

A horizontal band of a grid of small blue squares, with the density of the squares increasing towards the center.

Acute heart failure: ECMO

Cardiology & Vascular Medicine **2012**

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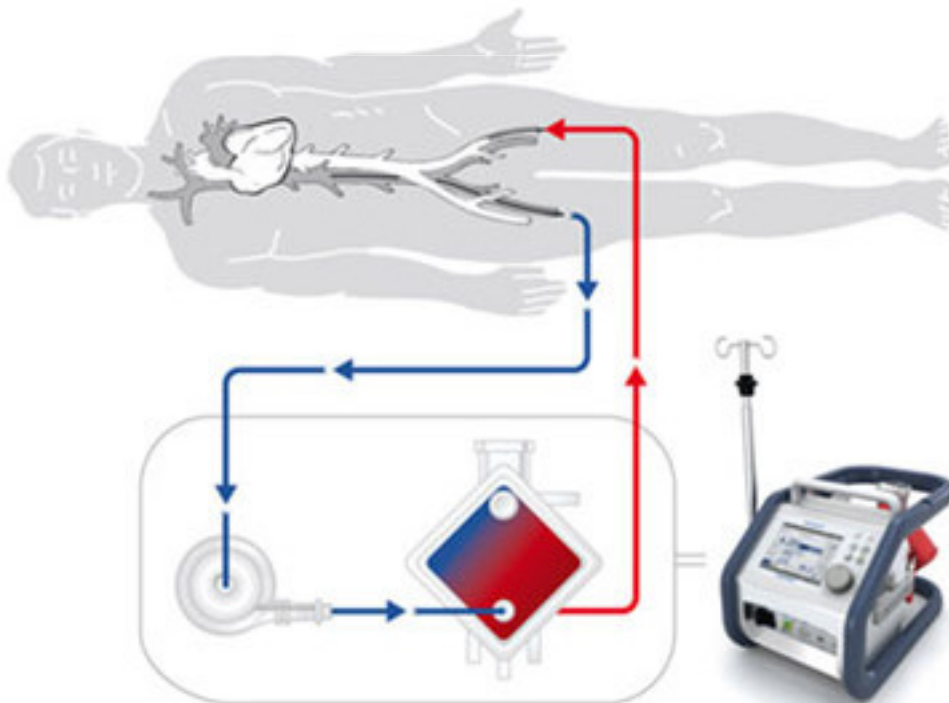
- 14 beds/8 ICU beds
- Acute coronary syndromes
- Heart failure/ Cardiogenic shock
- Post cardiotomy
- Heart transplantation
- IABP/ECMO/LVAD
- Post-procedure observation percutaneous valves

Intensive Cardiac Care Unit (ICCU)

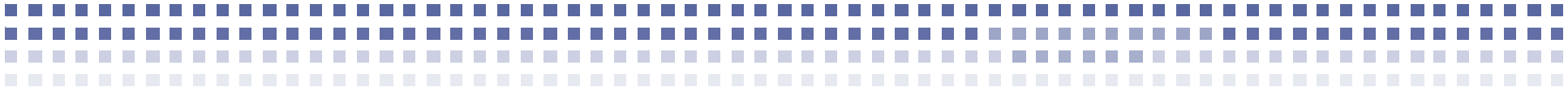



ECMO

Extra Corporeal Membrane Oxygenation



Q 1 : ECMO (extracorporeal membrane oxygenation)

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1. ECMO is available in my center and I have clinical experience with managing ECMO patients
 2. ECMO is available in my center but I am not directly involved in the program
 3. I have heard about ECMO; I am not familiar with this therapy and its clinical applicability
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Case

- Female 59 years old
- No medical history
- Referred from regional hospital with sub-acute myocardial infarction complicated by cardiogenic shock and third-degree AV block

ECG

HR 111 bpm BP -1/-2
QRS-P-T-axes 103 -52 -67
QRS 192 ms P 80 ms
PR 220 ms QT 380 ms QTc 469 ms

Notes
Routine ECG

Phys. Sign:
Referred by:
Nurse/Tech:



Case

- PCI left anterior descending artery: trombus aspiration and stenting (Promus DES 3.0x20 mm). RCA occluded with collateral flow from the left anterior descending artery. Stenotic lesion ramus circumflexus
- Treated with temporary pacing lead, intra-aortic balloon pump and high dose inotropics
- Transferred to ward after 1 week; ACE-inhibitor, diuretics and eplerenone

Case

- CK peak 5100 U/l, CK-MB peak 250 µg/l
- Weaned from IABP, inotropics and mechanical ventilation
- Echocardiography (TTE): Poor LV function
- Transferred to ward after 1 week; ACE-inhibitor, diuretics and eplerenone

Case

- DDD-ICD implanted
- Several shocks >> ventricular arrhythmias
- Medication: ACE-inhibitor, Eplerenone, beta-blocker, diuretics, statines, ASA, prasugrel



Reflections: what to do?

1. detection ischemia
 2. increase dose beta blocker and/or add amiodarone
 3. adjust ICD settings
- 

Case

- MIBI scan: large defect apex, septum, anterior- and inferior wall, no ischemia
- FDG-PET scan: no hibernation myocard
- Increased beta blocker dosage
- Amiodarone added
- ICD settings adjusted

Case

- Despite all this : electrical storm with hemodynamic instability
- Admitted into ICCU
- Amiodarone iv, Lidocaine iv, optimized electrolytes, anxiolytica, vasopressor, inotropics
- Remained unstable →→ eventually sedated, intubated and put on mechanical ventilation

Case

- Less arrhythmias, not event free
- Hypotensive (systolic blood pressure 90 mmHg) despite vasopressors and low dose inotropics
- Oliguria (< 35 mL/h), creatinin 144 $\mu\text{mol/L}$
- Signs of tissue hypoperfusion (cold peripheries)
- Lactate 1.7 mmol/l

Q 2: what would be the next step?

