A Guide to Mechanical Circulatory Support in Critical Care

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This leaflet aims to provide you with some information about Mechanical Circulatory Support (MCS) at the Queen Elizabeth Hospital Birmingham (QEHB). As the doctors have explained your relative is extremely ill. The main problem is that their heart and/or lungs are not functioning properly. The medical team believe that using mechanical support can help by reducing demand on your relative’s heart and/or lungs and thereby allow potential recovery.

**Why does my relative need mechanical circulatory support?**

Despite being given the maximum medical support available your relative is still extremely sick. We can give them additional temporary help using a mechanical pump outside of their body. We only consider putting patients onto mechanical support when it is clear that despite current treatment their heart and/or lungs are not working well enough to provide their body with the blood flow and oxygen it needs.

It is important to note that MCS is not a cure; it provides support to aid recovery. However, we believe the condition your relative has is potentially reversible and if the heart and/or lungs are rested recovery may be possible.

**Which type of mechanical circulatory support does my relative need?**

Depending on your relative’s diagnosis we will use one of the following:

**Extracorporeal Membrane Oxygenation (ECMO)**

ECMO provides support to patients with severe heart and/or breathing failure. A heart surgeon will place two plastic tubes (cannulas) into large blood vessels in your relative’s neck, groin or chest. This will usually be done in the operating theatre but sometimes in the critical care unit if they are too unwell to be transferred to our operating theatres.
The tubes will then be connected to the mechanical support machine to form a circuit. Blood is drawn out of the body from a large vein by the turning of a pump that acts as an artificial heart. The blood then flows through an oxygenator that acts as an artificial lung adding oxygen and removing carbon dioxide. Once re-warmed the blood is returned to your relative’s body. This circulation cycle is continuous whilst your relative is on ECMO.

**Ventricular Assist Devices (VADs)**

Patients with good lung function but severe heart failure can be supported with a Ventricular Assist Device. This reduces the workload of the heart allowing it to rest. A heart surgeon will place plastic tubes (cannulas) into blood vessels in your relative’s chest. This will usually be done in the operating theatre but sometimes in the critical care unit if they are too unwell to be transferred to our operating theatres.

We can provide support for the left ventricle of the heart (LVAD), the right ventricle of the heart (RVAD) or both ventricles (BiVAD). Depending on which device is used two or four tubes will be required. Blood is drawn out of the body from a large vessel by the turning of a pump that acts as an artificial heart and is then returned to your relative’s body. This circulation cycle is continuous whilst your relative is on VAD support.

**How long will my relative need mechanical circulatory support?**

This will vary depending on their diagnosis and how they respond to treatment but may be for a period of days or weeks. During this time your relative will remain on the cardiac critical care unit. Patients are reviewed by medical teams throughout each day and night and plans of care change according to their progress. Staff will update you about any changes in treatment.
How do you know when my relative is ready to come off MCS?

The exact length of time that your relative spends on MCS depends on the reason it was needed in the first place. Regular monitoring and observations show how much your relative’s heart/lungs have recovered and indicate when they have recovered enough to try to take them off the MCS machine.

When your relative is first placed on MCS the blood pump speed and flow are kept high so that the machine does most of the work of the heart and/or lungs. As your relative improves the blood pump speed and flow will be decreased allowing their heart and/or lungs to take on more of the work. This is called the weaning process.

Your relative’s improvement is measured by taking blood samples, observations of chest movement, improving chest x-rays and improved heart function. When sufficient improvement is seen the MCS blood pump speed and flow will be gradually reduced over several hours or even days, a process which concludes with the removal of mechanical support. During the weaning process your relative may need full ventilation and possibly extra medicines which will be reduced as their condition improves.

Sadly in some cases it becomes clear that mechanical circulatory support is not helping your relative and if this is the case we will fully discuss this with you.

Will my relative be awake whilst on mechanical circulatory support?

Your relative will initially be kept asleep (sedated) using drugs given intravenously (through a vein) and may remain like this for a period of time depending on their condition. However when appropriate we may decide your relative no longer requires sedation and they will be woken up.

Once awake your relative will need lots of psychological and emotional reassurance as they begin to come to terms with their condition. Your support and encouragement will be very important during this time.
Will my relative be in pain?

