Heart Transplantation Guidelines

Patients are considered for orthotopic heart transplantation if they have ICM or NICM with continued low cardiac output requiring advanced heart failure therapy. Patients may be bridged with home inotropes (if this improves their cardiac output and they are on a stable dose), IABP (if they aren’t stable on inotropes only), or ventricular assist device (if they are unstable and cannot wait for OHT).

I. Surgical Considerations

• Indications for heart transplantation include progressive congestive heart failure on maximal medical therapy or mechanical circulatory support. Common etiologies for heart failure include ischemic and non-ischemic cardiomyopathies, and congenital heart disease.

• Patients presenting for heart transplantation may have had prior cardiac surgery including revascularization procedures, congenital palliative procedures, or placement of mechanical circulatory assist devices. If the patient is undergoing a redo sternotomy due to prior cardiac surgery, peripheral venous and arterial cannulation may be achieved prior to sternotomy to assist with expedient implementation of cardiopulmonary bypass (CPB) if necessary.

Workflow: From Go Call to Incision

II. Case Set-up

Set up

• Cardiac drug tray: Standard cardiac drug tray (includes epinephrine and phenylephrine) plus norepinephrine and milrinone

• Fluid warmer with blood tubing set up

• Triple transducer setup: A line, CVP, PA catheter
• TEE probe, machine, and probe holder
• Ensure current type and screen, order blood:
  o Primary chest: 4U PRBC and no FFP.
  o Redo chest/LVAD in situ: 6-8u RBC and no FFP.
  o During briefing, please discuss blood availability, may decide to order more products during this
time if anemic, or significant antibodies are present.
• Call respiratory therapy on 7W for iNO/Veletri for pre-CPB

III. Monitoring
• Arterial line (LEFT)
• RIJ MAC and PA catheter
• TEE probe, machine, and probe holder

IV. Preoperative Considerations
• Preoperatively: Evaluate allergies, current medications, cardiopulmonary status and NPO status
• If patient has a VAD or IABP, will need perfusion assistance to transport patient to OR (Perfusion pager 970-1599)
• When a donor heart becomes available, the recipient may be taken off milrinone and placed on dopamine
preoperatively (by the transplant cardiology team) to increase blood pressure.
• Preinduction: Arterial line and large bore peripheral IV placement under local anesthesia. Avoid
benzodiazepines or opiates pre-induction to prevent decrease in sympathetic tone and severe
hypotension, unless specifically discussed with attending anesthesiologist.
• First time out performed with circulating nurse and anesthesia attending. Anesthesia attending will sign
onto UNET (https://portal.unos.org) and verify the donor ID and blood type/compatibility. Documentation
will then be performed in EPIC by anesthesia attending and circulating RN. Second time out (when organ
arrives) will be performed between attending surgeon and circulating RN.
• Communication: It is important for the attending surgeon and attending anesthesiologist to communicate
regarding the surgical plan and specific concerns. The surgical fellow or attending should be present in the
room on induction of anesthesia.
• Place Kimberly Clark warming devices prior to induction of anesthesia
• Place external defibrillator pads prior to induction of anesthesia
• Pulse oximeter: If right axillary cannulation planned, pulse oximeter should be placed on left upper
extremity. Have an ear probe in the room, as upper extremity probe can lose signal due to low cardiac
output.

V. Intraoperative Considerations
   Induction of Anesthesia to Incision
• Goals for induction:
• Airway protection given likely inadequate NPO status
• Avoidance of myocardial depression and catecholamine decline
• Rapid sequence induction with cricoid pressure if high risk for aspiration, though caution advised due to
cardiopulmonary risk
• Airway:
• Single lumen endotracheal tube
• Consider availability of video laryngoscope in case of difficult airway.
• Do not use OG tube to aspirate stomach prior to TEE since the patient received PO cyclosporine
• Anesthetic maintenance: Balanced technique using opiates, volatile anesthetics and neuromuscular
blockade.
Venous access: Right IJ MAC. Consider an additional central venous line if re-do sternotomy. Peripheral IVs should ideally be placed in the forearms to avoid kinks and poor flow after positioning.

PA catheter: CCO swan to be placed through the MAC, left at 20cm until post-CPB, then floated through new donor heart.

Foley Catheter: To be placed by OR Nursing after induction of anesthesia.

Temperature: Nasal and bladder temperature probes placed

Antibiotics:
- Vancomycin 20mg/kg
- Cefuroxime 1.5gm

If patient has AICD, call anesthesia tech for specific brand programmer and have anesthesia attending turn AICD off prior to surgical incision

Positioning: supine with both arms tucked at the side.

