V-A ECMO PATIENT ACCEPTANCE AND TRANSPORT HOTLINES
24/7 VAD Transport Coordinator: 801-507-LVAD (5823)
CT Surgeon, Dr. Bruce Reid: 801-719-8253
Interventional Cardiologist, Dr. Jim Revenaugh: 801-440-7496

REFERRAL CHECKLIST
Provide the following information to the Intermountain Medical Center receiving physician:

- Patient history:
  - Patient’s name, age, date of birth, height, weight
  - Cardiac conditions and prior cardiac interventions
  - Comorbidities
  - Active infection
  - Vascular access
  - Limiting advance directives
- Cardiac arrest? If yes, duration and etiology of arrest, whether chest compressions were required
- Bleeding issues
- Vital signs:
  - BP, HR, RR, temp, SpO2
- Neuro:
  - Status and when last assessed
- Echo:
  - Date and time, inotropes or pressors at time of echo
  - LVEF, RVEF, other findings
- Chest x-ray
- Swan/PA cath parameters: RA, PA, PCWP, CI, SvO2
- Inotropes/pressors: Agent and dose
- Ventilator parameters: Mode, PEEP, VR, TV, FiO2
- Arterial blood gas:
  - Time of ABG, FiO2 and PEEP at time of ABG
  - pH, HCO3, PCO2, PO2
- Lab data:
  - Lactate, AVO2 difference, CBC, PTT, PT/INR, CMP, fibrinogen

ASSESS CARDIAC DYSFUNCTION
See the other side for diagnostic tests, primary indications, clinical presentations, exclusions, and red flags that indicate V-A ECMO must be initiated immediately.

CALL FOR PATIENT ACCEPTANCE AND TRANSPORT
See the panel at left for a hotline number to contact the Intermountain Medical Center CV receiving MD, with the needed referral checklist information.

The Intermountain Medical Center receiving physician will contact the MCS on-call nurse to make Life Flight transport arrangements.

CHOOSE APPROPRIATE CANNULA
- Open chest cannula:
  - Aortic cannula: DLP 22 Fr. CB77722 or DLP 24 Fr. CB77724 (depending on size of patient)
  - Right Atia Edwards Thinflex 40 Fr. D11TF040L90
- Femoral cannula:
  - Femoral artery: Bio-Medicus 17 Fr. #96570-017, FemFlex II 20 Fr. D11FEM11020A or DLP 22 Fr. CB77722
  - Femoral vein: Edwards 24 Fr. DVFEM024

PERFORM CANNULATION
- Open sternotomy:
  - V-A ECMO: uptake in RA appendage to RA/IVC junction, return to ascending aorta
  - RVAD configuration: uptake in RA appendage to RA/IVC junction, return to main pulmonary artery
  - LVAD configuration: uptake in right superior pulmonary vein to left atrium, return to ascending aorta
- Femoral venous-femoral arterial (groin access):
  - RA uptake via femoral vein, tip in RA or RA/SVC junction
  - Return cannula to contralateral femoral artery (+/- dacron side graft by cutdown)

STABILIZE PATIENT
- Ensure correct positioning and stabilization of cannulae
- Ensure stable and adequate ECMO flows
- Achieve hemostasis, then start IV heparin drip to aPTT of 55–70
- Ensure optimized gas exchange and acid base status
- Apply open chest sterile dressing
- Give meds for sedation and immobilization

COMMUNICATE WITH THE FAMILY
- Lead family discussion regarding:
  - Patient’s prior directives for ongoing ICU and surgical support
  - Referral of patient to Intermountain Medical Center for tertiary level multidisciplinary Advanced Heart Failure Team evaluation and management
  - Assessment for best therapy after arrival at Intermountain Medical Center, with the opportunity for the family to participate in treatment planning
  - The risks and benefits of transport
  - Guarded survival prognosis for post-cardiotomy shock
**Primary Indications**

- Significant cardiac decompenstaion that does not respond to medical therapy, due to:
  - Post-cardiotomy heart failure
  - Acute myocardial infarction
  - Adverse non-hemorrhagic outcomes during percutaneous intervention
  - Acute myocarditis
  - Postpartum cardiomyopathy
  - Hantavirus-related cardiac injury
  - Immediate post-cardiac transplant graft failure
  - Acute cardiac transplant rejection
  - Cardiac medication toxicity
  - Hypothermia
  - Pulmonary embolism
  - Refractory arrhythmia
  - Cardiac arrest non-responsive to ACLS (<60 minutes)

*Note: Consider initiating V-A ECMO request early in resuscitation efforts (<20 minutes)*

