Extracorporeal Membrane Oxygenation
Cath Lab, ICU, ED

PURPOSE: To outline the initiation, operation, and patient management for patients receiving (Extracorporeal Membrane Oxygenation ECMO) using the CARDIOHELP extracorporeal cardiopulmonary system.

SUPPORTIVE DATA: The ECMO is an extracorporeal cardiopulmonary support therapy that is used for blood oxygenation and carbon dioxide removal with mechanical circulatory assistance. The CARDIOHELP System is the machine used to provide ECMO via venoarterial cannulation and veno-venous cannulation. When venoarterial cannulation is used, blood is removed through the femoral vein, and returned via the aorta after oxygenation, thereby bypassing the heart and pulmonary circulation. ECMO may be initiated only by a qualified provider (e.g., surgeon, interventional cardiologist) with the assistance of a trained and experienced Cardiac Cath lab or ICU RN competent in the implementation and operation of ECMO. Nurses trained in ECMO will be responsible for the management of ECMO.

An Arterial line and either central venous pressure or pulmonary artery catheter monitoring are required for the patient on the CARDIOHELP system.

The ECMO trained nurse manages the CARDIOHELP machine as outlined in this standard, and the primary nurses manage care of the patient including management of hemodynamic monitoring in the ICU setting. The ECMO trained nurse manages hemodynamic monitoring in the ED setting.

ASSESSMENT:

1. Assess the following parameters continuously and record upon initiation, a minimum of every hour, and as necessary from the Expanded Parameter Screen:
   - Flow V (lpm): measured blood flow in liters per minute from the Flow/Bubble Sensor
   - Speed P (rpm): the rotations per minute the centrifugal pump is turning
   - Venous Pressure Pven (mmHg): measures blood inlet (inflow) pressure
   - Internal Pressure Pint (mmHg): measures blood pump and oxygenator pressure
   - Arterial Pressure Part (mmHg): measures blood outlet (outflow) pressure
   - Delta Pressure Δp (mmHg): measures the pressure drop between the Internal Pressure [Pint] and the Arterial Pressure [PArt]
   - Venous Temp T. (^{0}C): measures blood inlet (inflow) temperature from the Venous Probe
   - Arterial Temp TM (^{0}C): measures blood outlet (outflow) temperature from the Integrated Pressure Sensor
2. Assess the following parameters continuously and record a minimum of hourly and as necessary from the "Blood Parameter Screen."
   - Oxygen Saturation of Venous Blood (Sv02) (%)
   - Hemoglobin (Hb) (g/dl)

- Hematocrit (HCT) (%)
- Blender FiO2 (when in use)
- Gas Flow

3. Assess cannula, tubing, and insertion sites every hour:
   - Cannula insertion sites should be frequently assessed to rule out excessive bleeding, hematoma formation, kinking or movement. Verify the cannula remains securely fastened in place. Use transparent dressing (e.g. 3M Tegaderm ^{TM} CHG Chlorahexidine Gluconate I.V. Securement Dressing).
   - Assess for color, temperature, sensation, and distal pulses of the cannulated limbs (as appropriate) to detect and prevent limb ischemia.
   - Distal pulses may not be palpable due to the non-pulsatile circulatory nature of blood flow from the Pump. The use of a Doppler may be necessary to assess distal flow.
   - Assess for fibrin clots in oxygenator/pump, inlet/outlet lines, arterial/venous tubing's and cannulas

ANTICOAGULATION:

4. Administer heparin as ordered.
5. Assess Activated clotting time (ACT, Cath lab only) /activated partial thromboplastin clotting time (aPTT) for adequacy of anticoagulation
   - Usual guidelines for ACT:
     - ACT of 180 - 220 seconds (patient without bleeding complications)
     - ACT of 120 -180 seconds (patient with bleeding complications)
   - Once the patient's coagulation status is stabilized, the patient may be converted to monitoring aPTT
     - Goal per provider order

MANAGEMENT:

