

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

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

Mustafa CIKIRIKCIOGLU, MD, PhD, FETCS

Staff Cardiovascular Surgeon (Chef de Clinique FMH)

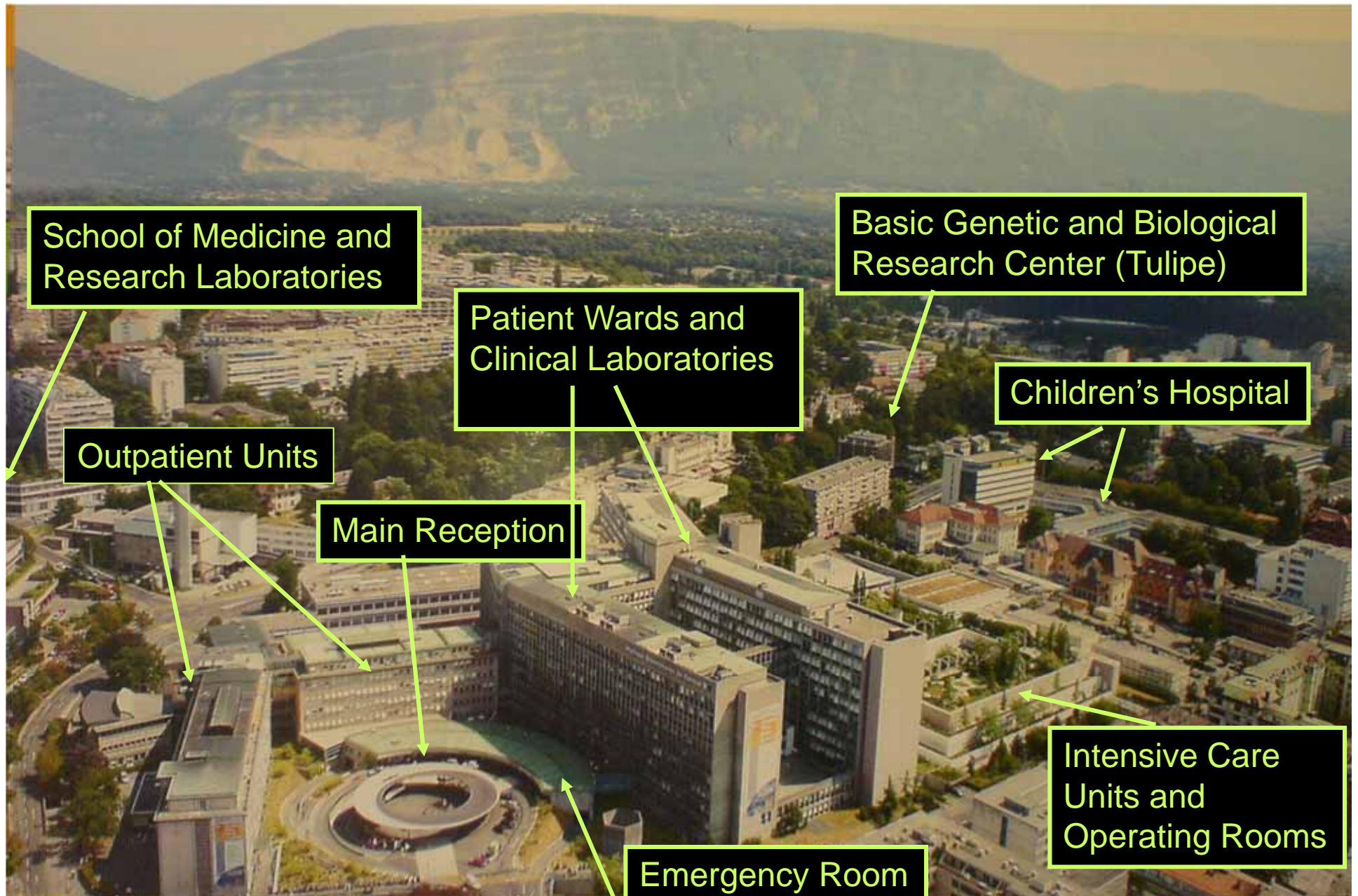
Department of Surgery, Division of Cardiovascular Surgery
University Hospitals of Geneva



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No conflict of interests



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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

Improved Survival After Acute Myocardial Infarction Complicated by Cardiogenic Shock With Circulatory Support and Transplantation: Comparing Aggressive Intervention With Conservative Treatment

J Heart Lung Transplant 2006;25:504-9.

