Nobody deserves to be dead without having a ventricular assistance!?

EXTRA-CORPOREAL LIFE SUPPORT
(EXTRA-CORPOREAL MEMBRANE OXYGENATION)

Mustafa CIKIRIKCIIOGLU, MD, PhD, FETCS
Staff Cardiovascular Surgeon (Chef de Clinique FMH)

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No conflict of interests
First Patient-

- 22 years old, female patient
- Application to your emergency department with the symptoms of common cold and gastro-enteritis
- She does not have a specific medical history
- Medical examination- Low blood pressure which did not respond to fluid transfusion
- Deterioration in the general status- confusion- transfer to ICU
- TTE- Biventricular heart failure with LV EF 20%
- Full hemodynamic monitorisation and inotropic treatment- No recovery
- + IABP- No recovery
- Next ???
Second Patient-

- 45 years old, male patient
- Application to the emergency department with the chest pain and after having a cardiac arrest, recovery after short CPR
- Medical history: Myocardial infarction, coronary stenting on LAD and RCA
- Diagnosis: Acute anteroseptal infarction
- Transfer to cath lab – Triple vessel disease, failure for percutaneous dilatation
- Cardiogenic shock not responding to inotropic treatment and IABP
- Transfer to operating room, triple bypass with saphenous veins
- Weaning failure from CPB
- Next ??
Acute heart failure - Cardiogenic shock

- **Acute myocardial infarction**
  - Irreversibly damaged of the myocardium (> 40 %)
    - Particularly the anterior cardiac wall
    - Inferior wall infarction - preload failure, arrhythmia
  - Free wall rupture
  - Papillary muscle rupture
  - Post-MI VSD

- **Post-pump failure**
  (weaning failure from cardiopulmonary bypass)

- **Acute fulminant myocarditis**

- **Post- tx allograft failure**
• 138 patients with acute myocardial infarction complicated by cardiogenic shock during a 6-year period at the Cleveland Clinic

• In-hospital mortality
  – 81 % for the patients supported only with medical treatment and IABP
  – 54 % for the patients undergoing early revascularization
  – 33 % for the patients supported by extracorporeal membrane oxygenation or LVAD and after transplantated
Improved Survival After Acute Myocardial Infarction Complicated by Cardiogenic Shock With Circulatory Support and Transplantation: Comparing Aggressive Intervention With Conservative Treatment

Wakkas Tayara, MD,a Randall C. Starling, MD, MPH,b Mohamad H. Yamani, MD,b Oussama Wazni, MD,b Fuad Jubran, MD,b and Nicholas Smedira, MDc

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![Graph showing survival over months with ECMO/LVAD/OHT and PCI/CABG compared]
Ventricular assist device:

Not to early, not to late!

Sword of Democles

Richard Westall (1765-1836)
Circulatory assist system: When?

– Correction of all metabolic problems
– On maximal medical and IABP support
  • Two or more and high dosage inotropic support
– Complete and adequate surgical procedure

  • Cardiac index < 1.8 L/min/m2
  • Systolic BP < 80 mmHg
  • SVR >2000 dyn.sn.cm$^{-5}$
  • LAP or PAWP > 20 mmHg
  • Urine output < 20 mL/h
  • Mixed venous oxygen saturation < 55 %
Circulatory assist system

When?

Benefits
- Bridge to thinking
- Bridge to recovery
- Bridge to heart tx
- Bridge to bridge
- Protection of end organ functions

Risks
- Surgical complications
- Device related complications
  - Hemorrhagic
  - Thrombo-embolic
  - Infectious
Ideal circulatory assist system

- Fits all
  - Support all patients regardless their size
  - Support patients for all indications
    (short and if necessary for long term)
    - Bridge to recovery
    - Bridge to bridge
    - Bridge to transplantation

- Easy, less invasive for implantation and explantation
- Hemocompatible (no hemolysis, no thrombogenesis)
- Compatible for combination with an oxygenator
- Compatible for uni or biventricular support
- Economic
- Compatible for patient’s mobilisation and rehabilitation
Mechanical circulatory support

- Indirect (IABP)
  - Pulsatile flow
    - Abiomed BVS 5000
    - Thoratec
    - Berlin Heart Excor

- Direct
  - Continuous flow
    - Micro axial pump- Impella
    - TandemHeart
    - ECMO & Centrifugal pumps
Extra Corporeal Membrane Oxygenation (ECMO) is a mechanical treatment which provides both cardiac and/or respiratory support to the patients who have heart and/or lung dysfunction. ECMO resembles a heart-lung pump.