- Elective cardiac support for high-risk cath lab interventions

**Clinical Presentations**

- **CV surgical post-cardiotomy heart failure:**
  - Unable to wean from OR cardiopulmonary bypass (CPB)
  - Due to cardiac failure — 3 failures to wean from CPB, despite adequate resuscitation and pharmacologic support
  - Recoverable patient
  - Systolic pressure <90 mm Hg with the following pharmacologic support thresholds:
    - **Patient on multiple vasoconstrictors:**
      - Norepinephrine max: 0.1 mcg/kg/min IV gtt
      - Vasopressin max: 3 units/hr IV gtt
      - Phenylephrine max: 100 mcg/kg/min IV gtt
    - **Patient on multiple inotropes:**
      - Milrinone max: 0.4 mcg/kg/min IV gtt
      - Epinephrine max: 0.1 mcg/kg/min IV gtt
      - Norepinephrine max: 0.1 mcg/kg/min IV gtt
      - If using dopamine, max: 10 mcg/kg/min IV gtt
      - If using dobutamine, max: 10 mcg/kg/min IV gtt

- **Acute, primary cardiogenic shock:**
  - Systolic heart failure (usually unanticipated) due to inadequate contractility or arrhythmia, that results in immediate catastrophic hypotension (due to low cardiac output and hypoperfusion), which leads to:
    - Cardiogenic pulmonary edema
    - Renal, hepatic, GI, and CNS dysfunction

*Note: Implement V-A ECMO early in shock state to avoid irreversible end-organ injury from hypoperfusion and effects of high-dose pressors. Use peripheral cannulation in acute cath lab situations.*

- **Sub-acute progressive deterioration of cardiac function in spite of maximal medical therapies:**
  - Cardiac dysfunction requiring progressively increasing inotropic or vasoconstrictor support, or requiring mechanical ventilation for cardiogenic pulmonary edema
  - Unstable arrhythmia requiring frequent unscheduled cardioversions
  - End-stage cardiomyopathy (if LVAD or transplantation can be considered)
  - Patients supported with percutaneous devices who are not demonstrating progressive recovery

**Urgent Red Flags**

**Physiologic thresholds that predict impending medical management failure:**

- Oliguria with diuretic resistance
- Hepatocellular enzyme elevation
- Abdominal pain
- Cool and mottled extremities
- Lactic acidemia
- Tachycardia
- Progressive ventricular and/or atrial arrhythmias
- Tachypnea, hypoxemia, increased respiratory effort
- Systemic hypotension despite escalation of drips (see pharmacologic support thresholds at left)
- Pulmonary arterial O2 (mixed venous) saturation < 50% with Hct <26% and temp <38.3°C
- Arterial to mixed venous O2 content difference >7
- Abdominal pain
- Cardiac Index (CI):
  - <2.0 L/min/m²
  - 2.0 – 2.2 L/min/m² with inotropic support:
    - Milrinone max: 0.4 mcg/kg/min IV gtt
    - Epinephrine max: 0.1 mcg/kg/min IV gtt
    - Norepinephrine max: 0.1 mcg/kg/min IV gtt
    - Dopamine max: 10 mcg/kg/min IV gtt
    - Dobutamine max: 10 mcg/kg/min IV gtt
- Acutely elevated LVEDP or PCWP >25 mm Hg
- Acutely elevated RAP/CVP >15 mm Hg

**Exclusions**

- Survival unlikely: >60 minutes of CPR; lactic acid >20 mmol/L; end-tidal CO₂ <5 mm Hg for >15 minutes; irrecoverable multi-organ failure
- Severe vasodilatory shock
- Severe septic shock: viral, bacterial, or fungal
- Hemorrhage:
  - Uncontrollable coagulopathy / hemorrhage
  - Recent hemorrhagic CNS injury
  - CPR or trauma-induced active chest or intra-abdominal hemorrhage
- Aortic dissection or severe peripheral vascular disease
- Primary lung failure (ARDS or decompensated COPD) or primary pulmonary hypertension
- Not a candidate for transplant or implantable VAD:
  - Irreversible heart/lung/liver/CNS disease or other known non-cardiac terminal illness (advanced malignancy, end-stage renal disease, etc.)
  - Known exclusionary advanced directives
  - Advanced age
  - Known illicit substance addiction (active addiction)
  - Known medical non-compliance

**Exclusions for V-A ECMO**

- 12-lead ECG
- Cardiac markers
- CBC, renal and hepatic panels, BNP, coagulation testing
- Arterial blood gas with lactic acid
- Chest x-ray
- Inadequate hourly urine output (<30 mL/hour)
- Arterial line for continuous BP monitoring
- PA catheter:
  - RAP, PCWP, PAP, SvO2, (A-V)O2 diff
  - Echocardiogram:
    - LV, RV function: segmental, global, dilation, hypertrophy, outflow obstruction
    - Atrial abnormalities
    - Valvular disease
    - Pericardial disease
    - Septal defects
    - Aortic pathology

**Diagnostic Assessment**

Objective assessment of cardiac dysfunction before deciding to implement V-A ECMO may include:

- CT Surgeon, Dr. Bruce Reid: 801-719-8253
  - Aortic pathology
- Interventional Cardiologist, Dr. Jim Revenaugh: 801-445-7496
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