Chapter **5**

Case selection

Introduction

ECMO is a support modality that buys time. During that time, the patient can be treated. If the patient recovers, ECMO has provided a bridge to recovery. If treatment fails, or if no treatment is available and recovery is not expected, ECMO provides a bridge to further treatment or support. Patients with cardiac failure can be bridged to another device or to a heart transplant. Patients with respiratory failure can only be bridged to a lung transplant, as long-term support devices are not yet available.

Selection of patients who will ultimately benefit from ECMO is crucial to the success of a service. Failure to select patients who will either recover or be suitable for further therapies will cause a lot of suffering. Patients will remain for weeks in intensive care with no prospect of recovery. Staff will lose morale by having to care for futile patients. Managers will question the high cost when assessed against outcome.

Sadly, many patients are referred too late for consideration by the ECMO team. ECMO is not a miracle machine and cannot reverse the irreversible.

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In the absence of clearly recognized criteria backed up by evidence, the clinician will often have to rely on expertise and experience. ECMO can kill even when patient selection is perfect, or can cause major harm with life-changing injuries. The good clinician will remain fearful, wondering if the timing of starting is absolutely right, as there are no definite indicators.

For all these reasons, most programmes require more than one person to be involved in making the decision to support or not.

Respiratory diseases

The clinician will face multiple factors when considering a patient with acute severe respiratory failure. Potential recovery will be obvious in many conditions, such as acute infection (e.g. *Legionella pneumoniae*, H1N1 influenza pneumonia, aspiration) or status asthmaticus.

An underlying respiratory condition may undermine the prospect of recovery, but this is not always easy to predict. A patient with mild emphysema may suffer a bad bout of flu and recover unscathed after a few days, while others might end up condemned to the ventilator for ever.

Co-morbidities, previously existing or newly acquired, will weigh in when deciding whether to go ahead or not. Constant progress and a team daring to challenge current clinical wisdom keep pushing the boundaries of what will be successful.

Too often, the underlying diagnosis is unknown when life or death decisions must be taken, and inevitably some conditions

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that appear to be reversible will prove ineluctable. Plans must be made for the patient, relatives and team to cope with this.

The chosen treatment and support modalities instituted because of or during ECMO may transform a potentially reversible condition into an irreversible one. Examples include mismanagement of mechanical ventilation or incorrect choice of antibiotics.

Reversibility

There is not yet a score that allows prediction with certitude of the recovery of any patient presenting with acute severe respiratory failure.

Patients presenting with acute infective pneumonia will usually recover if appropriate antibiotics and/or antiviral drugs are given early. Similarly, patients with acute severe asthma of allergic origin will recover if the trigger is removed. Patients with acute vasculitis or infiltrative disease of immune origin can recover if the diagnosis is made promptly and treatment given accordingly.

Immunosuppressed patients may not have the ability to fight the cause of the failure, and ECMO will not change the course of the disease. It is incredibly difficult to assess the immune system, and clinicians will be torn between the desire to try to save a life by gaining more time and the risk of potential harm.

Transplant centres are repeatedly reporting reversibility of acute rejection, justifying ECMO in immunosuppressed transplant patients presenting with this condition. This often requires great clinical acumen, as immunosuppression and other treatments have to be continuously adapted in this group of patients, balancing carefully the risk or spread of infection and the containment of rejection.

Patients with human immunodeficiency virus infection presenting with an acute severe respiratory failure should be considered. The CD4 cell count helps to predict outcome, but this is not absolute. However, patients with acquired immunodeficiency disease (AIDS; stage 4 of the disease) will most likely not have the immune reserve to control the pathological process.

Many lung diseases are not reversible, including lung fibrosis, emphysema, cystic fibrosis and chronic obstructive pulmonary disease. However, an acute infection may just be recoverable with the possibility that the patient's condition will return to baseline or slightly worsen after ECMO support. The clinician will have to assess the impact of 'slightly worse' and weigh up the probability of a good outcome versus failure to recover.

