Further information on the ECMO workshops held at the Cardiac Thoracic Vascular and Perfusion (CTVP) SIG Meeting
July 23-26, 2017
Millennium Hotel Queenstown, New Zealand

An Introduction to Veno-Arterial ECMO:

Facilitated by: Andy Pybus.

In this workshop we’ll outline the basic principles of Veno- Arterial ECMO (“VA ECMO”) and illustrate these principles using a high fidelity VA ECMO simulator.

The areas to be covered during the session will include:

- The rationale for VA ECMO.
- Patient selection.
- System / circuit design.
- Cannula selection and insertion.
- Anti-coagulation management.
- Basic manipulation of a VA ECMO system.
- The ‘Special’ problems of VA ECMO.
- Comparisons with VV ECMO.
- Ventilator management during VA ECMO.
- Cardiovascular management during VA ECMO.
- Weaning from VA ECMO.

We’ll start our workshop by describing ‘typical’ VA ECMO patients and outline the factors that determine their suitability (or otherwise) for the use of the technique.

We’ll then move on to describe the features of a modern VA ECMO system. The rationale for the use of non-porous, hollow-fibre, artificial lungs will be explained and their performance characteristics illustrated using the simulator.

Similarly, the selection of non-occlusive, centrifugal pump systems will be justified and again their performance characteristics will be examined.

The impact of cannula design, size and insertion technique will be evaluated and the important differences between central vs peripheral cannulation in the VA ECMO patient outlined.

The basic manipulation of the system will then be described. In particular, the effect of changing the blood flow through the ECMO system will be examined in some detail. The nexus between VA ECMO blood flow rate and left ventricular (“LV”) loading will be demonstrated.

The ‘Special’ problems of VA ECMO (including left atrial (“LA”) hypertension / stasis, differential hypoxia and downstream limb ischaemia) will be discussed.

The relative merits of VA vs VV ECMO will be enumerated and a ‘typical’ virtual patient treated with both modalities in order that comparisons can be made.

Protocols for ventilatory and cardiovascular management during VA ECMO will be described and the advantages (and disadvantages) of the maintenance of ventricular ejection debated.
VA ECMO Introduction:

Scenario:
You are called urgently to see a 24 year-old man in the Emergency Department of your hospital. The patient had been brought in by ambulance complaining of chest pain and dyspnoea. You arrive in the department just after the patient has been intubated by the resident. The resident tells you that the patient deteriorated shortly after having a portable chest x-ray. He performed the intubation because the patient became profoundly hypotensive, unresponsive to commands and started to have frequent ventricular ectopy.

History:
According to the family, the young man had suffered a flu-like illness some weeks before and had been complaining of increasing shortness of breath and lethargy ever since. His family practitioner had prescribed two courses of broad-spectrum antibiotics and some bronchodilator therapy.

Initial Examination:
The endotracheal tube appears to be correctly positioned and breath sounds are symmetrical. The patient is hypotensive, tachycardic and has an irregular pulse. He is afebrile. His ventilation is being assisted using 100% oxygen and an Ambu ® bag. Pulse oximetry indicates a saturation of ~90%.

Previous Medical History:
The family tells you that the patient has previously been in good health, that he takes no regular medications, and that he has no drug allergies. He has no relevant previous medical history.

Subsequent Management:
The patient is transferred to the Intensive Care Unit, further investigations are performed, a tentative diagnosis of viral myocarditis is made, and the decision is taken to support the patient with VA ECMO.

An Introduction to Veno-Venous ECMO:
Facilitated by: Andy Pybus.

In this workshop we’ll outline the basic principles of Veno-Venous ECMO (“VV ECMO”) and illustrate these principles using a high fidelity VV ECMO simulator.

The areas to be covered during the session will include:

- The rationale for VV ECMO.
- Patient selection.
- System / circuit design.
- Cannula selection and insertion.
- Anti-coagulation management.
- Basic manipulation of a VV ECMO system.
- Ventilator management during VV ECMO.
- Basic problem solving during VV ECMO.
- Weaning from VV ECMO.