From Incision to Initiation of CPB
- Heparin: CPB dose of heparin prepared in case of emergent need for CPB. 5,000 units given if axillary cannulation performed.
- TEE performed
- Heparinization 300-400 units/kg with goal ACT >480 given.
- Tranexamic acid (TXA) bolus and infusion started after heparinization.
- Be prepared for major blood transfusion in case of major vascular or cardiac structures injuries (blood products prepared, hot line primed and connected).

Immunosuppressants:
- Solumedrol 1000 mg IV at induction
- Basiliximab (Simulect) 20mg in 100ml NS, IV
  1. Dosed post CPB, when coagulopathy is controlled.
  2. Basiliximab should be infused in a separate central IV line and should not be mixed with other infusions.
  3. Do not reconstitute basiliximab until you are prepared to infuse it.
- Liothyronine (Triostat): <60kg: 4mcg; 60-80kg: 6mcg; >80kg: 10mcg
  1. Dosed prior to removal of the aortic cross-clamp after discussion with the surgeon.
- Hepatitis B Immune Globulin 10,000 units IV given over 2-3 hours in the OR
  1. Given only in the event that donor is HepB core Ab positive. Indicated by a “YES” on the transplant coordinator care sheet.
- Plasmapheresis
  1. If HLA antibodies are present at a 1:16 dilution, it is considered an HLA mismatch. When there is a known antibody in common with the donor but one that is weak, plasmapheresis is used in the OR and crossmatch results are awaited. If the crossmatch comes back positive, 5 rounds of plasmapheresis will be given in the ICU.
  2. Performed if confirmed history of Heparin Induced Thrombotic Thrombocytopenia (HIT/HITT).
  3. When plasmapheresis is planned, dose antibiotics as usual. There is no need to redose Vancomycin or Cefuroxime after plasmapheresis. Do not give TXA until plasmapheresis is complete.
  4. The apheresis team will set up their own FFP.
- Blood products: 4u RBC in room and checked
5. Intraoperative Considerations

**Figure 1:** Recipient Cardiectomy. Two venous cannula are present (SVC and IVC) with circumferential vessels ties present to exclude any flow around the cannula into the RA. The aortic cross clamp is present on the ascending aorta. A left atrial cuff is present with the pulmonary veins intact. The donor left atrium will be anastamosed to the recipient LA cuff. The right atrium has been excised.

**Figure 2:** Transplanted heart. Note the bicaval anastomoses, main PA anastomosis, and ascending Aorta anastomosis. Not visualized here is the left atrial anastomosis (which is posterior).
<table>
<thead>
<tr>
<th>SURGICAL STEPS</th>
<th>ANESTHETIC CONSIDERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recipient Cardiectomy</strong></td>
<td>• If re-do sternotomy, peripheral arterial and venous cannulation may be obtained prior to sternotomy. Ensure R2 pads on in the event of intractable VT/VF prior to sternotomy or in event of re-do sternotomy with longer time to access heart</td>
</tr>
<tr>
<td></td>
<td>• Sternotomy performed</td>
</tr>
<tr>
<td></td>
<td>• Cannulation for CPB: Arterial-often right axillary cannulation (alternative femoral artery). Venous-bicaval cannulation (SVC/IVC)</td>
</tr>
<tr>
<td></td>
<td>• Heparinize fully, give antifibrinolytic (TXA), go on CPB</td>
</tr>
<tr>
<td></td>
<td>• Aortic cross-clamp placed</td>
</tr>
<tr>
<td></td>
<td>• Recipient cardiectomy occurs</td>
</tr>
<tr>
<td></td>
<td>• While on CPB, keep ACT &gt;480, assist perfusionist with maintenance of the MAP 60-80 with the addition of vasoconstrictor (Phenylephrine/Norepi) or vasodilators (clevidipine)</td>
</tr>
<tr>
<td></td>
<td>• Correct anemia, hyperglycemia. Do not correct K or Ca until cross-clamp off.</td>
</tr>
<tr>
<td><strong>Left atrial anastomosis/Aortic Anastomosis</strong></td>
<td>• A small left atrial cuff is left over from recipient-the donor left atrium is now approximated to the remnant cuff and anastomosis occurs.</td>
</tr>
<tr>
<td></td>
<td>• The back wall of the recipient main pulmonary artery is anastomosed to the back wall of the donor PA</td>
</tr>
<tr>
<td></td>
<td>• The donor ascending aorta is then anastomosed to the recipient ascending aorta</td>
</tr>
<tr>
<td></td>
<td>• After these anastomoses are complete, you will ventilate the patient with 100 O₂ to “de-air” the left side of the heart</td>
</tr>
<tr>
<td><strong>PA/Caval Anastamoses</strong></td>
<td><strong>Pacing Wire Implantation</strong></td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Evaluate LA/LV air with TEE</td>
<td>After the aortic cross-clamp is removed, the anterior wall of the recipient pulmonary artery is anastomosed to the donor pulmonary artery</td>
</tr>
<tr>
<td>Aortic cross-clamp removed</td>
<td>Bicaval (SVC/IVC) anastomoses then occur.</td>
</tr>
<tr>
<td></td>
<td>Send labs at 32°C bladder temperature.</td>
</tr>
</tbody>
</table>