Specific considerations

ECMO clinicians are eager to have clearly defined selection criteria. Selection criteria have been used in trials (such as the CESAR trial; see Table 5.1) and are used by many centres, such as the national respiratory ECMO service in England. These criteria are interpreted loosely as clinicians are confronted with previously healthy patients and encouraged by previous results.

Age is no longer recognized as an accurate indicator of outcome, and an index of frailty should be used. A reliable

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Table 5.1 Eligibility of patients with severe acute respiratory failure, as used in the CESAR trial

Inclusion
Reversibility
18–65 years of age
Murray score (see Table 5.2) ≥3
Non-compensated hypercapnia with pH <7.2
Exclusion
Ventilated with fraction of inspired oxygen (FiO_2) >80% or peak airway pressure >30 cmH_2O for more than 7 days
Severe trauma within last 24 h, intracranial bleeding and any other contraindication to limited heparinization
Moribund and any contraindication to continuing active treatment

index of frailty has yet to be published (and is likely to include age but alongside other parameters).

The duration of ventilation is directly linked to the duration of support and outcome, but these vary from disease to disease and depend on co-morbid status. Waking and mobilizing patients on ECMO changes the duration of support and the ability to recover. A patient can be woken up while on ECMO and extubated, or can breathe through a tracheostomy. This allows mobilization and intensive rehabilitation, improving outcome and long-term recovery.

The Murray score gives an indication of disease severity but not necessarily of the chance of survival (Table 5.2).

Patients with cerebral haemorrhage would not have been offered ECMO support a few years ago, and those developing cerebral haemorrhage while on support would have been palliated. This is now challenged, as new veno-venous circuits

Table 5.2 Murray score for acute lung injury

Characteristic	Score
Chest X-ray	
No alveolar consolidation	0
Alveolar consolidation confined to one quadrant	1
Alveolar consolidation confined to two quadrants	2
Alveolar consolidation confined to three quadrants	3
Alveolar consolidation confined to four quadrants	4
Hypoxaemia	
PaO_2/FiO_2 ≥300 mmHg	0
PaO_2/FiO_2 225–299 mmHg	1
PaO_2/FiO_2 175–224 mmHg	2
PaO_2/FiO_2 100–174 mmHg	3
PaO_2/FiO_2 <100 mmHg	4
PEEP	
PEEP ≤5 cmH_2O	0
PEEP 6–8 cmH_2O	1
PEEP 9–11 cmH_2O	2
PEEP 12–14 cmH_2O	3
PEEP ≥15 cmH_2O	4
Respiratory system compliance	
Compliance ≥80 mL/cmH_2O	0
Compliance 60–79 mL/cmH_2O	1
Compliance 40–59 mL/cmH_2O	2
Compliance 20–39 mL/cmH_2O	3
Compliance <19 mL/cmH_2O	4

The total score is attained by dividing the values obtained from the initial analysis by the number of elements used for the analysis. A score of zero indicates no lung injury. PaO_2, partial pressure of O_2 in arterial blood; FiO_2, fraction of inspired oxygen; PEEP, positive end-expiratory pressure.

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can be used for long periods (weeks) without anticoagulation and with minimum trauma to the blood. Many patients with an intracranial bleed have now been supported to full recovery. This extends to other causes of haemorrhage, and ECMO can be used in the trauma patient if the source of bleeding has been controlled.

Frailty

It may be paradoxical to claim that a patient has to be fit enough to survive the major insult leading to acute severe respiratory failure. The patient may indeed not be fit when presenting for ECMO. The physiological reserve will impact on how the patient will sustain the multiple insults linked to both support and treatment.

It is well recognized that modern medicine is increasingly treating older patients who benefit from multiple interventions or adjustments to maintain their health. Drugs given to control blood pressure and heart function may affect renal function but with no direct obvious impact until this finely tuned physiology is disturbed. Severe illness neuropathy or myopathy may lead to so much muscular loss that mobility becomes impaired leading to further problems. Scarring of lung tissue may result in an insufficient functioning lung volume and the inability to recover when the initial disease has been controlled.

Age in itself is not a definite indicator, but it is known that physiological reserve decreases with age. Registries have shown that a prolonged duration of ECMO support is needed

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in older patients, and poorer outcomes are reported for patients older than 65 years.