1. Further adjustments of inotropics and anti-arrhythmics
2. place an intra-aortic balloon pump
3. no adjustments

Case

- adjustments in medication did not improve hemodynamics
- intra-aortic balloonpump was placed

Goal of treatment reached?



dreamstime.com

Q 4 : What do the guidelines say?

Which are immediate goals of treatment in acute heart failure?

1. restore oxygenation, improve hemodynamics and organ perfusion
2. limit cardiac and renal damage
3. prevent thrombo-emboli and minimize ICU length of stay
4. all of the above

Table 22 Goals of treatment in acute heart failure


Immediate (ED/ICU/CCU)
• Treat symptoms
• Restore oxygenation
• Improve haemodynamics and organ perfusion
• Limit cardiac and renal damage
• Prevent thrombo-embolism
• Minimize ICU length of stay
Intermediate (in hospital)
• Stabilize patient and optimize treatment strategy
• Initiate and up-titrate disease-modifying pharmacological therapy
• Consider device therapy in appropriate patients
• Identify aetiology and relevant co-morbidities
Pre-discharge and long-term management
• Plan follow-up strategy
• Enrol in disease management programme, educate, and initiate appropriate lifestyle adjustments
• Plan to up-titrate/optimize dose of disease-modifying drugs
• Ensure assessed for appropriate device therapy
• Prevent early readmission
• Improve symptoms, quality of life, and survival

CCU = coronary care unit; ED = emergency department; ICU = intensive care unit.

*ESC guidelines acute and
chronic heart failure
Eur Heart J. 2012 May 19*



How is the patient doing?

- Arrhythmias
 - Sustained hypotension (systolic blood pressure < 90 mmHg) despite vasopressors and low dose inotropics
 - Oliguria (< 35 mL/h)
 - Signs of tissue hypoperfusion (cold peripheries)
- 

Q 5: what do the guidelines say?

In patients remaining severely hypoperfused despite inotropic therapy and with a potentially reversible cause short-term mechanical circulatory support:

1. is recommended (Class I)
2. should be considered (Class II a)
3. may be considered (Class II b)
4. is not recommended (Class III)
5. ECMO is not considered to be short-term mechanical support

Patients with hypotension, hypoperfusion or shock

Electrical cardioversion is recommended if an atrial or ventricular arrhythmia is thought to be contributing to the patient's haemodynamic compromise in order to restore sinus rhythm and improve the patient's clinical condition.

I

C

-

An i.v. infusion of an inotrope (e.g. dobutamine) should be considered in patients with hypotension (systolic blood pressure <85 mmHg) and/or hypoperfusion to increase cardiac output, increase blood pressure, and improve peripheral perfusion. The ECG should be monitored continuously because inotropic agents can cause arrhythmias and myocardial ischaemia.

IIa

C

-

Short-term mechanical circulatory support should be considered (as a 'bridge to recovery') in patients remaining severely hypoperfused despite inotropic therapy and with a potentially reversible cause (e.g. viral myocarditis) or a potentially surgically correctable cause (e.g. acute interventricular septal rupture).

IIa

C

-

An i.v. infusion of levosimendan (or a phosphodiesterase inhibitor) may be considered to reverse the effect of beta-blockade if beta-blockade is thought to be contributing to hypoperfusion. The ECG should be monitored continuously because inotropic agents can cause arrhythmias and myocardial ischaemia, and, as these agents are also vasodilators, blood pressure should be monitored carefully.

IIb

C

-

A vasopressor (e.g. dopamine or norepinephrine) may be considered in patients who have cardiogenic shock, despite treatment with an inotrope, to increase blood pressure and vital organ perfusion. The ECG should be monitored as these agents can cause arrhythmias and/or myocardial ischaemia. Intra-arterial blood pressure measurement should be considered.

IIb

C

-

Short-term mechanical circulatory support may be considered (as a 'bridge to decision') in patients deteriorating rapidly before a full diagnostic and clinical evaluation can be made.

IIb

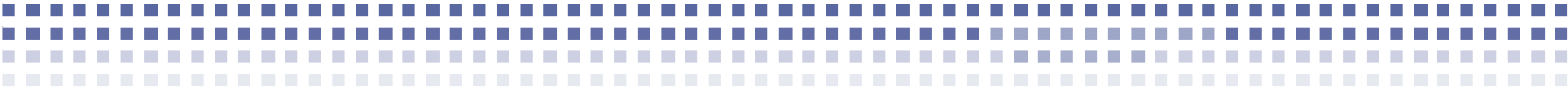

C

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Mechanical circulatory support