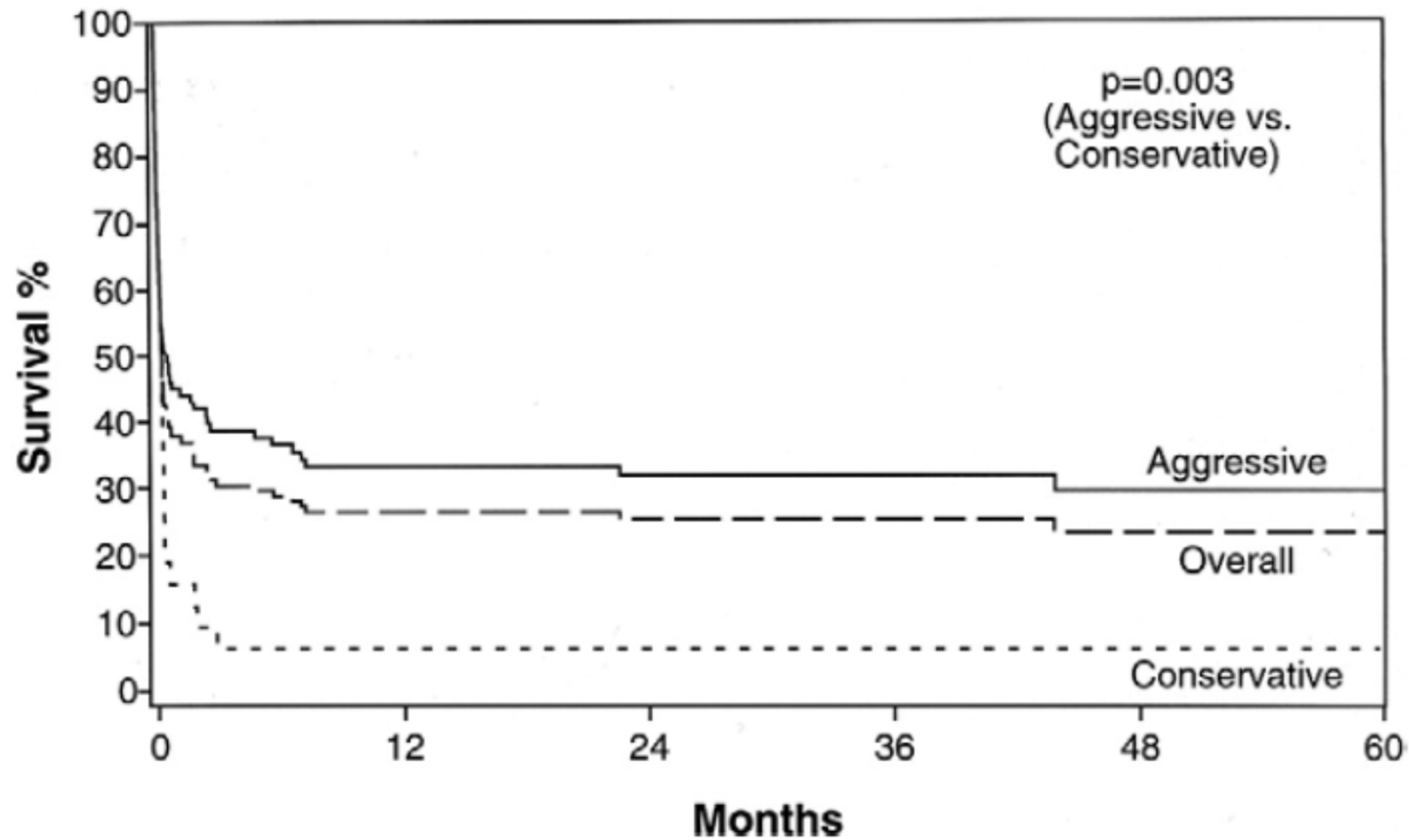
Wakkas Tayara, MD,^a Randall C. Starling, MD, MPH,^b Mohamad H. Yamani, MD,^b Oussama Wazni, MD,^b Fuad Jubran, MD,^b and Nicholas Smedira, MD^c