Patients requiring heavy nursing care in their day-to-day life will be poor candidates as they are unlikely to recover any autonomy. At best, they would return to their previous status, but sadly this is the exception.

The difficulty in assessing frailty, coupled with the progress made in supporting sicker patients, supports the importance of detailed history taking and physical assessment before starting support. The clinician will be eager that all patients who may benefit from ECMO will receive it, but will want to avoid causing unnecessary harm and inappropriate use of resources by commencing ECMO in some patients.

Obesity

Obesity was previously thought to negatively predict survival, but this has been disproven. While challenging for the ECMO team, morbidly obese patients can be supported with success. Limitations in care are usually due to other factors, such as unavailability of adequate transport equipment, the impossibility of entering a CT scanner and complications caused by physical difficulties mobilizing patients when in bed.

Brain injury

Brain injury is not a contraindication to ECMO, as long as recovery is expected.

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Currently, veno-venous ECMO circuits can run for long periods of time without anticoagulation, and many patients with a cerebral haemorrhage have been supported to full recovery.

Duration of ventilation

Mechanical ventilation using positive pressure is detrimental to lung recovery. Studies have repeatedly shown that high-volume, high-pressure ventilation leads to poorer outcomes. The duration effect is well characterized, but one would logically infer that the longer it goes on, the worse it will be. Data also show that starting ECMO at a later stage leads to poorer outcomes.

Many guidelines suggest that patients should have been ventilated for fewer than 10 days to have a chance of recovery. However, they often mitigate such statements by adding that it is acceptable to take on patients ventilated for longer periods but at reasonable volumes and/or pressures.

One approach is to agree that fewer than 7 days of ventilation is acceptable. Any longer periods of time require estimation of the amount of lung that can be saved. This estimation is fraught with difficulties, and there are no defined rules to follow.

Failure of conventional management

It is a widespread misconception that a patient cannot be referred for ECMO before all other methods of conventional ventilation have been attempted. While ECMO carries an

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iatrogenic risk, it can only be beneficial if the patient can still be bridged to recovery or transplant. Delaying referral or commencement of ECMO to attempt another modality is not wise.

The CESAR trial, a randomized controlled ECMO trial in adult respiratory patients, showed that moving the patient to a centre providing ECMO was beneficial (although the study did not show that the survival of patients supported by ECMO was better). Transport of the patient is a difficult and dangerous time, and is better attempted before last ditch treatment has failed.

Irreversibility and lung transplantation

The question of reversibility is a moot point as patients whose lungs do not recover could be bridged to lung transplant. Issues arise immediately when this is evoked, as multiple conditions must be met:

- The patient has to be eligible for lung transplant.
- The patient will compete against other patients on the waiting list, and will need to be prioritized as they are using precious and expensive resources while on ECMO.
- Organ availability means that long waiting times are often expected. This is compounded by the build-up of antibodies if transfused when on ECMO.

Data have shown that the outcomes of patients transplanted from ECMO are worse than those of patients who have been waiting at home. Many now argue that patient care while on

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ECMO has improved since these results were published, and patients awaiting transplant can now be woken up and receive intensive rehabilitation while on ECMO, improving fitness and increasing physiological reserve, in turn improving the chance of surviving the transplant operation.

Some centres have developed strategies by which they offer ECMO support to patients already on the waiting list and progressing to end-stage respiratory failure. Elective commencement of ECMO allows them to wait while awake, exercising and spending time with their family, albeit in the confines of an acute care environment. This concept is intriguing, as one has to be on the waiting list to be accepted, while others who are too fit to even be considered for lung transplantation will not be accepted for ECMO after an acute disease. Ethical dilemma and debate are a constant feature when offering ECMO to patients.

Cardiac diseases

As with respiratory disease, the clinician will face multiple factors when considering a patient with acute severe cardiac failure.

Potential recovery is usually not obvious except in the rare cases of intoxication (such as with β-blockers or calcium antagonists). Patients suffering major intoxication with the drugs listed in Table 5.3 have been successfully bridged to recovery, and it is likely that this can be achieved with other drugs.

