ECHOCARDIOGRAPHY IN ICU

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Medical City
HMC
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Role of echo in patients with ECMO

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Outline

- ECMO description
- Indication, controindications and complications
- Echocardiographic imaging in patients with ECMO
**ECMO – definition**

Spectrum of modalities able to provide cardiac and respiratory support, which can be used for extended period (hours to weeks).

**VV – ECMO** → Provide support in case of isolated respiratory failure

**VA – ECMO** → Provide support for cardiac and/or respiratory failure
Indications for VV-ECMO

Refractory respiratory failure
(PO2 < 60mmHg and/or acidosis - PH <7.2 or
PO2<100% with FiO2/=90%)

➢ Severe bacterial or viral pneumonia
➢ ARDS
➢ Aspiration syndromes
➢ Primary graft failure after lung transplantation
➢ Massive hemoptysis or pulmonary hemorrhage
➢ Smoke inalation
➢ Status asthmaticus
➢ Airway obstruction
➢ Alveolar proteinosis
➢ Pulmonary contusion

Platts et al. JASE 2012
Indications for VA-ECMO

- Cardiac arrest/near-cardiac arrest
- Cardiogenic shock
- Inability to wean from CP bypass after cardiac surgery
- Primary graft failure after heart or heart-lung transplantation
- Sepsis with profound cardiac depression
- Drug overdose/toxicity with cardiac depression
- Myocarditis
- Arrhythmic storm refractory to other measures
- Pulmonary embolism
- Isolated cardiac trauma
- Acute anaphylaxis

- Periprocedural support from high risk PCI
- Chronic cardiomyopathy: bridge to VAD, bridge to transplant, bridge to decision

Platts et al. JASE 2012
Contraindications

ABSOLUTE
- Non recoverable disease
- Irreversible neurologic injury
- Advanced multi-organ failure
- Contraindication to anticoagulation
- Body weight > 125 Kg (difficult vascular cannulation, inadequate flow?)

RELATIVE
- Age >75 ys
- Inability to anticoagulate
- High dose immunosuppression
- CPR >60 min
- Multiple trauma with multiple bleeding sites
Complications

- Bleeding, Thromboembolism, sepsis
- Limb ischaemia, hemolysis, mechanical failure
- Intracerebral bleeding, circuit rupture, accidental decannulation, air embolism
Role of Echo

- PATIENT SELECTION
- INSERTION AND PLACEMENT OF CANNULAS
- MONITOR PROGRESS
- DETECT COMPLICATION
- DETECT CARDIAC RECOVERY / WEANING
Patient’s selection
Look for the cause of hemodynamic instability.
Assessment of valvular function
Assessment of valvular function
Assessment of the inter-atrial septum
Assessment of the left atrium
Assessment of the right atrium
Assessment of the right ventricle

<table>
<thead>
<tr>
<th>Right ventricle</th>
<th>RV end diastolic area/LV end diastolic area</th>
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</thead>
<tbody>
<tr>
<td>Morphology</td>
<td>Triangular shape versus rounded shape of apex</td>
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<tr>
<td>RV wall thickness</td>
<td></td>
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</tbody>
</table>
Systolic function

TAPSE, tissue Doppler at tricuspid annulus, S wave

Fractional area of change
Tricuspid morphology (regurgitation/stenosis)
Presence of a tricuspid prosthesis

Assessment of PW Pulmonary Doppler

PAT 60 ms
Assessment of the left heart

LVEF <20% should support the indication of VA-ECMO in case of associated respiratory failure

<table>
<thead>
<tr>
<th>Morphology</th>
<th>Size, wall thickness</th>
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<tbody>
<tr>
<td>Systolic function</td>
<td>Ejection fraction (Simpson's method) or FAC</td>
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<td>Wall motion abnormalities</td>
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<td>S wave at mitral annulus</td>
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<td>Velocity time integral in LVOT</td>
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Cannulation
There are currently no recommendations on which imaging modality is superior to guide ECMO cannulation.

**VV-ECMO**

2 venous cannulas:

1) One in the IVC (drainage) and the other in the SVC (reinjection)

2) Reinjection cannula in the RA from the IVC, the drainage cannula in the femoral vein

3) A single, dual-lumen cannula inserted into the SVC via the right internal jugular vein.

**VA-ECMO**

1 venous cannula in the IVC

1 arterial cannula in the femoral/iliac artery

Pavlushkiv et al. Ann Transl Med 2017; 5: 70
SVC drainage cannula

Return flow orifice

IVC drainage cannula

Griffee MG et al. Jour of Cardioth and Vasc Anesth 2018
VA-ECMO

Venous cannula in the IVC

Aortic cannula in the iliac artery or distal aorta.
Utility of echo in the assessment of proper cannula positioning

193 pediatric patients supported on ECMO:
101 procedures without Echo guidance → 17.8% repositioning
92 procedures under Echo guidance → 3.3% repositioning

TTE vs XR for cannula positioning in pediatric patients:
33 procedures under TTE guidance → 24% required readjustement
XR didn’t reveal incorrect cannula positioning.

✓ XR is largely available, but lacks sensitivity in detecting cannula positioning
✓ Echocardiography provides better spatial orientation of cannulas
Assessment of the patient on ECMO
1) Assessment of pericardial effusion/Tamponade

2) In case of reduced flow, look for thrombosis of the drainage cannula with 2D, PW and Colour Doppler

3) Serial assessment of LV function
60 pediatric patients on ECMO → 7 thrombosis:
   3 SVC syndromes
   4 incidental thrombosis detected at TTE

→ No specific cause for thrombosis was identified in these patients

VA-ECMO weaning

Reduce ECMO flow → 0.5 to 1 L/min
Potential increase in the risk of circuit thrombus formation!

Assess clinical/hemodynamic parameters:
- HR, BP
- Arterial waveform pulsatility
- PaO2 in the radial artery
- Changes in CVP

Assess Echo parameters like:
- VTI Ao > 10 cm
- LVEF > 20-25%
- S wave velocity (Sa) > 6 cm/s at the lateral mitral annulus
- Increase in LV GLS of at least 20%

Aissaoui N et al JASE 2012
MF, 39 yo

Primary dilated cardiomyopathy
Acute HF

LVEF 10%
VTI-LVOT 6 cm
CO 1.8 L/min
SOR 0.26 cm$^2$
VR 32 ml

Very elevated LV filling pressure

PAPs 37 mmHg, but RV dysfunction
Patients receiving dobutamine 10 μg/Kg/min

→ Hypotension, oligo-anuria, progressive kidney and liver failure

→ Noradrenaline 0.5 μg/Kg/min

VA-ECMO
Thanks for the attention!