**Prior to Weaning from Cardiopulmonary Bypass:**
- Re-perfuse the heart (on CPB) for at least 60 minutes
- Ventilate with 100% FiO2 and inhaled NO/Veletri
- Re-zero transducers
- Do not supplement calcium without discussing with the attending. Generally, calcium should be supplemented as needed immediately prior to separation from CPB.
- Initiate medium dose of epinephrine (0.04-0.06 mcg/kg/min) only after allowing the heart to re-perfuse for at least 30 minutes after the aortic clamp has been removed.
- Float swan into the Pulmonary Artery (SVC cannula must have been removed)
- Discuss with the perfusionist the amount of volume available in the venous reservoir, which should be enough to allow slow separation from CPB. If Hb marginal (approx. 8g/dl) and volume in the venous reservoir low, discuss administration of PRBC prior to separation from CPB.

**Coming off Cardiopulmonary Bypass:**
- Maintain a MAP >70 mmHg
- Maintain a CVP <15 mmHg
- Maintain a HR >90BPM (prefer atrial/AV synchronous pacing)
- Do not decrease inotropy (if hypertensive, initiate afterload reduction)
- Maintenance after Cardiopulmonary Bypass
- After anesthesiologist and surgeon approve of graft function, give test dose of protamine (2 mL) and evaluate for significant hemodynamic instability.
- After confirming with surgeon, proceed with protamine reversal. After 1/3 in, announce to surgeon and perfusionist and confirm perfusionist has turned off the “pump suckers.”
- Float PA catheter (this can be done while protamine is being given if enough people helping) and collect CCO data.
- Correct coagulopathy with PCCs, platelets, cryoprecipitate, or FFP as labs indicated by the transfusion algorithm.
• Draw arterial blood gases q30mins to ensure metabolic acidosis is corrected and all labs normalized.
• Redose Cefuroxime 1.5gm once protamine is in and coagulopathy controlled.
• Administer basiliximab after coagulopathy has been controlled as a slow central infusion.
• Be careful with volume administration, constantly assess RV function and volume status.

Post-Bypass Coagulopathy:
• Have all blood products checked prior to coming off CPB
• Consider having Kcentra in room if patient was on preoperative Coumadin
• After CPB, give protamine
• Once protamine administered, give platelets if indicated
• Consider cryoprecipitate if Fibrinogen <200
• If coagulopathy ensues, ensure blood products are constantly reordered so that there is adequate supply
• Consider Belmont if severe coagulopathy-do not transfuse platelets or cryoprecipitate through Belmont
• Follow transfusion algorithm

Management of Hemodynamics:
• Refer to algorithm

TEE Exam:
• Prebypass: perform a complete examination (see Duke TEE Imaging Protocol).
• Postbypass evaluation: RV and LV function
  o Valvular function (severity of TR, presence of MR, AI)
  o PA anastomosis (ME Asc Ao SAX, UE aortic arch SAX)
  o ASc Ao anastomosis (ME Asc Ao SAX, ME Asc Ao LAX)
  o SVC/ IVC anastomosis (ME bicaval view)
• Perform a complete examination (see Duke TEE Imaging Protocol) including diastology.

End of surgery
• Existing AICD: To be removed at the end of the case.
• Existing intraabdominal VAD pump: To be removed at the end of the case.
• Existing PICC line: To be removed at the end of the case.
• Ensure pacemaker in synchronous mode

VI. Postoperative Considerations
• Call respiratory therapy to help transport the nitric oxide/ Veletri back to the unit with ICU ventilator (385-7941)
• Place transport monitors
• Ensure safe handover to the ICU team
• Management in the ICU includes
  o Weaning of inotropes and pressors, nitric oxide, and continued resuscitation
  o Early extubation if possible, weaning FIO2 and transition to pressure support ventilation
• Early ambulation and diuresis

Revision History:
Version: 1 Created by: Sharon McCartney MD, Alina Nicoara, MD, FASE Date: 11/28/17