We’ll start our workshop by describing a ‘typical’ VV ECMO patient and outline the factors that determine their suitability (or otherwise) for the use of the technique.

We’ll then move on to describe the features of a modern VV ECMO system. The rationale for the use of non-porous, hollow-fibre, artificial lungs will be explained and their performance characteristics illustrated using the simulator.
Similarly, the choice of non-occlusive, centrifugal pumping systems will be justified and again their performance characteristics will be examined.

The impact of cannula design, size and insertion technique will be evaluated and the relative advantages of dual lumen, bi-caval cannulae will be explored.

The basic manipulation of the system will then be examined in some detail. In particular, the impact of changing blood or gas flow through the artificial lung, changing the FiO$_2$ of the gas supply to the lung and the adjustment of the patient’s temperature will be illustrated.

A protocol for ventilator management during VV ECMO will be suggested and the principles (and importance) of ‘Lung Rest’ during VV ECMO discussed.

**VV ECMO Introduction:**

Andy Pybus

The patient is a 24 year-old man, weighing 105 kgs, who has been admitted to your Intensive Care Unit for ongoing care.

On admission, he gave a 6 day history of increasing respiratory distress, fever and a productive cough.

His family doctor prescribed a course of ampicillin, but he failed to improve.

Shortly after admission, he deteriorated rapidly and required intubation and ventilation.

Sputum cultures were negative, but H1N1 PCR testing of his bronchial washings was positive.

Despite treatment with oseltamivir (‘Tamiflu’), broad-spectrum antibiotics and the use of prone ventilation, permissive hypercarbia and inhaled nitric oxide, his condition has not improved.

Current blood gas analysis is reported as:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>PaO$_2$</td>
<td>4.6 kPa (34.5 mm Hg)</td>
</tr>
<tr>
<td>PaCO$_2$</td>
<td>6.8 kPa (51 mm Hg)</td>
</tr>
<tr>
<td>pH</td>
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<td>BXS</td>
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<tr>
<td>Hct</td>
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<tr>
<td>SaO$_2$</td>
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</tbody>
</table>
Problem solving during ECMO:

Facilitated by: Andy Pybus.

In this workshop we’ll examine the problems that can arise during ECMO using a high fidelity ECMO simulator.

The main focus of the workshop will be on problem solving during VV ECMO, but the 'special' problems associated with the use of VA ECMO will also be addressed.

The main areas to be covered during the session will include:

- Cannulation problems during ECMO
- The determinants of blood flow from centrifugal pumps
- The differential diagnosis & management of hypoxia during VV ECMO
- The differential diagnosis & management of hypercarbia during VV ECMO
- Oxygenator / Equipment failure

We’ll start our workshop with a brief description of the basic components of a modern ECMO system and present you with a patient who is being treated using such a system.

The problems associated with cannulation will be discussed. The impact of cannula size on system performance and the effect of variations in cannula position on blood flow and gas exchange and the diagnosis and management of recirculation will be described.

Then we’ll move on to examine the flow characteristics of modern centrifugal pumps and highlight their afterload dependence. The consequences of the use of such pumps when either drainage (venous) or outflow (arterial) lines are obstructed will be demonstrated.

The differential diagnosis & management of hypoxia during VV ECMO will be explored in some detail. The effect of variation in blood flow through the system and the impact of variations in the patient’s native cardiac output will be demonstrated. The importance of lowering metabolic rate and maintaining haematocrit in the patient with marginal oxygenation will also be explained.

The impact (and time course) of gas supply failure and / or reduction in FiO₂ will be demonstrated. In a similar fashion, the differential diagnosis & management of hypercarbia will also be explored. The relative ease with which normocarbia (as opposed to normoxia) can be achieved will be demonstrated and explained.

Finally, the causes and management of oxygenator failure during ECMO will be addressed and various strategies for minimizing the impact of oxygenator change out will be discussed.

Please visit the meeting webpage for the full workshop program.