULMONARY ARTERY THROMBOENDARTERECTOMY PROTOCOL

Background:

Acute pulmonary embolism occurs in about 600,000 patients annually in the US. In about 1000 patients per year, after extensive embolization, emboli do not completely resolve, and chronic pulmonary hypertension results which is not responsive to medical management. Patients who have mean PA pressures greater than 30 after pulmonary emboli are reported to have a 5 year survival rate of about 30%. Highly significant reductions in pulmonary hypertension and cardiac performance have been reported after pulmonary endarterectomy, with one series reporting an in-hospital mortality following the surgery of 8.7%. For further reading, see:


The Operation:

Median sternotomy followed by aortic and bicaval cannulation. The patient is cooled to 20°C. PA and LV vents are inserted. Cardioplegia is used. The right and left pulmonary arteries are incised, and thrombus removed. Endarterectomy is carried out during periods of circulatory arrest limited to about 20 minutes each. After closure of the pulmonary arteries, the atrial septum is examined for ASD, which is repaired. If additional procedures are needed (CABG, valve) they are accomplished during patient rewarming. The heart is de-aired, and aortic crossclamp removed. With pulmonary reperfusion, impairments in oxygenation can occur, and the lowest FiO2 possible to maintain arterial oxygen saturations of 90-94% are used.

Patients often have underlying hypercoagulable diathesis, and have invariably been anticoagulated (coumadin will have been de'd and heparin drip instituted). Many have evidence of right heart failure. All have had pulmonary angiograms, and have had coronary artery catheterization to rule out important by-passable disease.
Anesthesia protocol:

I. Setup

A. Cardiac cart
B. Cardiac syringe kit and standard cardiac resuscitative drugs
C. Standard monitors, plus CCO/SVO2 PA catheter, femoral and radial arterial lines, R2 patches
D. Drips to have prepared:
   1. Nitroglycerin 50 mg/250cc
   2. Norepinephrine (20mg/250ml=80mcg/ml)
   3. Phenylephrine 25 mg/250cc
   4. Vasopressin 1U/cc
   5. Epinephrine 5 mg/250 cc

E. Other drugs to have on hand:
   1. Dilantin 1 gm for administration during cooling
   2. Solu-Medrol 30 mg/kg to administer during cooling
   3. Heparin: 2 syringes containing 5000 U, in addition to 30cc syringe of heparin
   4. Furosemide 10 mg
   5. Lidocaine 200 mg
   6. Mannitol 25 gms X 2
   7. Solu-Medrol 500 mg IVPB

F. Discuss with Dr. Mulligan the need for Nitric Oxide (NO).

II. Patient Preparation:

A. IV access--Two large bore 14g/16g Ivs. Consider connecting directly to large bore RIS tubing and stopcock. (Do not set up RIS)
B. Arterial lines--1 radial arterial line prior to induction. A femoral arterial line should be placed after induction in the operating room
C. SVO2/CCO PA catheter (this will be withdrawn during the surgery. Use extreme caution when advancing the dilator and cordis, as the alrge veins are distended and very thin--innominate venous rupture has been reported.
III. Induction and pre-bypass

A. Standard cardiac induction, with precautions for patients with potentially low cardiac output. Etomidate, fentanyl, pancuronium are usual drugs of choice.

B. After induction, consider phlebotomy if the patient is very polycythemic (Hct 50). Citrated blood storage bags can be obtained from an anesthesia technician (the bags are kept in the anesthesia workroom). Blood should be labeled with a patient ID sticker, and left at room temperature (so that platelet function is intact) for up to 4 hours for safe auto-transfusion.

C. After induction, give 1cc test dose of Aprotinin, and if no adverse response, give aprotinin 200cc over 30 minutes, followed by a 50 cc/hr infusion until termination of bypass.

D. Baseline TEG, OR hemostasis panel, and arterial blood gases should be sent

E. Antibiotics: per surgery. Usually ancef 1 gm IVPB

F. PVR calculation: requires LA pressure (wedge). If wedge not obtainable, may derive LAP from the following equation:

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\text{Systolic BP - (pressure gradient between LA and LV).}
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The pressure gradient is derived from the peak velocity of the mitral regurgitant jet.

G. TEE: Look for PFO with color, bubble study +/- valsalva. Assess degree of TR and RV dysfunction.

H. Standard heparinization for cannulation (250U/kg)--check pre and post heparin ACT. (ACT should be >480 with aprotinin in use)

I. During cooling, give:

1. Dilantin 1 gm IV
2. Solu-Medrol 30 mg/kg
3. Pack head in ice (this is per surgeon's request)

IV. Deep Hypothermic Circulatory Arrest (DHCA): Just prior to DHCA, give

A. Mannitol 25 gm
B. Heparin 5000 U

V. Re-warming:

A. Remove ice from head
B. At this stage, any other necessary surgical procedures (eg CABG, Valve, etc) will be performed.)
VI. After cross-clamp removal

A. Administer:
   1. furosemide 10 mg
   2. lidocaine 200 mg
   3. mannitol 25 gm
   4. magnesium sulfate 3 gm
   5. methylprednisolone 500 mg

Send TEG and coags, and order factors as needed

V. Prior to seperation from CPB

A. Begin inotropes
B. Consider nitric oxide
C. Suction lungs--blood may have accumulated, and may lead to ventilatory obstruction

VI. After Seperation from CPB

Be aware of the possibility of post-reperfusion injury (usually not a factor until some hours later). If ventilation becomes difficult, consider microprocessor ventilator.

Turn up the room temperature.

**Checklist**

1. Cefazolin or Vancomycin

2. During cooling, give:
   a. Dilantin 1 gm IV
   b. Solu-Medrol 30 mg/kg
   c. Pack head in ice (this is per surgeon’s request)

3. Just prior to DHCA, give:
   a. Mannitol 25 gm
   b. Heparin 5000 U

4. After cross-clamp removal, give:
   a. Furosemide 10 mg
   b. Lidocaine 200 mg
   c. Mannitol 25 gm
   d. Magnesium sulfate 3 gm
   e. Methylprednisolone 500 mg