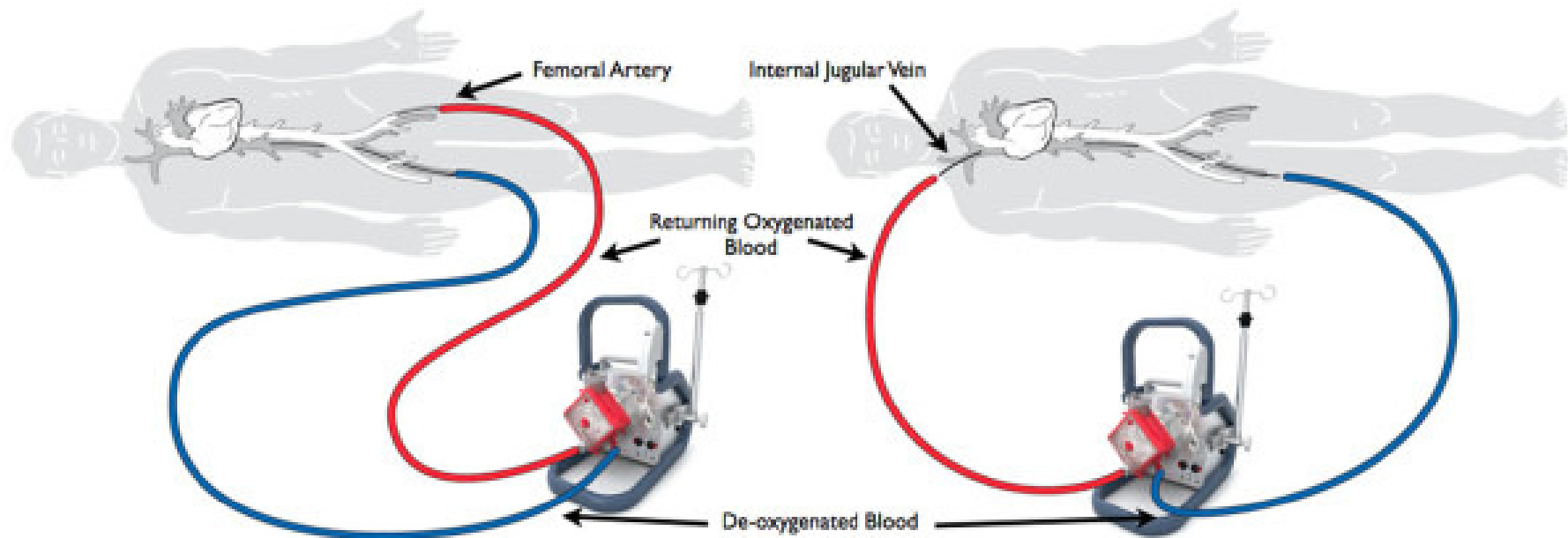
- intra-aortic ballonpump
 - Ventricular assist devices
 - percutaneous (Tandem Heart, Impella)
 - surgical: LVAD, RVAD, BIVAD (Centrimag, Biomedicus, Medos, Heartmate)
 - ECMO
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- ECMO is a modification of the cardiopulmonary bypass circuit which is used routinely in cardiac surgery
 - It is used as temporary support, usually awaiting recovery of organs
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Dynamics of ECMO

