

AIR ALARM IN ECMO CIRCUIT

Signs

- “Venous Air” or “Arterial Air” Alarm on ECMO Controller (Cardiohelp)
- Visible Bubble in Tubing
- Bubbling/Foaming at the top of the oxygenator
- ECMO will STOP when a bubble is detected

Immediate Action

- **CALL FOR HELP**
- **Notify ECMO SPECIALIST and ATTENDING**
- **Clamp arterial line of the circuit**
 - **VV ECMO:** Go to **emergency vent settings**
 - **VA ECMO:** Increase **vasoactive meds** and prepare for **CPR**
- Grab a penlight or flashlight and **inspect tubing**
- If no bubble is identified:
 - Check that bubble sensors are firmly attached
 - Reset the alarm and resume ECMO
- If the air bubble is only on the venous side of the oxygenator:
 - Identify source of air and eliminate the offending cause (uncapped line, inadvertent bubble injection, central line)
 - “Walk” the bubble up to the oxygenator
 - Increase flows to push bubble into oxygenator, avoid crossing air into arterial limb
 - Aspirate bubble from oxygenator or circuit (white cap between Cardiohelp console and oxygenator)
 - Restart the circuit
- If the air bubble has spread to both sides of the oxygenator:
 - Identify source of air and eliminate the offending cause (uncapped line, inadvertent bubble injection, central line)
 - Attempt to “burp” from cap at top of oxygenator or aspirate from cap on line leaving pump
 - Prepare for a **circuit change**
 - Bring **standby circuit** to the bedside
 - Bring **cannulation supply cart** to the bedside
 - Bring “**ECMO Pan**” to bedside
- **Restart ECMO** and **Unclamp the circuit** once the bubble and source have been eliminated

Next Steps

- If you are unable to aspirate air or a high volume of air has entered the circuit and the patient is decompensating, you must perform a **circuit change**.
- **Circuit Change:**
 - With both lines clamped, the provider **cuts the circuit** near the cannulae
 - Provider performs a **wet-to-wet** connection with the new **standby circuit**
 - **Unclamp** the lines and **restart ECMO**

Pump Failure / Hand Cranking Circuit

Signs

- **No flow** through blood tubing
- Obvious loss of power (blank screen, other sign of device malfunction)
 - If the Cardiohelp console screen is on, the problem is likely not pump failure
- New hypoxia or new/increasing pressor requirements

Immediate Action

- **CALL FOR HELP**
- **Notify ECMO SPECIALIST and ATTENDING**
- **Clamp both lines of the circuit**
 - **VV ECMO:** Go to **emergency vent settings**
 - **VA ECMO:** Increase **vasoactive meds** and prepare for **CPR**
- Call for **backup circuit**
- Hand-crank until the backup circuit is available
 - Lift up handle on Cardiohelp
 - Detach data cable from oxygenator
 - Stop heater and disconnect heater lines
 - Unhook oxygenator using metal tab at 9 o'clock and a gentle clockwise turn of the oxygenator
 - Move oxygenator to hand-crank
 - Lean the **top** part of the oxygenator into the notch at the **top** of crank
 - Push in the button at the 6 o'clock position of crank to secure bottom of oxygenator
 - Begin hand-cranking, increase RPMs to ~1500.
 - Unclamp circuit and increase hand-cranking speed to obtain pre-failure RPMs

Next Steps

- Move the patient's circuit onto the backup console:
 - Power on the backup console
 - **Detach the backup oxygenator** from the backup circuit
 - **Clamp both lines** of the patient circuit
 - Detach the patient oxygenator from the handcrank
 - Insert the patient oxygenator into the backup console
 - Increase RPM on the new console to 1500
 - Unclamp both lines of the patient circuit
 - Increase RPM to pre-failure settings
 - Set alarms and interventions on the new console.

HYPOXIA ON V-V ECMO

Signs

- **Low Pulse Ox** (< 88%)
- **Low PaO₂ on ABG** (< 60 mmHg)
- **Dark “Venous” blood** in **both** sides of the ECMO circuit
- OR rarely **bright “Arterial” blood** in **both** sides of the ECMO circuit

Immediate Action

- **CALL FOR HELP**
- **INFORM ECMO SPECIALIST**
- **NOTIFY ATTENDING**

- Ensure that Fresh Gas Flow tubing is connected to the **wall** and to the **oxygenator**.
- Make sure that oxygen is flowing.
 - The “ball” in the flowmeter should be spinning.
 - Turn flow up and down to assure that the “ball” isn’t stuck
- Check SvO₂ on CardioHelp
 - Low SvO₂ (<60%) suggests **high oxygen consumption (see below)**
 - High SvO₂ (>80%) suggests **recirculation (see below)**

