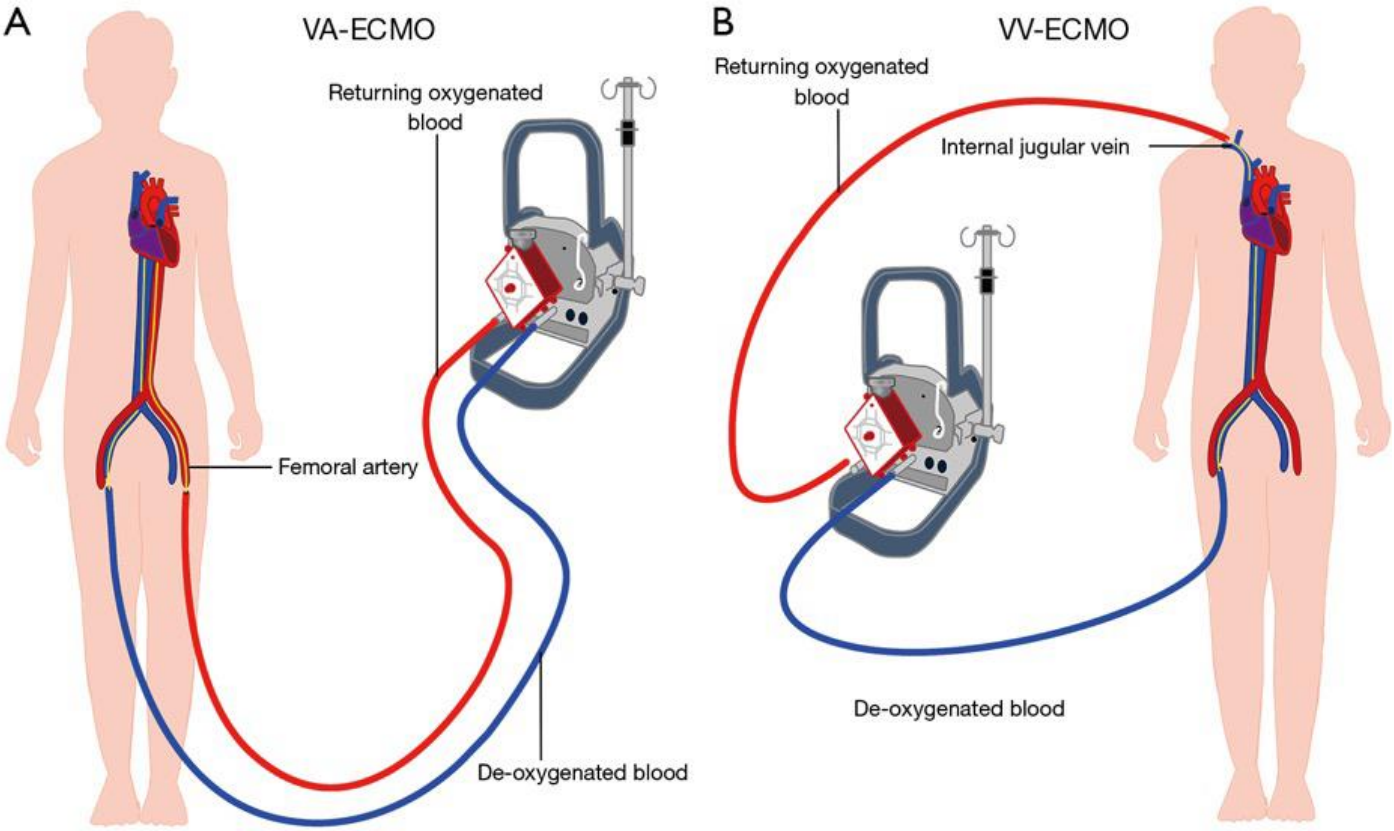
- This resource will focus primarily on the basics of ECMO, with a few dot points at the end focusing on the role of ECMO in COVID19
- ECMO stands for Extracorporeal Membrane Oxygenation – they function similarly to heart-lung bypass machines used in cardiothoracic surgery. It allows for oxygenation and removal of CO2 from the blood, and can also be hooked up to a haemofiltration machine if the kidneys are impacted. When discussed in the context of critical care, it is also often referred to as ECLS – extracorporeal life support
- There are several types. The two main types are
    - VA (veno-arterial) – One large bore cannula is placed in a large central vein and one in the aorta. Blood runs from the venous cannula, through the oxygenator, and then into the aorta. This bypasses both the lungs and heart, allowing its use in cardiorespiratory conditions. This includes
        - Non-ischaemic cardiogenic shock
        - Bridging to LVAD (left ventricular assistance devices)
        - Drug overdose
        - Acute anaphylaxis
        - ?Bridging to organ donation in brain death (a controversial topic)



Two of the main circuit setups for VA and VV ECMO. Source: Pillai et al.