VA-ECMO

VV-ECMO



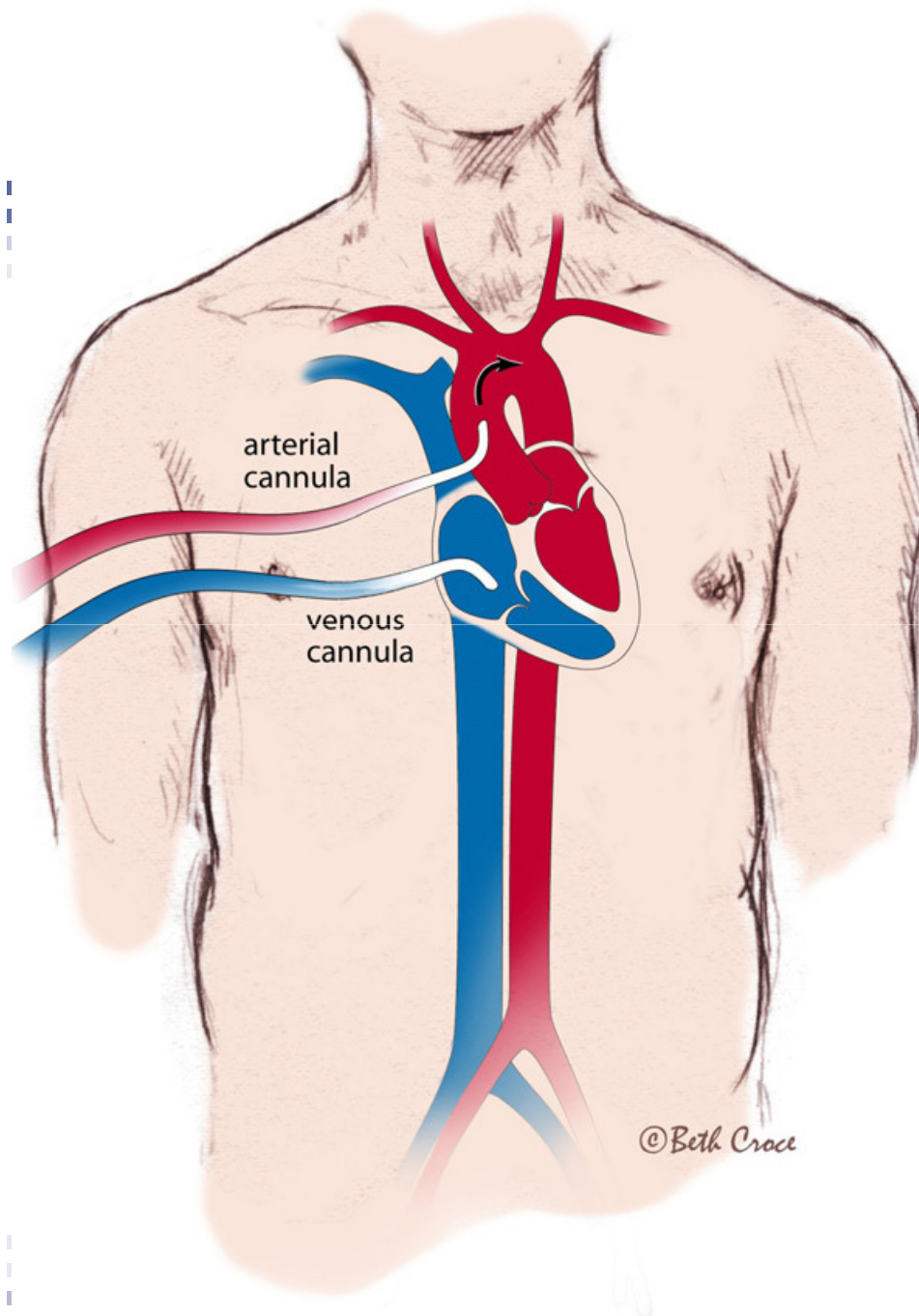
Indications for ECMO

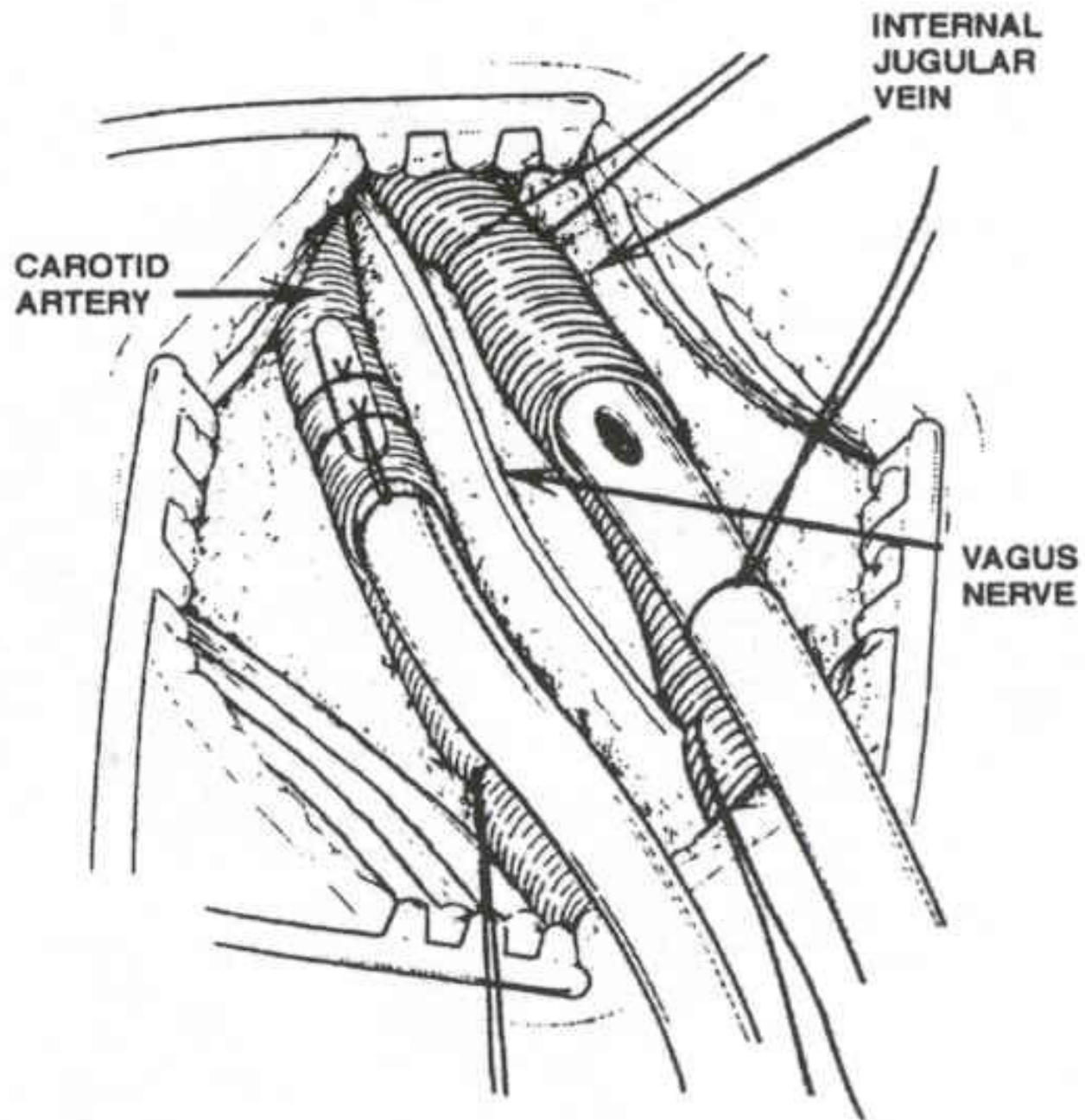
- Divided into two type
 - Cardiac Failure
 - Respiratory Failure