Common scenarios of patients requiring ECMO support include: (1) patients with cardiac arrest requiring prolonged

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Table 5.3 Drugs where patients presenting with acute intoxication have been successfully bridged to recovery with ECMO

Flecainide
Tricyclic antidepressants
β-Adrenergic-receptor antagonists
Calcium-channel antagonists
Digoxin
Bupropion

cardiopulmonary resuscitation (CPR) and for whom the cause might be reversible; (2) patients with intractable arrhythmias requiring haemodynamic support while the arrhythmia is treated; (3) patients with an acute mechanical defect that may be amenable to surgery; (4) patients eligible for transplantation or mechanical assist devices when these are not immediately available; (5) patients unable to be weaned from cardiopulmonary bypass or with major cardiogenic shock in the immediate post-operative period; (6) patients with primary graft dysfunction after heart transplantation; and (7) patients with non-determined problems who can be supported by cardiorespiratory support while awaiting a solution.

Similarly to respiratory diseases, co-morbidities, whether previously existing or newly acquired, will impact on the decision to go ahead or not. Constant progress and a team daring to challenge clinical wisdom keep pushing the boundaries of what is successful.

Too often, the underlying diagnosis is unknown when life or death decisions must be taken, and inevitably some conditions

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that appear to be reversible will prove irreversible. Plans must be made for the patient, relatives and team to cope with this.

Reversibility

Cardiac failure justifying mechanical support is rarely recoverable solely with medical management. At best, an intervention is required to correct the cause (e.g. coronary revascularization in the case of acute myocardial infarction) or to repair the failed mechanism (e.g. a ruptured papillary muscle).

Recovery is the ideal outcome and will usually be obvious. However, recovery is not the norm, and even a good heart can be impeded by the ECMO support and associated complications.

Veno-arterial ECMO is not conducive to cardiac recovery. Used in the peripheral configuration (see Chapters 3 and 9), it increases the afterload and may lead to overdistension of the left ventricle. Used in the central configuration, it requires opening of the chest to insert and remove the cannulas and is fraught with problems.

Patients with cardiac failure can be bridged to another device, for either the short or long term. Modern short-term devices use the same pump principles as those used for ECMO, the differences being the absence of an oxygenator and the location of the drainage and return cannulas. Short-term ventricular assist devices are easier to manage and lead to fewer complications than ECMO.

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Long-term devices are now implanted in the body and are designed to allow patients an independent life.

The return of circulation instituted by the use of ECMO does not always mean full recovery for all organs. Noteworthy is cerebral damage caused by a prolonged period of hypoxia or low flow. Brainstem death is unusual and extensive ischaemic insults are more frequent. Prognostication is difficult. When it is accepted that recovery will not happen, organ donation should be considered.

Specifics considerations

ECMO-assisted cardiopulmonary resuscitation

Sudden cardiac arrest is still a major cause of death in developed countries, despite multiple campaigns to raise awareness of the value of immediate CPR.

The main reasons for poor prognosis in cardiac arrests are a lack of return of spontaneous circulation, re-arrest from haemodynamic instability after the return of spontaneous circulation and hypoxic brain injury. This extremely poor prognosis, especially with refractory cardiac arrest, has led to considering ECMO support as an alternative to conventional CPR. This has been named extracorporeal or ECMO-assisted CPR (eCPR).

The first successful use of eCPR was described by Kennedy in 1966 within a case series of eight patients. The survivor was a 45-year-old woman, who fully recovered after being

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supported on ECMO following 45 min of CPR. Due to the absence of randomized controlled trials, available data are limited to observational studies and small case series characterized by a large heterogeneity in the age of the patient, the precipitating cause and the duration of CPR before initiation of ECMO.

The resuscitation guidelines of the American Heart Association published in 2010 gave eCPR a class IIb recommendation if the 'no flow' time was brief and the cause of the cardiac arrest was potentially reversible or amenable to heart transplantation or revascularization.

While the importance of a reversible cause is easily understood, the appropriate duration of CPR before ECMO initiation remains unclear. Thus, eCPR was considered after more than 10 min of CPR in two large in-hospital cardiac arrest case series, whereas CPR duration of more than 20 min or even more than 30 min was considered in out-of-hospital cardiac arrest case series.