    - VV (veno-venous) – large bore cannulas are placed in the large central veins, so a circuit runs from the vein, through the oxygenator, then is returned to the venous circulation near the right atrium. It's the most common form of ECMO, but only functions as a lung bypass (it relies on a functioning heart to pump the blood oxygenated by the machine around the body). As such, it mainly provides support for severe respiratory failure, such as
        - ARDS
        - Pneumonia
        - Status asthmaticus/airway obstruction

      You wouldn't use VV ECMO in patients with cardiac pathology (eg. a cardiac arrest) as there is an issue with the pump (heart) as well as the lungs.

- Apart from whether the heart is bypassed or not, both methods have indications/contraindications and pros/cons. The list of these are extensive, but you can read up on them in the further resources. The LITFL resource is particularly good
- Each circuit can also have multiple variations as to how they're set up, changing variables such as cannula placement. This can overcome some of the cons with certain line placements, but each positive also has a trade-off.
    - A common variation with VA ECMO is central rather than peripheral (peripheral is shown in the above diagram). Central cannula placement places the aortic cannula higher up the aorta to address the preferential perfusion to the lower body seen in peripheral placement. However, the trade-off is that central VA ECMO requires a sternotomy and tissue dissection.
- Some of the potential complications of ECMO include
    - Clot formation – plastic tubing isn't the same as endothelium, and if the patient isn't adequately anticoagulated clots will rapidly form. However, anticoagulation can lead to…
    - Haemorrhage – These patients are sick and already have dysregulated physiology, including haemostasis. It can be easy to over- or under-coagulate
    - Pharmacokinetic changes – many drugs interact with the ECMO circuit, changing their effective concentrations in the blood. There is some literature published on particular drugs, but for the most drugs we aren't entirely sure what the effect of ECMO is. As ECMO is a (relatively) recent intervention, it's likely more and more data will become available with time. This post by Jeanna Marraffa on Tox and Hound is a great starting point on pharmacokinetic changes on ECMO.
- So, what role does ECMO play in COVID19?
    - In short, probably not a lot. ECMO is very resource intensive – most states only have 1-2 ECMO centres, and even then each centre only has a few machines
    - The ANZICS (Australian and New Zealand Intensive Care Society) guidelines are probably the best guide here.
        - Most critically ill patients are either going to respond to intubation and ventilation or are inappropriate for ECMO. As such, ECMO isn't going to achieve a lot for these patients
        - However, a minority of the patients who end up in ICU are going to be young without any comorbidities, and as such will have the physiological capacity to tolerate ECMO. If these patients aren't responding well to intubation/ventilation, then these patients may be suitable for ECMO
            - If it's a purely respiratory issue where the lungs are so impacted that adequate gas exchange cannot occur, VV ECMO is probably the best option
    - A minority of patients may develop a severe viral/cytokine myocarditis resulting in cardiogenic shock. Depending on the patient, VA ECMO may be suitable for use in these patients
    - A minority of patients may develop severe multi-organ dysfunction syndrome (MODS, likely as a result of cytokine storm). These patients may require ECMO +/- haemofiltration
    - The take home message is – standard criteria for patient selection still applies. ECMO isn't going to be first, second or even third line in the management of COVID19, and should really be reserved for the patients who are extremely sick and have a chance of recovery following resolution of symptoms (which is why young, otherwise healthy people are the most likely to receive ECMO should they get extremely ill).
- Resources
    - https://www.anzics.com.au/wp-content/uploads/2020/03/ANZICS-COVID-19-Guidelines-Version-1.pdf
    - https://litfl.com/ecmo-extra-corporeal-membrane-oxygenation/
    - https://litfl.com/pharmacokinetics-and-ecmo/
    - https://www.aci.health.nsw.gov.au/__data/assets/pdf_file/0007/306583/ECMO_Learning_package.pdf
    - https://intensiveblog.com/ecmo/
    - https://edecmo.org/
    - https://emcrit.org/ibcc/COVID19/#ECMO
    - https://edecmo.org/63-covid-and-ecmo-who-do-we-cannulate-with-jenelle-badulak/