It is very important to us that your relative is comfortable and pain free and we recognise this may be a serious concern for you. We will allow your relative to be as alert as possible without subjecting them to pain or anxiety. This allows more precise monitoring of their neurological status and enables them to interact with you.

We will continually assess your relative for signs of pain or discomfort. They will receive continuous intravenous pain relieving medication and additional sedation and pain relieving drugs will be given if any further invasive procedures are performed.

How might I feel when I see my relative on mechanical circulatory support?

You may initially feel shocked and overwhelmed as there will be lots of tubes, machines and monitoring equipment attached to your relative. There will also be bleeping noises and alarms sounding from the equipment; this is normal and does not necessarily mean something is wrong.

Sometimes the chest may be left open but the area will be covered with a dressing and gauze. Please let a member of team know if you want this area covered while you are visiting.

We do encourage you to talk to your relative even if they are sedated. Although it is possible to touch them it is sensible to check with the nurses first.

There will initially be two nurses looking after your relative who have received specialist training in caring for patients on MCS. Their priority is to care for your relative but they will also help and support you as much as possible. If you are unsure of anything please feel free to ask the bedside nurse or one of the doctors and we will do our best to answer your questions.
What are the risks of mechanical circulatory support?

We do not take the decision to use MCS lightly due to the risks associated with this treatment. Furthermore some additional treatments or procedures that your relative may require (such as the insertion of invasive lines, chest drains or a tracheostomy (incision into the wind pipe), or transfer to the CT scanner or the operating theatre) pose a much higher risk of complications whilst being treated with MCS. However in your relative’s situation we feel the potential benefits outweigh the risks.

Some of the possible significant complications are listed below. Not everybody will experience these complications but some may so it is important that you are aware of them:

Bleeding

As blood travels around the MCS circuit a reaction is triggered that makes it more likely for clots to develop within the tubes. To prevent blood clotting in the tubing it is thinned with a drug called Heparin. However this drug can cause bleeding elsewhere; bleeding may occur around the sites where the cannulas enter the body, or within the lungs or possibly the brain. During this time your relative may need blood transfusions to maintain an adequate volume of blood in their body. Other components of blood such as platelets and plasma may also need to be transfused to help with clotting.

To reduce the risk of bleeding we regularly check the ability of the blood to clot (using a variety of blood tests) and monitor for signs of excessive bleeding. We understand that seeing your relative bleeding may be very distressing but our specialist nurses are very used to managing this. We will keep your relative as clean as possible however sometimes it is better not to move a patient as disturbing surface clots may cause more bleeding.
Infection

There is an increased risk of infection after any operation but especially when tubes are inserted into the blood vessels for a prolonged length of time. Patients are monitored for early signs of infection by the medical team. A specialist microbiology doctor will review your relative daily to ensure any infection is treated with antibiotics.

Neurological (brain) complications

Sometimes problems with the brain can occur due to how sick your relative was before going onto MCS rather than being caused by the treatment itself. However when the blood is thinned with Heparin it may cause bleeding into the brain. This is referred to as a brain haemorrhage and is a type of stroke.

Renal (kidney) complications

Acute renal failure can be an additional complication for patients on MCS. If this happens we can use a dialysis machine that acts as an artificial kidney until the kidneys start working again.

Blood vessel (vascular) complications

We sometimes have to use the left or right groin (femoral) blood vessels when inserting pipes for the ECMO circuit. The pipes have the potential to obstruct blood flow to the leg thereby increasing the risk of inadequate blood supply to the leg and potential limb loss. To reduce this risk the heart surgeon will insert an additional cannula to optimise blood flow to the leg whilst on femoral ECMO. We will also undertake regular assessments of blood supply to the legs and feet by assessing their temperature, colour, capillary refill time, and the presence of a pulse.
Pressure damage to skin

Due to the severe nature of your relative’s condition it may not be safe for us to move them immediately following insertion of mechanical circulatory support. A period of time is needed before we can move (roll or reposition) patients in bed. Being immobile increases the risk of pressure damage to areas of their skin. You will see us taking precautions to reduce the risk of skin damage such as: using a pressure relieving mattress, special boots to reduce pressure on the heels, and gel pads beneath the head and elbows. We regularly check accessible pressure points, reposition the limbs, and reposition tubes that may rest on the skin. Despite our best efforts some patients will unfortunately still go on to develop pressure damage to their skin during this initial stage.