In 2008, an observational cohort study described the outcome of 135 in-hospital cardiac arrests of cardiac origin and supported with ECMO (Chen *et al.*, 2008a). Overall, 58% of patients were liberated from ECMO and 34% were alive at hospital discharge. Similarly, the same team reported a short- and long-term benefit of eCPR over conventional CPR.

A 3-year prospective observational study compared eCPR for in-hospital patients undergoing CPR for more than 10 min with patients receiving conventional CPR (Chen *et al.*, 2008b). A total of 59 patients were included in the eCPR group after a median of 40 min of CPR. Patients who underwent eCPR had

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a higher survival rate to discharge and a higher 1-year survival rate. This has also been reported by others, with survival to discharge as high as 41% with an acceptable neurological status in 85% of the patients (Jo *et al.*, 2011).

Interestingly, survival to discharge decreased by about 1% for each 1 min increase in the duration of CPR. The probability of survival was 65, 45 and 19% when the duration of CPR was 10, 30 or 60 min, respectively (Jo *et al.*, 2011).

Details of these and other studies exploring the use of eCPR in hospitals since 2008 are shown in Table 5.4.

This concept has been taken to the out-of-hospital setting, but data from clinical studies are scarce and limited to small case series or case reports, as shown in Table 5.5. Overall survival in these patients is low, with case series reporting between 4 and 36% survival with a favourable neurological outcome noted in 4–27%. Propensity analysis (matching like for like in observational cohorts) has shown that there might be a benefit of using eCPR in this population who are at very high risk of death.

Intractable arrhythmias

Recurrent ventricular fibrillation, ventricular tachycardia and other malignant rhythms are accepted indications for the institution of ECMO.

ECMO will provide adequate support to other organs and allow perfusion of the myocardium if the coronary arteries are patent and the myocardium not distended. Pharmacological or electrical cardioversion are more likely to be successful when the patient is supported with ECMO.

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Table 5.4 Main studies in adults on eCPR in in-hospital cardiac arrest patients since 2008

Reference	Study design	Study year	Country	No. of patients	Mean age (years)	Mean CPR duration (min)	No. (%) weaned from ECMO	Hospital discharge survival (survivors/ total no. of patient (%))	Favourable neurological outcome in survivors (number/no. of patients (%))
Chen *et al.* (2008a)	Retrospective	–	Taiwan	135	54	56	79/135 (59%)	46/135 (34%)	NA
Chen *et al.* (2008b)	Prospective	2004–6	Taiwan	59	57	53	29/59 (49%)	17/59 (29%)	9/59 (15%)
Jo *et al.* (2011)	Retrospective	2004–7	South Korea	83	58	37	48/83 (58%)	34/83 (41%)	29/83 (35%)
Shin *et al.* (2011)	Retrospective	2003–9	South Korea	85	60	42	NA	29/85 (34%)	24/85 (28%)
Avalli *et al.* (2012)	Retrospective	2006–11	Italy	24	67	55	14/24 (58%)	11/24 (46%)	9/24 (38%)
Kagawa *et al.* (2012)	Retrospective	2004–11	Japan	61	69	33	36/61 (59%)	22/61 (36%)	20/61 (33%)

NA, not available.

Table 5.5 Main adult studies on eCPR in out-of-hospital cardiac arrest since 2011

Reference	Study design	Study year	Country	Number of patients	Mean age	Mean CPR duration (min)	Weaned from ECMO	Hospital discharge survival (survivor/total patient number) (%)	Favourable neurological outcome in survivors (number/survivor) (%)
Ferrari *et al.* (2011)	Retrospective	2007–8	Germany	22	55	49	8/22 (36%)	8/22 (36%)	8/22 (36%)
Mégarbane *et al.* (2011)	Retrospective	2005–8	France	66	46	155	1/66 (2%)	1/66 (2%)	1/66 (2%)
Le Guen *et al.* (2011)	Prospective	2008–10	France	51	42	120	2/51 (4%)	2/51 (4%)	2/51 (4%)
Avalli *et al.* (2012)	Retrospective	2006–11	Italy	18	46	77	3/18 (17%)	1/18 (6%)	1/18 (6%)
Kagawa *et al.* (2012)	Retrospective	2004–11	Japan	25	56	65	7/25 (28%)	3/25 (12%)	1/25 (4%)
Maekawa *et al.* (2013)	Prospective	2000–4	Japan	53	54	49	NA	17/53 (32%)	8/53 (15%)

NA, not available

Preventing overdistension of the heart during ECMO is discussed briefly in Chapter 9.

