Ultrasound Guidance for Extra-corporeal Membrane Oxygenation

General Guidelines

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Disclaimer

These guidelines describe useful and safe practice for extracorporeal life support (ECLS, ECMO) but these are not necessarily consensus recommendations. These guidelines are not intended as a standard of care, and are revised at regular intervals as new information, devices, medications, and techniques become available. These guidelines are intended for educational use to build the knowledge of physicians and other health professionals in assessing the conditions and managing the treatment of patients undergoing ECLS / ECMO. These guidelines are not a substitute for a health-care provider's professional judgment and must be interpreted with regard to specific information about the patient and in consultation with other medical authorities as appropriate. In no event will ELSO be liable for any decision made or action taken in reliance upon the information provided through these guidelines.

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This document is scheduled to expire by May 2018. After this date, users are encouraged to contact the ELSO Guidelines Editorial Board to confirm that this document remains in effect.

Introduction

This guideline "Ultrasound guidance for extra-corporeal membrane oxygenation (ECMO)-general guidelines" is a supplement to ELSO's "General Guidelines for all ECLS cases" which describes prolonged extracorporeal life support (ECLS, ECMO). This supplement addresses specific discussion for ultrasound use in ECMO. This provides a general outline for the use of ultrasound in ECMO. This should be read with the Veno Arterial (VA) -ECMO specific and Veno Venous (VV)-ECMO specific guidelines for ultrasound guidance for ECMO.

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The background, rationale and references for these guidelines are found in "ECMO: Extracorporeal Cardiopulmonary Support in Intensive Care (The Red Book)" published by ELSO. These guidelines address technology and patient management during ECLS. Equally important issues such as personnel, training, credentialing, resources, follow up, reporting, and quality assurance are addressed in another ELSO documents or are centre-specific.

Ultrasound plays a key role in the safe delivery of ECMO.[1,2] It has the inherent advantage that it can be performed at the bedside in real time without exposing the patient to radiation. It not only guides the initiation of ECMO, but also helps to detect and prevent some of the complications associated with ECMO. The main disadvantage of ultrasound is that it can be operator dependent. Hence, it is important that appropriately trained personnel use it to guide management of patients on ECMO.

The uses of ultrasound can be considered under three broad categories- pre-ECMO initiation, during ECMO initiation and post-ECMO initiation.[3]

1. **Pre-ECMO initiation**

Routine ultrasound evaluation of a patient prior to commencing on ECMO can help with diagnosis, selection of the appropriate mode of ECMO, size of cannulae and detail important cardiac pathologies, which may influence the management.

Patient selection

A routine focused echocardiogram (echo) in a patient prior to consideration of ECMO helps with the diagnosis and also in determining the configuration of ECMO. Detection of severe left ventricular dysfunction in a patient with severe respiratory failure, for example, may help in determining the best mode of ECMO support. Demonstration of echo features of acute cor

pulmonale and proximal pulmonary artery emboli in a patient with massive pulmonary embolism is another example.

Identification of concurrent pathologies:

Pre-ECMO echo may unmask concurrent pathologies which might be a contra-indication to ECMO. Detection of severe or moderate to severe aortic regurgitation precludes the patient from VA-ECMO. It is very important to exclude this prior to initiation of VA-ECMO.

Identification of vessels and assessment of vessel size:

Vascular ultrasound prior to peripheral percutaneous cannulation is used to identify the vessels, delineate the vascular anatomy and measure the diameter of the vessel to determine the appropriate size of the cannula (French Gauge size of cannula = 3 X diameter of the vessel in mm).[4]

This also helps to describe any anatomical variation and avoid local complications during puncturing of the vessels.

2. During ECMO initiation

Vascular Ultrasound

Real-time ultrasound guidance during percutaneous ECMO cannulation helps to identify and puncture the intended vessel without causing any local complications. These can include inadvertent arterial puncture, sapheno-femoral junction cannulation and transfixation of inguinal ligament during cannulation. This is of immense value in cannulation during pulseless circulatory state like cardiopulmonary resuscitation when it is impossible to differentiate between the artery and vein using palpation method.[4] Likewise, as femoral vascular anatomy is very variable, relying on blind techniques using surface anatomy is frequently inadequate to prevent complications.

Echo guidance during cannulation

The end of the guidewire (J-loop) can be visualised also in the inferior vena cava (IVC) or aorta using echo (subcostal view). This helps avoid ventricular placement of the wire and arrhythmias and ensures safe dilatation of the vessel. After dilatation and introduction of the cannula into the vessel, the final desired position of the cannula can be guided by echo. As vascular ultrasound and echo can be done at the bedside and can guide percutaneous cannulation, the problems associated with patient transfers to other clinical areas for ECMO cannulation can be avoided.

Trans-oesophageal versus transthoracic echo for guidance of ECMO cannulation

Transthoracic echo (TTE) should be considered in the first instance if the patient has adequate transthoracic acoustic windows. Trans-oesophageal echo (TOE) should be considered if transthoracic views are suboptimal. For certain cannula such as bi-caval double lumen cannula for VV ECMO (e.g. Avalon Elite®) it is necessary to use TOE to guide the cannulation if an image intensifier is not being used. This is discussed further in the section on ultrasound guidance for VV ECMO.

3. Post ECMO initiation

Depending on the ECMO configuration both echo and vascular ultrasound can help in identifying the final cannula position.

In case of venous access insufficiency, it is very important to evaluate the position of the cannula tip and echo can help in determining this. This is particularly important, as it is difficult to visualise the radiolucent distal end of the ECMO cannula on radiography. A malpositioned cannula tip may be identified and appropriate interventions put in place to prevent access insufficiency and the associated problems. Complications such as tamponade leading to access insufficiency may also be diagnosed on echo.

With respect to VV ECMO, echo has a very important role to play in the evaluation of a patient with refractory hypoxia on ECMO. In relation to VA ECMO, echo has a very important role to play in the evaluation of loss of pulsatility, pulmonary oedema and assessment for weaning from ECMO. These are described separately in the VV and VA ECMO sections.

References

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