Veno-arterial (VA) configuration

- Blood being drained from the venous system and returned to the arterial system
- Provides both cardiac and respiratory support
- Achieved by either peripheral or central cannulation

Central





Peripheral

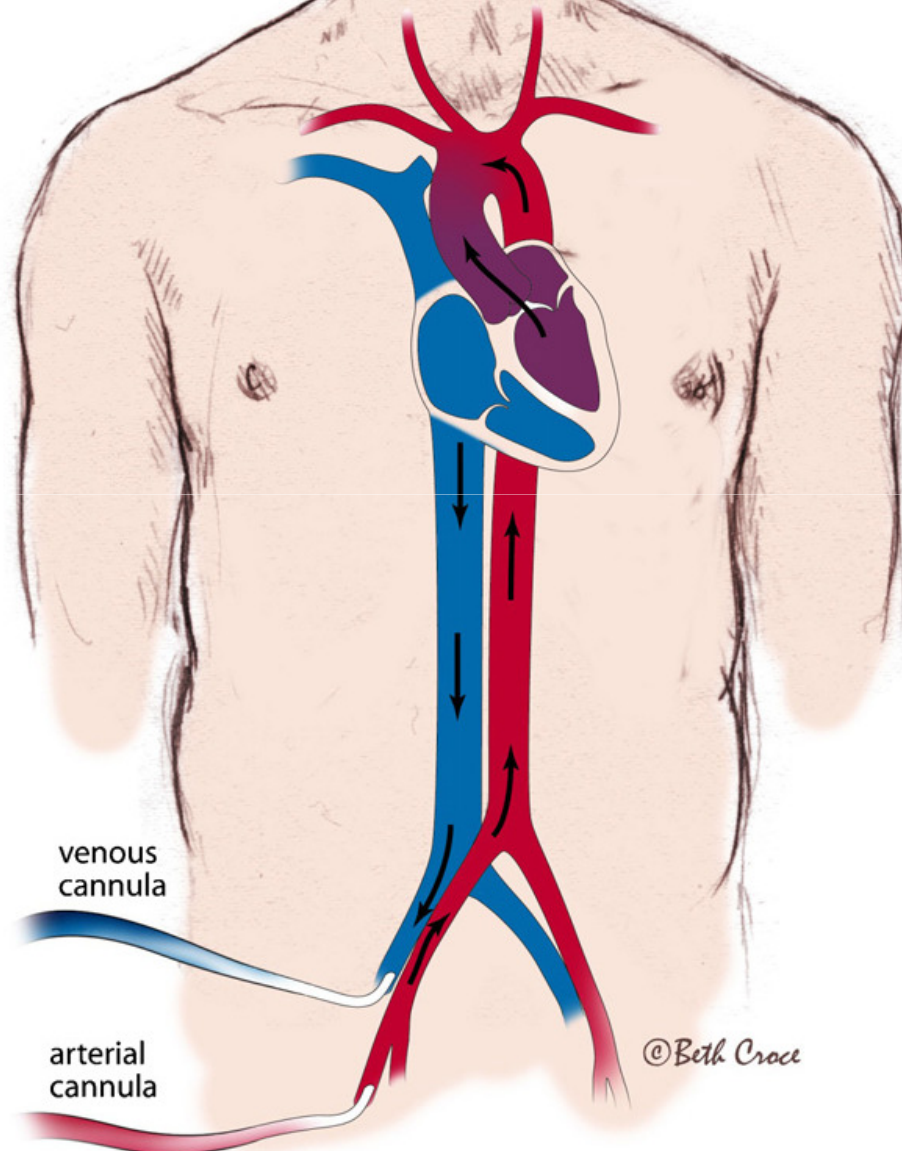


Figure 1

Basic ECMO Circuit

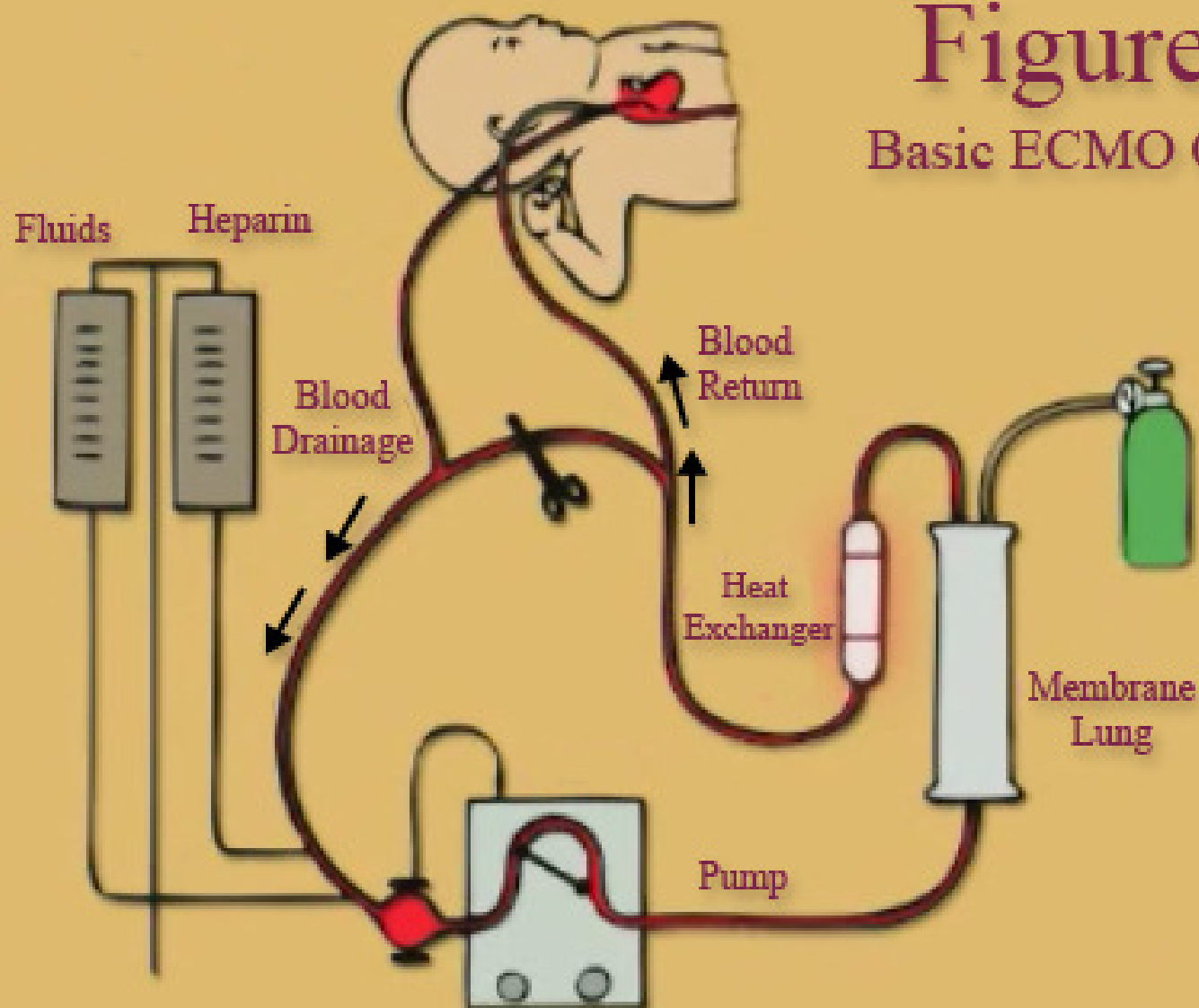
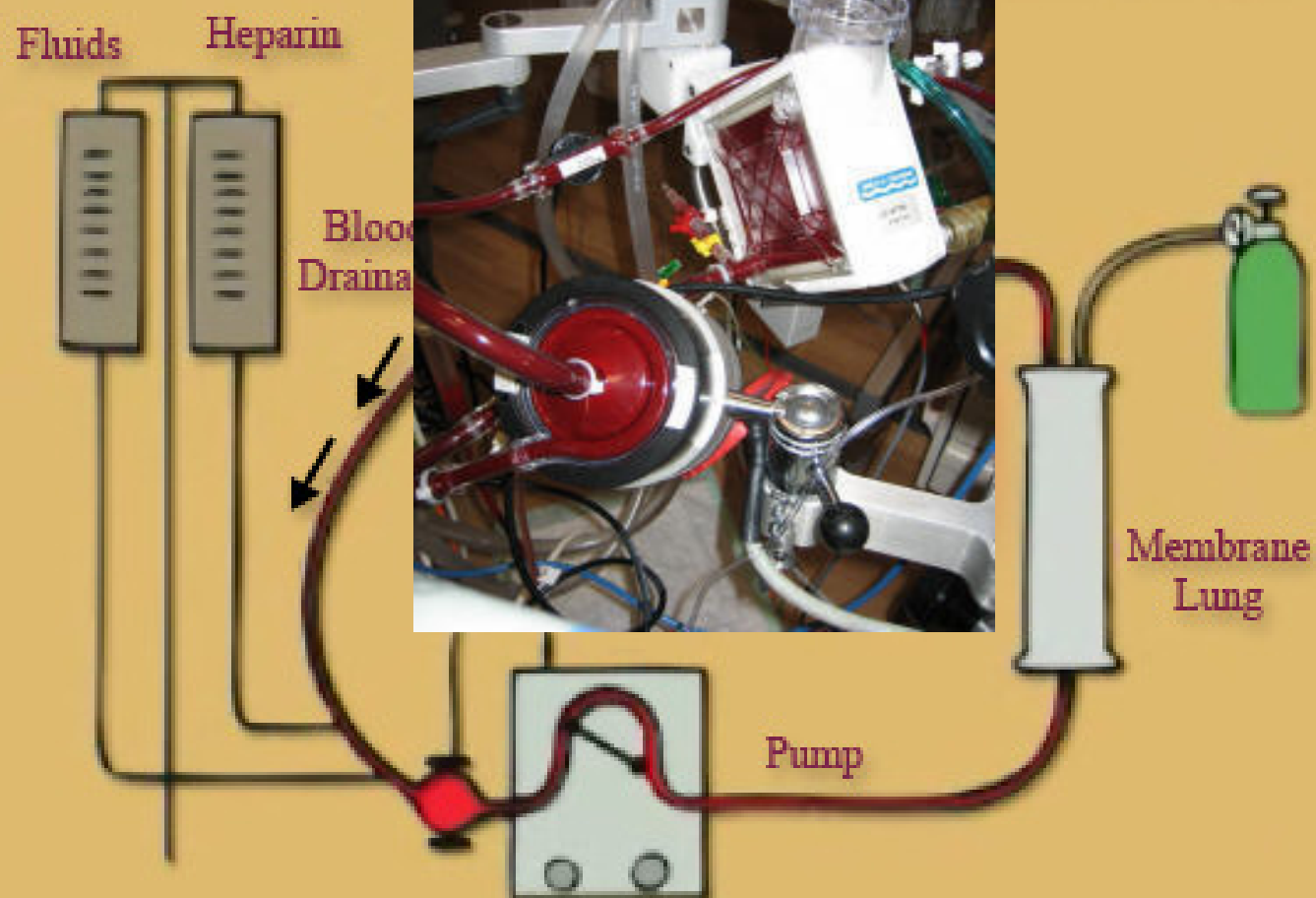