Next Steps

- If **High oxygen consumption** is suspected
 - **Increase flows**
 - Increase RPM incrementally on the pump. Measured flow should also increase incrementally
 - If ECMO flows do not increase, or if there are excessive negative pressure alarms or “chatter”, there may be **access insufficiency (see below)**
 - Consider checking labs and **transfusing to Hb > 10**
 - Consider decreasing oxygen consumption with **paralytics**
 - Consider decreasing patient **temperature**
- If **Recirculation** is suspected
 - Obtain stat Chest X-ray to examine cannula position
 - Turn down ECMO flows, to see if this helps desaturation
 - Consider re-positioning cannulae so ends are >10cm apart
- If **Access Insufficiency** is suspected
 - Evaluate preload - consider a volume challenge with 500mL of crystalloid, albumin, or blood
 - Consider adding an additional venous drainage cannula

DECANNULATION

Signs

- External: obvious and massive hemorrhage
- Internal: Rapid swelling or discoloration in affected area
- Both: Rapid decline in flows, rapid hypoxemic or cardiac arrest.

Immediate Action

- **CLAMP BOTH LIMBS OF THE CIRCUIT**
- **STOP ECMO FLOWS**

- **CALL FOR HELP**
- **INFORM ECMO SPECIALIST**
- **NOTIFY ATTENDING**
- **Hold pressure PROXIMAL to cannula insertion site**

- Call CT Surgery, Vascular, and CCM Attending at once (or delegate to another team member).
- Initiate/Increase vasoactive medications
- Call for **MASSIVE TRANSFUSION** blood pack
- Resuscitate the patient using aggressive ACLS and/or ventilator support as needed

Next Steps

- If patient hemodynamically stable and your concern for decannulation is low, consider imaging such as angiography or CT to verify cannula position
- If patient is not stable, surgery may need to perform a cutdown to directly visualize or reposition cannula

if

CANNULA SITE BLEEDING

Signs

- **Visible oozing from cannula insertion site**
- Blood-soaked gauze at insertion site
- Local tissue/extremity swelling near cannulation site

Immediate Action

- **CALL FOR HELP**
- **INFORM ECMO SPECIALIST and NOTIFY ATTENDING**
- Inspect site: is blood coming from around the cannula? Which one? Is it bleeding from the suture site?
- **Local Site bleeding**
 - Signs
 - Single site identified, mild bleeding, extremity appears unchanged, labs are in range
 - Use pressure, suture, and/or Surgi-Seal with pressure dressing to try and stop bleeding
- **Cannula Dislodgement**
 - Signs
 - Extremity change (size, firmness, discoloration, worsened distal neurovascular exam)
 - Hemodynamic change (loss of BP or flows)
 - Change in cannula position
 - Hold pressure PROXIMAL to the skin insertion site
 - Call CT surgery
 - Give blood as needed
 - See separate card for Cannula Dislodgement
- **Suspected Coagulopathy / Over Anti-Coagulation if:**
 - Check labs including Anti-Xa and ACT, consider decreasing or stopping heparin/anticoagulant drip

Next Steps

- If cannula displacement suspected: if
 - Contact CCM attending and CT Surgery Immediately

CHUGGING/CHATTER

Signs

- **Swaying of the venous drainage cannula**
- Fluctuating flows despite steady RPMs
- Increasingly negative venous pressures

Immediate Action

- **CALL FOR HELP**
- **INFORM ECMO SPECIALIST and NOTIFY ATTENDING**
- **Check venous drainage cannula position**
 - Changes in position, kinking, or compression should be corrected
- **Turn down RPMs** as tolerated to reduce negative venous pressure
 - **Go down incrementally until flows near zero**, then increase incrementally to previous level
- **Check for thrombus** in membrane oxygenator or tubing—use a flashlight!
- **Consider a volume challenge** if hypovolemia is suspected

Next Steps

- If hypovolemia is diagnosed, identify any causes of hypovolemia (bleeding, leaking stopcock, etc.)
- **Consider gradually increasing RPMs** to assess for access insufficiency (“ramp test”)
 - If increasing RPMs consistently leads to chugging, an additional drainage cannula may be needed
- Discuss with CCM attending and/or CT Surgery about:
 - **Adjusting cannula position.** This can improve overall flow through the circuit.
 - **Adding a second drainage cannula.** This will achieve the same flow rate with less negative pressure in each cannula.