Acute mechanical defect

Patients who present with an acute mechanical defect may be too unwell to survive to surgery. A common example is the patient presenting with an acute papillary muscle rupture during an acute inferior myocardial infarction. Prompt institution of ECMO will allow the patient to receive coronary revascularization in the angiography suite (if appropriate) and then be moved to the operating theatre for the mechanical defect to be fixed.

In these situations, starting ECMO in the peripheral veno-arterial configuration (see Chapter 9) is an immediate life-saving measure. In theatre, the circuit can be converted to a central veno-arterial configuration that can be continued for a few hours or days post-operatively to allow recovery of the stunned heart.

Bridge to heart transplantation or mechanical assist devices

Patients eligible for transplantation or a mechanical device may present with pump failure and organ dysfunction precluding progression to the definitive treatment or support. ECMO will buy time in these conditions, allowing rapid stabilization and optimization of all organs. ECMO is not the best support for the medium to long term, and we advocate using ECMO only for a short period of time. Blood trauma

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(platelet consumption and overall transfusion requirements) and risk of mechanical complications are greater while on ECMO. The balance of risk to benefit is difficult to gauge and will require discussion between ECMO and transplant physicians and cardiothoracic surgeons. As a rule of thumb, it is surprising when a patient remains on peripheral veno-arterial ECMO for more than 2 weeks without suffering any complications that may be prevented by an early switch to a ventricular assist device. Centre experience in both ECMO and ventricular assistance often influences the decisions. Surgeons may be reluctant to open a chest that is still intact when considering subsequent transplantation and may prefer to prolong the period on veno-arterial ECMO in the hope that a suitable heart may become available. Physicians will be concerned with the recurring transfusion that may increase the titre of human leukocyte antigen (HLA) and other antibodies.

Unable to wean from cardiopulmonary bypass

Patients unable to be weaned from cardiopulmonary bypass are overall poor candidates as they are unlikely to be able to be bridged to a next stage. However, this is not always the case and some may recover (stunned myocardium) or be eligible for transplant or permanent mechanical devices.

The difficulty in these situations is to separate those patients likely to survive from those for whom ECMO will only mean a few more hours or days in intensive care. Clinical judgement is often paramount, and decisions are best made by several

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clinicians rather than a lone operator. The operating surgeon will invariably be keen to embark on ECMO, subconsciously avoiding a death in the operating room.

If ECMO is considered in such circumstances, it is better to initiate it early rather than inflict multiple insults to the patient's other systems by allowing several episodes of poor perfusion. The institution of ECMO will compound post-operative bleeding, and such patients may end up being stabilized in intensive care with an open chest with surgical packs remaining *in situ* for a few days. A balance between proper haemostasis and thrombus formation needs to be achieved. The most likely location of a thrombus is in the cardiac cavities rather than the ECMO circuit. Anticoagulation will be recommenced at the earliest opportunity. Continuous cardiac ejection should be maintained to prevent blood stasis in the cardiac chambers, as this could cause thrombus formation. Judicious use of inotropes and optimization of ventricular filling are required. Venting of cardiac chambers might be needed to avoid the blood stagnating.

When committed to ECMO, a plan should be agreed and shared with the rest of the team. The patient's next of kin must be prepared for the possibility of failure to recover. Weaning is likely to be difficult (see Chapter 11).

Pulmonary embolism

Pulmonary embolism inspired Gibbon to develop the cardiopulmonary bypass circuit. By maintaining perfusion, allowing gas exchange and avoiding distension of the right ventricle, ECMO was perceived as an ideal tool. This was reinforced by the need to anticoagulant aggressively, an appropriate treatment for pulmonary embolism.