Figure 1
Basic ECMO Circuit



Things to Think About

- Mechanical ventilation must be continued during ECMO support
- ECMO flow can be very volume dependent

Weaning of ECMO – VA ECMO

Depends on cardiac recovery

- Echo: improvement LV function
- Increasing blood pressure
- Return or increasing pulsatility on the arterial pressure waveform

Complications

Falls into one of three major categories

- 1) Bleeding/Hemolysis
- 2) Mechanical failure
- 3) Neurologic events

Decision to place ECMO

Several considerations must be weighed:

Likelihood of organ recovery

Advanced age

Malignancy

Graft vs. host disease

Known severe brain injury

Unwitnessed cardiac arrest or cardiac arrest of prolonged duration.

Q 5 : use of mechanical circulatory support



In this patient ECMO can be used as a:

1. bridge to decision
 2. bridge to transplant
 3. bridge to recovery
 4. destination therapy
- 

Table 24 Terms describing various uses of mechanical circulatory support (MCS)

Bridge to decision (BTD):	Use of MCS in patients with drug-refractory acute circulatory collapse and at immediate risk of death to sustain life until a full clinical evaluation can be completed and additional therapeutic options can be evaluated.
Bridge to candidacy (BTC):	Use of MCS to improve end-organ function in order to make an ineligible patient eligible for transplantation.
Bridge to transplantation (BTT):	Use of MCS to keep a patient at high risk of death before transplantation alive until a donor organ becomes available.
Bridge to recovery (BTR):	Use of MCS to keep patient alive until intrinsic cardiac function recovers sufficiently to remove MCS.
Destination therapy (DT):	Long-term use of MCS as an alternative to transplantation in patients with end-stage heart failure ineligible for transplantation.

MCS = mechanical circulatory support.

INTERMACS profiles of advanced heart failure.

ADULT PROFILES	Current CMS - DT Functional Indication	IV INO*	Official Shorthand	NYHA CLASS Assumed	Modifier option
INTERMACS LEVEL 1	Met	X	"Crash and burn"	IV	TCS A
INTERMACS LEVEL 2	Met	X	"Sliding fast" on inotropes	IV	TCS A
INTERMACS LEVEL 3	Met	X	"Stable" continuous inotrope dependent * Can be in hospital or at home	IV	TCA if hosp FF if home A
INTERMACS LEVEL 4	+ Peak $VO_2 \leq 12$		<u>Resting symptoms</u> on oral therapy at home	AMB IV	FF A
INTERMACS LEVEL 5	+ Peak $VO_2 \leq 12$		"Housebound", Comfortable at rest, symptoms with minimum activity ADL	AMB IV	FF A
INTERMACS LEVEL 6			"Walking wounded"-ADL possible but meaningful activity limited	IIIB	FF A
INTERMACS LEVEL 7			Advanced Class III	III	A only