6. Assess for inadequate filling:
   - Observe the outflow cannula for unusual vibration, movement, "chatter" or "shaking." Low atrial volume can result in the atrial tissue collapsing around the cannula.
   - Assess for persistent increasingly negative venous pressures outside of desired parameters (for example, persistently becoming more negative than -100 mmHg would be outside of baseline and desired parameters)
   - Actions to consider if there are inadequate filling pressures:
     - Manage underlying condition/ medical cause (e.g., administration of fluids/blood or blood products, identify source of bleeding)
     - Checking the system for kinks or obstructions
     - Check outflow cannula vibration, movement, "chatter" or "shaking"
       - Gradually reduce the speed (rpm) by approximately 100 rpm/10 seconds until the "chatter" resolves and the flow increases
     - Manage the underlined condition (e.g., administration of fluids)
     - Increase speed (rpm) carefully after the causes have been treated
     - Assess need to change head positioning of patient [if internal jugular (IJ) access used] to relieve possible kinking

7. Ensure and verify with primary RN that the three white caps on unit are tightly locked

8. Ensure bubble detector flow probe is placed on arterial tubing and arrow points to flow of blood (toward patient)

9. Initiate oxygen gas flow by connecting green O2 port to wall oxygen at 1:1 gas to blood flow (Flow V).
10. Do the following upon ICU arrival:
    - Plug unit into red outlet (CARDIOHELP only has 6-hour battery life)
    - Cath lab to report to ECMO trained Nurse the following baseline pressure readings:
        - Venous Pressure Pven (mmHg)
        - Internal Pressure Pint (mmHg)
        - Arterial Pressure Part (mmHg)
        - Delta Pressure Δp (mmHg)

SAFETY:

11. Use flashlight to check circuit for bubbles and clots a minimum of every hour.
12. Check for kinking and alarm settings a minimum of every hour.
13. Correlate labs results with values for Hemoglobin and Hematocrit obtained from the ECMO machine a minimum of every shift.
14. Ensure platelets, Fresh Frozen Plasma, and Cryoprecipitate are administered through a peripheral line, when possible. Administration of these products centrally will clot the circuit.
15. Do not administer cryoprecipitate or platelets via the central line, always administer via the peripheral IV or post pump oxygenator to prevent oxygenator clotting.
16. Use extreme care when moving or repositioning patient to prevent catheter migration, kinking or disconnection. Keep lower extremities in straight alignment (when femoral access is used).
17. Prevent backflow by ensuring rpm of at least 2000 per minute
18. Keep at minimum of 6 Kelly clamps at bedside at all times
19. Ensure yellow vent-cap (de-airing port) on tower of unit remains in place (on top luerlock at all times)
20. Use hand crank to maintain rpm in case of power failure.
21. Inform cardiology attending prior to transporting patient.
22. Keep the ECMO machine below the level of the patient's chest (in cardiocart)at all times.
23. Primed circuits will expire after 60 days, to be discarded if not used.
24. Ensure oxygen tank is full on ECMO carts at all times

WEANING & DICONTINUATION

25. Initiate weaning per provider's order by:
    a. Decreasing flow rate
    b. Decreasing sweep (if blender is in use)
26. Check anticoagulation status of the patient prior to device removal.
27. Discontinue heparin for 30-60 minutes prior to removal as ordered.

PATIENT/CAREGIVER EDUCATION:

28. Instruct on the following
    a. Purpose and function of ECMO management and monitoring
    b. To notify the nurse immediately for the following:
        - Cannula dislocation
        - Bleeding
        - Leg pain

REPORTABLE CONDITIONS:

29. Notify provider overseeing ECMO immediately for the following:
    - Continued inability to reach goal for flowrate (liters per minute)
    - Increasing arterial pressure and decreased flow rate
    - Increase in Delta Pressure (Δp)
    - Venous pressure becoming more negative and decreased CVP
    - Significant change in peripheral circulation
    - Bleeding at sites of cannula insertion
    - Significant change in blood gas results
    - Presence of fibrin clots or bubbles

ADDITIONAL STANDARDS:

30. Implement the following as indicated:
    - Central Venous Catheter
    - Central Venous Pressure Monitoring - ICU
    - Arterial Line – ICU
    - Pulmonary Artery Catheter - ICU

DOCUMENTATION:

31. Document in accordance with "documentation standards".
32. Document in iView on the Adult ICU lines/Devices navigator band:
    - Cardiopulmonary device (CardioHelp) section
    - CardioHelp Settings, measures section
27. Document in iView on the Systems Assessment navigator bar, neurovascular section.
28. Document initial pressures
    - As a formative note when initiated at bedside
    - In *Merge* system when initiated in Cath Lab

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