Circuit complications

The MCS circuit is regularly monitored by a Perfusionist and specialist nurses for signs of clots or other technical complications. The MCS team are trained to deal with any issues and can often anticipate problems before they become significant.

The risks listed above will be discussed with you, however if you have any further questions please do not hesitate to ask a member of the medical team.
Glossary

We sometimes use terms and abbreviations that you may not be familiar with. We have prepared a short list of some you may come across:

**ABG** – Arterial Blood Gas: A small amount of blood is drawn from an artery and tested to determine the level of oxygen and carbon dioxide it contains.

**ACT** – Activated Clotting Time: A test that assesses how long it takes for your relative’s blood to form a clot.

**Anaesthetist**: A doctor who specialises in intraoperative life support and the care of critically ill patients.

**BiVAD** – Biventricular Assist Device: A mechanical circulatory support device that helps to rest and assist both the left and right ventricles of the heart.

**Blood Pump**: A device that circulates blood through the ECMO/VAD circuit and returns it to the patient.

**Blood Pump Flow**: Refers to the volume of blood being pumped through the ECMO/VAD circuit and is measured in Litres per Minute (LPM).

**Blood Pump Speed**: Refers to how fast the blood pump is turning and is measured in Revolutions per Minute (RPM).

**Blood Transfusion**: Donated blood is given intravenously to replace blood lost during major surgery or bleeding associated with a clotting problem.

**Cannula**: A plastic tube used for the removal and return of blood to the body.

**Cardiothoracic Surgeon**: A doctor specialising in surgical procedures of the heart and lungs.

**Chest Drain**: A tube placed into the space between the lung and chest wall that removes unwanted air or fluid.

**CRT** – Capillary Refill Time: The time taken for colour to return to a fingernail or toenail after pressure has been applied. Prolonged CRT may be a sign of decreased blood flow to the limbs.
**CT Scan** – Computerised Tomography Scan: A scan using x-rays and a computer to create detailed images of the inside of the body.

**ECG** – Electrocardiogram: A test that can record the rhythm and electrical activity of the heart.

**ECMO** – Extracorporeal Membrane Oxygenation: A mechanical circulatory support system that helps to rest and assist the heart, add oxygen and remove carbon dioxide from the blood whilst outside of the body.

**EEG** – Electroencephalogram: A non-invasive monitoring method to record electrical activity of the brain.

**Heparin**: A drug given intravenously to prevent blood from clotting too quickly.

**Inotrope**: A term for drugs given intravenously to make the heart beat more effectively.

**LVAD** – Left Ventricular Assist Device: A mechanical circulatory support device that helps to rest and assist the left ventricle of the heart.

**Oxygenator**: Part of the ECMO circuit which removes carbon dioxide from and adds oxygen to the blood.

**Perfusionist**: A healthcare professional with specialised knowledge and training in cardiopulmonary bypass (heart/lung machine).

**RVAD** – Right Ventricular Assist Device: A mechanical circulatory support device that helps to rest and assist the right ventricle of the heart.

**Sedation**: A term for drugs given intravenously to keep patients asleep in a medically induced coma.

**TEG** – Thromboelastography: A method of testing the clotting efficiency of blood.

**TOE** – Transoesophageal Echocardiogram: An ultrasound scan that produces moving real-time images of the heart using a flexible sensor inserted into the oesophagus (the pipe that goes from the mouth to the stomach), to check the heart structures and assess its function.

**Tracheostomy**: A temporary opening created at the front of the neck so a tube can be inserted into the windpipe (trachea) to help with breathing.
TTE or ECHO – Transthoracic Echocardiogram: An ultrasound scan using a probe placed on the chest to produce moving real-time images of the heart to check the heart structures and assess its function.

Ventilator: A breathing machine used to provide oxygen to the lungs via a tube in the trachea (the pipe that goes from the mouth to the lungs), whilst the patient needs support with their breathing.
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