ECMO can still be used in the context of an acute pulmonary embolism that has not resolved. It is, however, an exceptional indication, as many will now be treated by medical therapy (anticoagulation) or less frequently by surgery (Trendelenburg operation).

Successes have been reported in patients suffering from chronic thromboembolic hypertension presenting with superimposed pulmonary embolisms. ECMO can be used in these patients as a bridge to curative operation if their pulmonary disease is amenable to a pulmonary endarterectomy. ECMO can stabilize the patient and allow transportation to a specialist centre.

Other problems requiring cardiopulmonary support

It can be argued that any condition requiring temporary cardiopulmonary support is suitable for ECMO.

ECMO is being used as a mini-cardiopulmonary bypass by some. The main difference with a cardiopulmonary bypass circuit is the absence of a blood reservoir. This has the benefit of removing the blood contact with air, which leads to activation of the inflammatory response. However, it removes the possibility of dissociating drainage from return (allowing the perfusionist to affect the pre- or afterload independently,

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by specifically adjusting separately the blood drained from or returned to the patient). One disadvantage of using an ECMO circuit as a cardiopulmonary bypass is that air entering the circuit cannot easily be evacuated.

Bridge to organ donation

Starting a patient on ECMO to support the cardiac function ensures optimal perfusion of organs. In the case of irreversible damage to some part of the body leading to survival being impossible, some organs will remain intact for longer. These are then suitable for transplantation.

This is often a very difficult topic for all concerned, but some will find solace when this becomes the outcome of unsuccessful interventions.

ECMO is used by some in deceased patients to maintain organ homeostasis during harvesting. It is used to optimize organ function and render the organs suitable for donation.

Other indications

Accidental hypothermia

Profound accidental hypothermia is a particular case. Survival with no or minor neurological impairment after profound accidental hypothermia is possible even when a number of hours of CPR is required before the initiation

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of extracorporeal rewarming. Recent guidelines from the International Commission for Mountain Emergency Medicine recommend that in the absence of an alternative cause of death, such as trauma or hypoxia, all patients with hypothermia who do not have vital signs should be considered for CPR. The use of CPR is recommended until extracorporeal rewarming is complete, regardless of the duration of CPR. However, the termination of CPR should be considered when the potassium level is higher than 12 mmol L^{-1}. Neurological recovery from profound hypothermia has been reported after several hours (1–5 h) of eCPR.

Drug intoxication

Because cardiotoxicity induced by a drug overdose could quickly recover after toxic epuration, refractory cardiac arrest and severe shock unresponsive to conventional therapies of poisoned patients may benefit from ECMO. Although data on ECMO use in poisoned patients are scarce, a few case reports have been published, detailing the successful use of ECMO in patients poisoned with various drugs (Table 5.3)

Miscellaneous

Patients presenting with liver failure may go into circulatory shock and support with veno-arterial ECMO has been reported as beneficial in several cases.

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Veno-arterial ECMO can help support patients with acute airway obstruction leading to cardiopulmonary instability. Patients with acute bronchial haemorrhage or tracheal tears may need acute resuscitation. Veno-arterial ECMO might be instituted to restore circulation and ventilation, allowing the initial insult to be treated.

When not to use ECMO

ECMO should not be used when there is no treatment available to reverse the current condition. ECMO has inherent risks and patients may end up suffering more as a consequence of the institution of support.

ECMO prediction scores

Physiological scoring systems are developed to assist clinicians in estimating the likely outcome of patients supported with ECMO.

The SAVE (http://www.save-score.com) and RESP (http://www.respscore.com) scores are online calculators that allow calculation of estimated survival. One of the limitations of these scores is the small number of patients used to construct them. These scores do not usually account for those patients considered for ECMO support but declined by experienced clinicians because they are either too well or because ECMO support is considered futile.

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Key points

- ECMO provides support and not treatment.
- ECMO can be used in any patient, but not all patients will benefit from ECMO.
- Selection of the right patient is crucial or patients will be harmed and resources wasted.

TO LEARN MORE

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