- 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 transplanted

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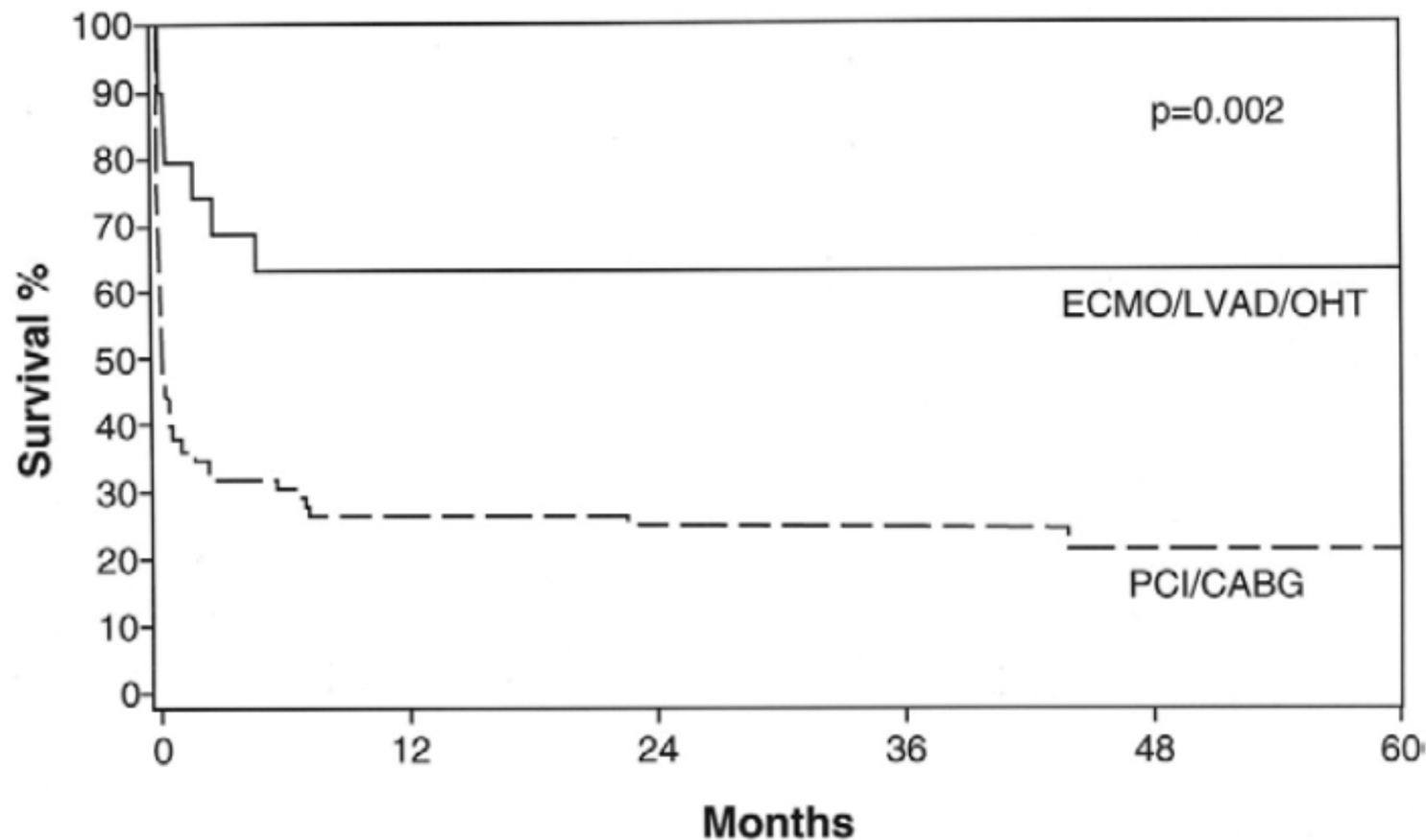
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Ventricular assist device:

Not to early, not to late!

Sword of Democles

Richard Westall (1765- 1836)

Circulatory assist system: When?