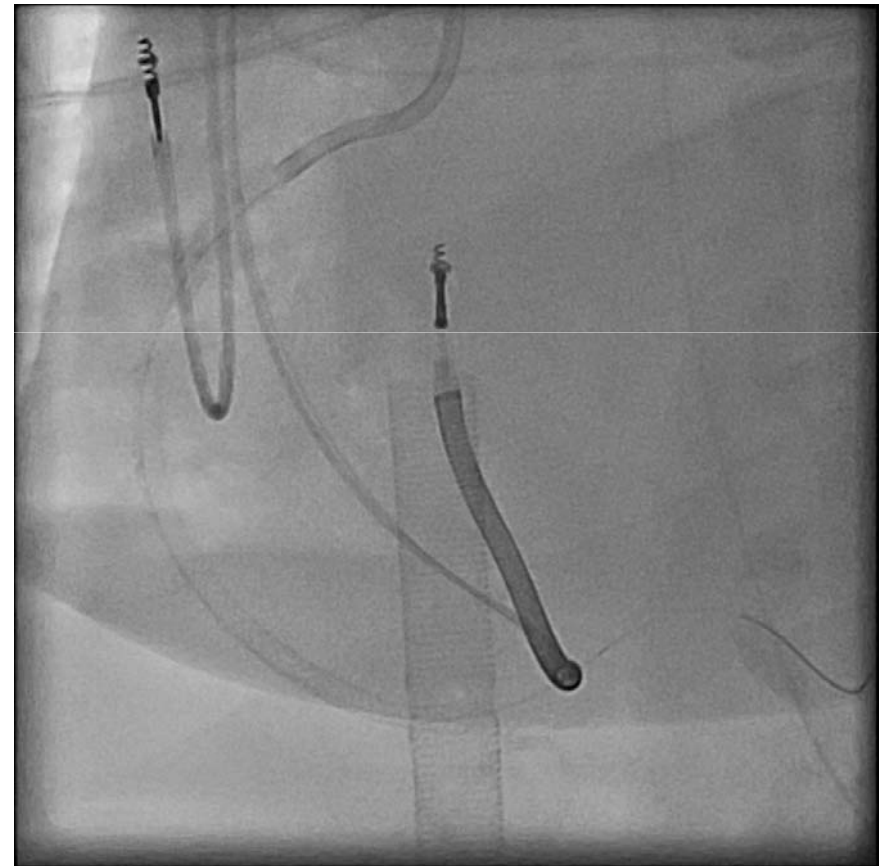
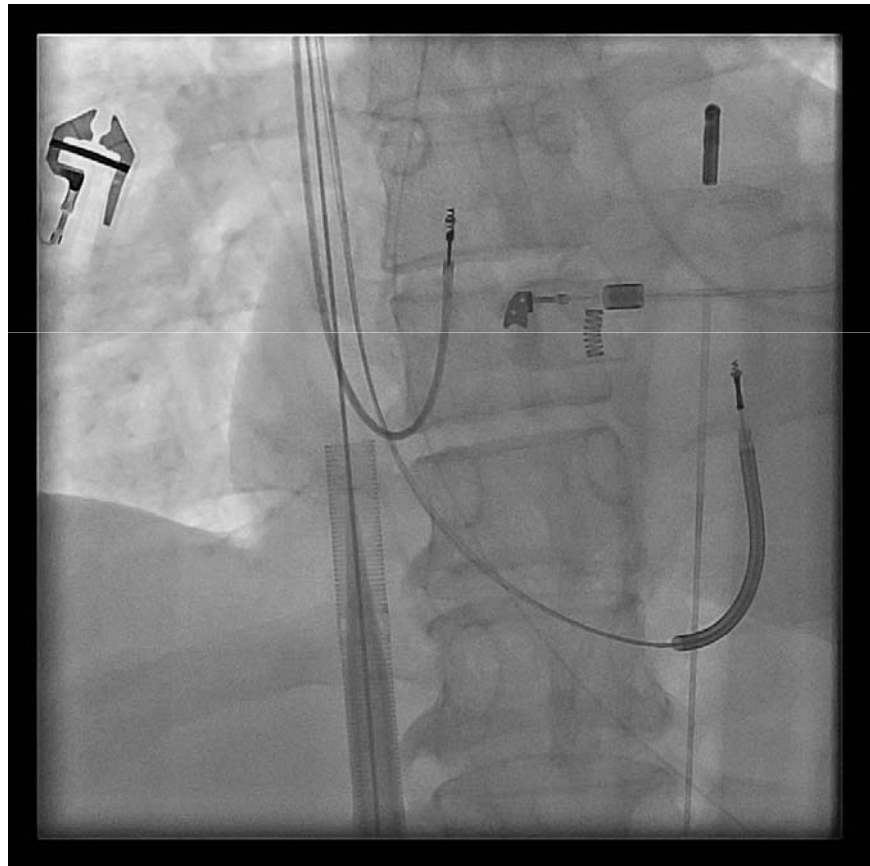
* Intravenous inotropic therapy only approved for refractory Class IV symptoms

Stewart G C , Stevenson L W Circulation 2011;123:1559-1568

Placement VA ECMO in cathlab



Angio



Case

Bridged to LVAD/ 4 days on ECMO

Discharged from hospital two months after initial admittance



Q 6 : survival following cardiac ECMO (adults) till hospital discharge

1. 54%

2. 44%

3. 34%

4. 24%

Table 1.

SURVIVAL AFTER ECMO

ECMO Indication	Number of ECMO Uses	Survival to Hospital Discharge
Neonatal (<30 days)		
Respiratory	23,558	75%
Cardiac	3,909	39%
ECPR	537	38%
Pediatric (30 days – 16 years)		
Respiratory	4,376	56%
Cardiac	4,776	47%
ECPR	1,003	39%
Adult (>16 years)		
Respiratory	1,860	52%
Cardiac	1,131	34%
ECPR,	408	27%

*ECMO, extracorporeal membrane oxygenation; ECPR, extracorporeal membrane oxygenation with cardiopulmonary resuscitation. Reprinted, with permission, from the 2011 International Report of the Extracorporeal Life Support Organization's Data Registry.¹³

Table 3. Evidence supporting extracorporeal membrane oxygenation use in cardiogenic shock complicating an acute myocardial infarction

Study	Patients	Survival rate ^a	Cardiogenic shock etiology
Golding <i>et al.</i> [42] (1992)	91	25.3%	Post-CABG ^b
Muehrcke <i>et al.</i> [43] (1996)	23	30.4%	Post-CABG ^b
Magovern <i>et al.</i> [44] (1999)	27	85%	UA or CHF
Formica <i>et al.</i> [39] (2008)	18	27.8%	AMI/Post-CABG
Combes <i>et al.</i> [38] (2008)	16	31.3%	AMI
ELSO [33] (2009)	153 ^c	39%	Not defined

^aSurvival to hospital discharge. ^bPostcardiotomy patients who were unable to wean off bypass or developed postoperative cardiogenic shock. ^cNumber of extracorporeal membrane oxygenation runs. AMI, acute myocardial infarction; CABG, coronary artery bypass graft; CHF, congestive heart failure; ELSO, Extracorporeal Life Support Organization; UA, unstable angina.

Present clinical use of ECMO

- Post-cardiotomy
- Post-heart transplant
- Myocarditis
- PCI -assist
- Acute coronary syndrome with cardiogenic shock?
- Profound cardiac depression due to drug overdose or sepsis?