- An in flow canula and and outflow canula (their position changes according to the type of ECMO)
- A pump (centrifugal)
- Membrane oxygenator
- Heat exchanger
Ideal ventricular assist device

- Fits all
  - Support all patients regardless their size
  - Support patients for all indications
    (short and if necessary for long term)
    - Bridge to recovery
    - Bridge to bridge
    - Bridge to transplantation

- Easy, less invasive for implantation and explantation
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Indications

• Initiate ECMO as temporary life support for patients with potentially reversible severe acute respiratory or cardiac failure.
Indications

• Initiate ECMO as temporary life support for patients with potentially **reversible** severe acute respiratory or cardiac failure.
  
  – Refractory cardiogenic shock
  
  – Cardiac arrest
  
  – Failure to wean from cardiopulmonary bypass after cardiac surgery
  
  – As a bridge to either cardiac transplantation or placement of a ventricular assist device
  
  – Hypoxemic respiratory failure despite optimization of the ventilator settings, position, treatment
  
  – Hypercapnic respiratory failure with an arterial pH less than 7.20
  
  – Rewarming of the hypothermia patients
Contra indications (relative)

• ECMO may not be initiated
  – if anticoagulation is contraindicated (eg, bleeding, recent surgery, recent intracranial injury),
  – if the cause of the respiratory or cardiac failure is irreversible for a patient who has a contraindication for a transplantation or for an implantable ventricular assist device (preexisting renal failure, preexisting hepatic failure, significant aortic valve insufficiency, or inadequate social support),
  – if the patient has been mechanically ventilated for longer than seven days,
  – advanced age,
  – neurologic dysfunction.
Veno- Arterial ECMO –

Peripheral or central cannulation

• Central cannulation is generally preferred for postcardiotomy failure (RA- Ao or RA + LA- Ao)
Veno- Arterial ECMO –
Peripheral or central cannulation
• Peripheral cannulation is preferred for emergency, on the scene implantations
  – Femoral arterio- venous cannulation (surgical)
Femoral arterio-venous cannulation (percutaneous)
Near infrared spectroscopy for controlling the quality of distal leg perfusion in remote access cardiopulmonary bypass

Thomas Schachner *, Nikolaos Bonaros, Johannes Bonatti, Christian Kolbitsch

Innsbruck Medical University, Innsbruck, Austria
Femoral arterio-venous cannulation (percutaneous)
PERIPHERAL CANNULATION AND LV DECOMPRESSION

Intra-aortic balloon counterpulsation

Percutaneous balloon atrial septostomy

Peripheral AV cannulation

Problems – Solutions

Percutaneous tr-septal LA canula
Veno- Arterial ECMO –
Peripheral or central cannulation
• Pediatric patients less than 15 kg
  – Carotid artery- jugular vein cannulation

!!! 70-80 % patency after carotid artery reconstruction
Veno-venous ECMO –
Generally peripheral cannulation
• Femoral vein (positioned in the inferior caval vein below the hepato- caval junction)- jugular vein (positioned in the superior caval vein or in the right atrium higher than the tricuspid valve)
• Femoral- femoral vein
• Double lumen canula- AVALON
  !!! Ultrasonography guidance for puncture and Echocardiography guidance for positioning !!!
Outcomes

Acute cardiac failure

• ECMO improves survival in patients with acute cardiac failure
  – Reported survival rates changes between 20 to 45 percent among patients who received venoarterial (VA) ECMO for cardiac arrest, severe cardiogenic shock, or failure to wean from cardiopulmonary bypass following cardiac surgery
  – In two observational studies, ECMO treatment for cardiac arrest was associated with increased survival compared to conventional cardiopulmonary resuscitation
  – VA ECMO has also been used as a bridge to cardiac transplantation or placement of a ventricular assist device.
Outcomes and long-term quality-of-life of patients supported by extracorporeal membrane oxygenation for refractory cardiogenic shock

Alain Combes, MD, PhD; Pascal Leprince, MD, PhD; Charles-Edouard Luyt, MD, PhD; Nicolas Bonnet, MD; Jean-Louis Trouillet, MD; Philippe Léger, MD; Alain Pavie, MD; Jean Chastre, MD

ECMO for Acute Cardiogenic Shock
n = 81

DOM
n = 18

AMI
n = 16

Myocarditis
n = 16

POCG
n = 16

Transplant
n = 10

Other
n = 5

38 Deaths under ECMO
n = 11

9 Deaths after ECMO weaning
n = 2

34 ICU survivors
n = 5

29 Long-term survivors
n = 4

n = 10

n = 6

n = 5

n = 5

n = 10

n = 3

n = 2

n = 1

n = 9

n = 7

n = 3

n = 1*
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Outcomes

Acute respiratory failure

- ECMO may improve survival in patients
  - Survival rates changes between 50 to 71 percent which is better among than historical survival rates.
  - Severe Acute Respiratory failure (CESAR) trial
    - 180 patients with severe, but potentially reversible, acute respiratory failure
    - Randomly assignation to conventional management or ECMO
    - ECMO group had significantly increased survival without disability at six months compared to conventional management (63 versus 47 percent).
Complications with ECMO

