



Extracorporeal Life Support Organization (ELSO)

H1N1 Specific Supplements to the ELSO General Guidelines

These guidelines were developed anticipating an epidemic of H1N1 flu in the US in 2009-10. Some of the details are specific for the US. **Overall ECMO management is described in the general and age specific guidelines. Use those guidelines for managing ECMO patients.. Only items unique to H1N1 infection are listed here.**

I Patient condition

A. Indications: An estimate of 50% mortality risk is requirement for FiO₂ 0.8 and/or requirement for 2 vasoactive drugs. An estimate of 80% mortality risk (indication for cannulation) is P/F under 80 on FiO₂ 1.0 and PPlat or HHOV P over 30 cmH₂O, and/or ongoing requirement for vasoactive drugs. All this despite optimal treatment, but in H1N1 disease progression can be very fast (12-24hours to arrest), so have a low threshold for” failure of optimal Rx. Survival is approximately 72% for patients on ECMO within 6 days of intubation, 30% for patients on ECMO 7 or more days after intubation..

B. Contraindications: Obesity and pregnancy are not contraindications. Concomitant immune suppression may be a contraindication, depending on the level of leukopenia (some use absolute neutrophil count less than 500) or the underlying prognosis. Age is not a contraindication per se, taking into account health status pre H1N1.

Availability of ECMO beds may be a factor in declining a patient or referring a patient to another center. It is wise to have a plan for how to deal with routine ECMO cases, and a plan for allocation of ICU beds during this epidemic.

II Extracorporeal Circuit

A. Plan for total support, it will probably be necessary. Refer to Guidelines.

B-C-D: Components

Membrane Lung: Most centers in the US are using the Quadrox D (Maquet). It is the only low resistance nonporous membrane lung available in the US in 2009. It can be used for any patient over 10 kg, and in smaller patients with a recirculating loop. It may function for a month or more and does not need regular change out. Although it is “nonporous” and will not leak plasma, there are micro holes which can entrain air if the pressure on the blood side is lower than ambient pressure, so it is essential to keep the lung below the level of the patient. Large patients (over 80 kg) may need two membrane lungs in parallel for adequate gas exchange when there is no native lung function.

Pump: The servoregulated roller pump is standard in most centers.

The new membrane lung can be used with a centrifugal pump if the inlet (suction) pressure does not exceed minus 200-300 mm Hg. This negative pressure can occur in seconds if the venous line “chatters” at high flow, so it should be prevented by keeping the RPM under 3000 and/or by incorporating a compliance chamber in the drainage line (“Better Bladder”). There are 2 centrifugal pumps with a center hole in the rotor which avoids thrombosis and heating: Centrimag (Levitronix) and Rotaflow (Maquet). Both are safe for long term use.

The advantage of a centrifugal pump is that it cannot blow out at normal pressure, even with the arterial line occluded. Remember there is no backflow valve with a centrifugal pump, so the patient can bleed out “backwards” if the pump stops during VA bypass.

G. Heat exchanger: There is a heat exchanger built into the QuadroxD. Use it with a conventional water bath. For large children and adults the use of the heat exchanger/water bath may not be needed.

H. Monitors: With the QuadroxD and centrifugal pump little continuous monitoring is needed. Circuit management is driven primarily by patient monitors. Inlet/outlet pressures, blood gases, and sats can be measured continuously, but can be measured intermittently if the data is needed for management. An exception is continuous SVO₂ for VA access.

J. Tubing: With the new system it is possible to use short tubing (1 meter), but longer tubing is needed for proning and trips to CT or OR. Short tubing can be used with

additions for road trips. Tubing diameter is 3/8” for >30kg, 1/4 for <30. 1/2” drainage is advised for large adults needing very high flow.

III. Vascular access: Standard 2 cannula VV and standard 2 cannula VA and Origen pediatric double lumen cannulas are used as described in the guidelines.