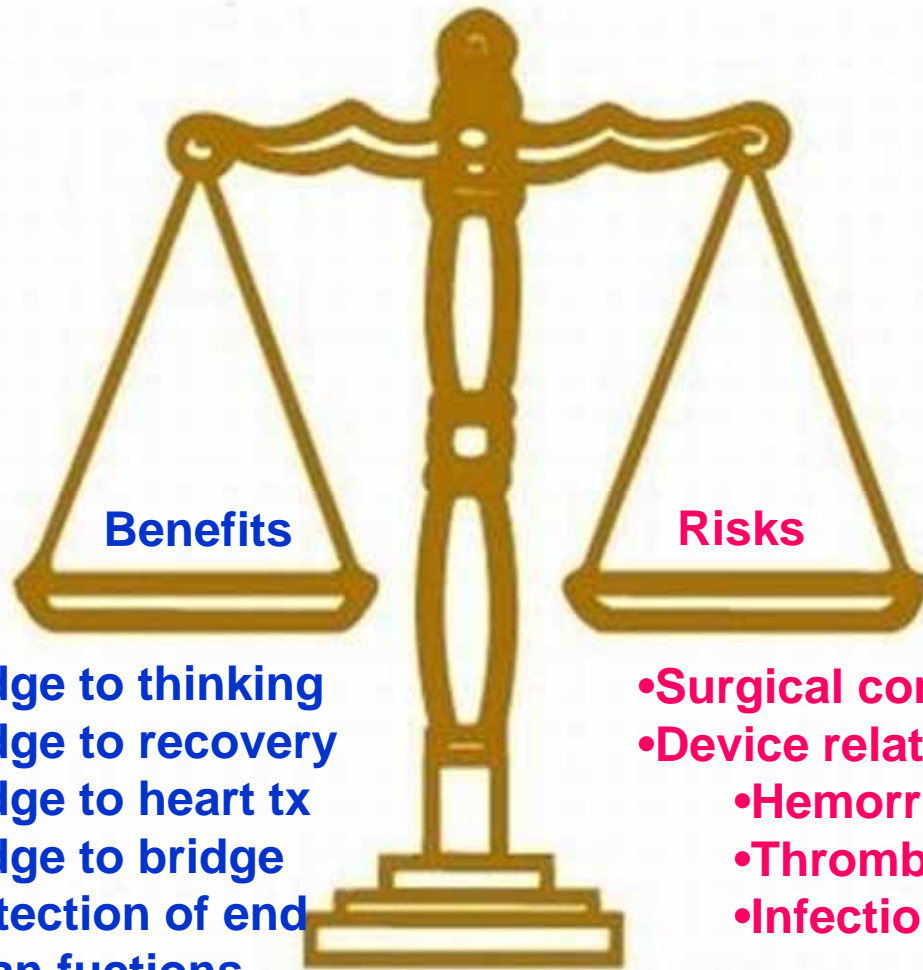
- Correction of all metabolic problems
- On maximal medical and IABP support
 - Two or more and high dosage inotropic support
- Complete and adequate surgical procedure



- 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?



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

- 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

```
graph TD; A[Mechanical circulatory support] --> B[Indirect (IABP)]; A --> C[Direct]; C --> D["Pulsatile flow  
• Abiomed BVS 5000  
• Thoratec  
• Berlin Heart Excor"]; C --> E["Continuous flow  
• Micro axial pump- Impella  
• TandemHeart  
• ECMO & Centrifugal pumps"];
```

Indirect
(IABP)

Direct

Pulsatile flow

- Abiomed BVS 5000
- Thoratec
- Berlin Heart Excor

Continuous flow

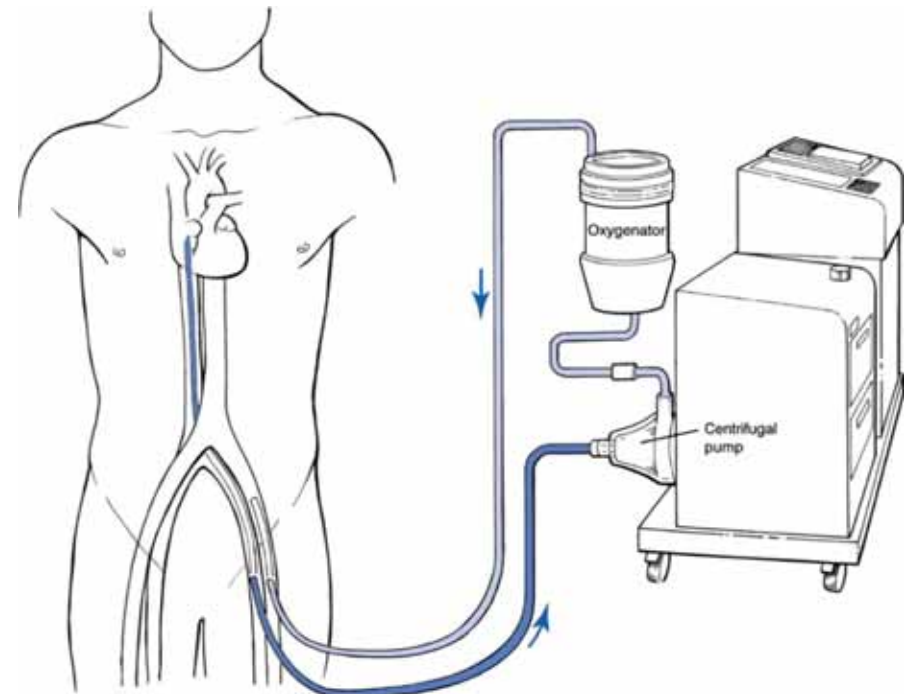
- Micro axial pump- Impella
- TandemHeart
- ECMO & Centrifugal pumps