• Bleeding
• Stroke
• Infection
• Blood vessel injury
• Mechanical (Malfunction of ECMO equipment)
HUG- CLINICAL EXPERIENCE

- ECMO ADULT
- ECMO PEDIATRIC
LEVITRONIX CENTRIMAG
Lifebridge B²T—A New Portable Cardiopulmonary Bypass System

Markus Krane,* Domenico Mazzitelli,* Ulrich Schreiber,* Alexander Menzeza Garcia,† Sigmund Braun,‡ Bernhard Voss,* Catalin C. Badiu,§ Gernot Brockmann,§ Rüdiger Lange,* and Robert Bauernschmitt*
CARDIOHELP – MAQUET
Positive anything is better than negative nothing.
ACR
Réalisation immédiate

Choc cardiaque
sever ou réfractaire

EP (avérée ou suspectée)
avec choc

ALARME ECMO
(indication per 2 spécialités parmi Anesth – SU – CCV – Cardi – SI)

Lieu du patient?

Soins Intensifs
Salle de cath, SU, Etage

ECMO sur site ou salle de cath?

CDC SI

CCV 7957644

Si implant hors SI : CDC anesth 7957866

Garde cardio 7928 888

A disp pour echo

Prise en charge et équipement pt.

Instr BOU

Circuit

Instr BOU

Chariot ECMO sur site

Cadre cardio

Préparation salle

ECMO percutanée sur site ou en salle de cath

Les indications : ARRÊT extra-hospitalier avec réanimation immédiate par professionnels de santé équivalents OU signes de réel

- Arrêt extra-hospitalier avec réanimation immédiate par professionnels de santé équivalents
- Signes de réel

- Hypotension nécessitant fortes doses d’amines ou réfractaire avec souffle périphérique (pH lactates)
- Hypoxémie réfractaire

- Échographie coronarienne claire (anémie, ECG) OU Écho dosoyant cause cardiaque

- Salle de cath si pr raisonnablement transportable OU ind à cette percutané coronari ou pour EP
Thinks to do

• Having a team
  “A man is an island”

• Having a VAD
• Plans for the disasters
Seven Deadly Sins

- Wealth without Work
- Pleasure without Conscience
- Science without Humanity
- Knowledge without Character
- Politics without Principle
- Commerce without Morality
- Worship without Sacrifice

Mahatma Gandhi
(1869-1948)
Seven Deadly Sins

- Wealth without Work
- Pleasure without Conscience
- Science without Humanity
- Knowledge without Character
- Politics without Principle
- Commerce without Morality
- Worship without Sacrifice

- Medicine without Teamwork

Mahatma Gandhi
(1869-1948)
Thinks to do

- Having a team
- Having a VAD
- Plans for the disasters
Ventricular support systems

**Bridge to bridge or recovery**
DELTASTREAM and JOSTRA
Centrifugal pump supported continuous flow with oxygenator-ECMO

**IMPELLA**
Continuous flow microaxial pump

**Bridge to recovery or transplantation**
EXCOR VAD
Pneumatic pump supported pulsatile flow

**Bridge to transplantation or destination therapy**
HEART MATE II
Continuous flow rotary pump
Thinks to do

• Having a team
• Having a VAD
• Plans for the disasters
Acute heart failure

Cardiac arrest & CPR (uncertain neurological status)

Femoral artery and vein cannulation

Femoro-femoral ECMO (+ IABP)

Decision

Cardiac recovery
Neurologic recovery
End-organ functions

1- Bridge to recovery
2- Bridge to bridge
3- Withdraw medical support
Acute heart failure → Inotropic support and IABP → Coronary catheterisation

Coronary artery disease
1- PCI
2- Surgery

Coronary artery disease
a- Successful CPB weaning
b- Fail to wean CPB

Normal coronary arteries
ECMO
Bridge to recovery
Bridge to bridge
Bridge to transplantation

ECMO
Bridge to recovery
Bridge to bridge
Bridge to transplantation
CONCLUSIONS

• ECMO is effective for the treatment of refractory acute heart failure
• The cardiovascular surgery and cardiology centers should have at least one VAD programme – ECMO?
• All patients should be assessed and followed before and after implantation by a team
• Patient selection and better timing for successful results
• Team work, thus training of the each member
• Not too early, not too late- High mortality is a consequence of the underlying cause and delayed implantation time rather than the technique itself.
THANK YOU