The new Avalon double lumen cannulas are very good for VV access in all ages. Placement and positioning should be done with Xray, fluoro or ECHO guidance. Fluoro is preferred for patient over 10 kg. The cannula can be placed percutaneously, but the skin and fascia should be incised or thoroughly dilated after the wire is placed. Semi-Seldinger technique (visualization of the vein for wire placement) is ideal for the Avalon cannulas. A second drainage cannula may be required to achieve high flow in a large adult. The infusion lumen is long and narrow, so use the largest cannula which will fit in the patient to avoid high infusion pressure.

IV Management:

A: Circuit:

4. Anticoagulation: H1N1 patients range from coagulopathic with low heparin requirement to hypercoagulable. Pulmonary emboli have occurred even during ECMO. Follow the general guidelines for anticoagulation and bleeding management. Although some centers use PTT for heparin titration, this plasma measurement does not take into account the interactions among platelets, WBC, RBC, and heparin. It is advised to use ACT measured frequently at first, moving to longer intervals and perhaps PTT as the pt becomes stable.

Minimize circuit access as much as possible to decrease the risk of clotting. One Luer pre and post membrane lung can suffice for most purposes including monitoring, blood sampling, and drug /fluid administration. 2 additional access sites are required for CRRT or plasmapheresis, Refer to the Guidelines for discussion of the A-V bridge in the circuit. Eliminate the bridge whenever possible.

B: Patient

2. Vent and lung management: Keep the vent at low settings, (Pplat under 25, FiO2 under 0.4) Adjust blood gases with the circuit, not the native lungs. Remember the SaO2 will be 70-80% on VV so a normal hematocrit is essential for O2 delivery. This will be a long run so early tracheostomy will facilitate all aspects of care including minimal sedation. These patients often have bleeding from the lung parenchyma. Frequent bronchoscopy may be required. Hemoptysis is not a sign of futility and should be managed as any bleeding complication. HFOV can be used at rest settings (mean airway pressure 12-14 CMH2O), and may help with recruitment.

Until there is some sign of lung recovery, there is no indication for recruitment maneuvers, or other vent devices or maneuvers. When there is some native gas exchange and aeration it is reasonable to begin recruitment maneuvers, (prolonged inspiration at 25 cm H2O). The use of adjunctive measures such as nitric oxide,

surfactant, prone positioning, fluorocarbon lavage, and percussive ventilation have been reported to be helpful in recruitment in some centers.

6. Many of these patients will be in renal failure. Have a low threshold for CRRT.

8. Positioning: Prone positioning will recruit posterior lung units when recovery begins. Chest CT showing posterior consolidation is an indication.

V: Weaning, trials off, Futility

This is all standard for H1N1 patients, realizing that weaning trials are not indicated until there is substantial sign of native lung recovery. The biggest question is futility. Most ECMO centers are not accustomed to 30-60 day runs but we have all learned that what seems to be total fibrosis is reversible. Even though there are ARDS survivors after a month (the longest is 120 days)the utilization of the ICU and ECMO resources is a consideration. The H1N1 database will provide some guidance in time. At present the best indicator of irreversible lung fibrosis is PA pressure at systemic level and right ventricular failure (although some patients have recovered with longer VA support).

Patients who come off ECMO after 2 weeks or more often have a picture of severe COPD (adequate oxygenation, poor CO2 clearance, honeycomb appearance on CXR). This is due to V/Q mismatch and resolves in a few weeks. There is a risk of DVT and thromboembolism after ECMO, especially if the femoral vein has been cannulated. It is wise to study patency of the leg veins a few days after ECMO, with a low threshold for an IVC filter. Prophylactic low dose heparin (or LMWH) is used in some centers post ECMO in adult patients who are not receiving heparin for CRRT.

Once off ECMO there is a tendency to let the patient drop back into fluid overload, anemia, hypoproteinemia, over sedation, and malnutrition. Watch for this syndrome and prevent it. Almost all patients weaned from ECMO should leave the hospital alive.

ANTI-VIRALS: Specific recommendations about anti-viral therapy will depend on local regulatory issues as well as emerging evidence, but patients viral status should be checked by BAL every few days and therapy tailored accordingly.

Vaccination: Is recommended for staff who come into contact with H1N1 patients.