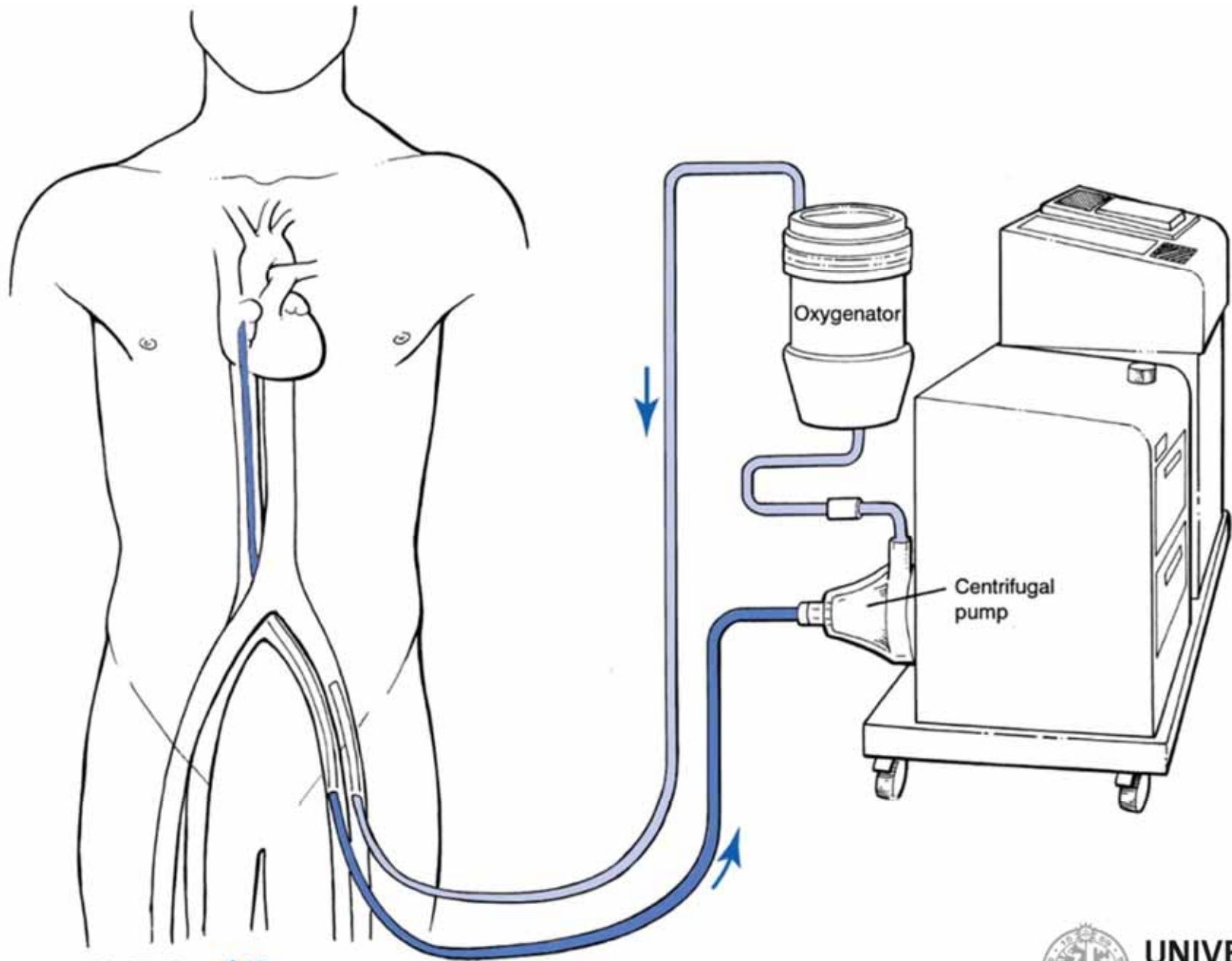
Extra Corporeal Membrane Oxygenation (ECMO)

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 an outflow canula (their position changes according to the type of ECMO)
- A pump (centrifugal)
- Membrane oxygenator
- Heat exchanger







Ideal ventricular assist device

- Fits all
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 - Support patients for all indications
(short and if necessary for long term)
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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

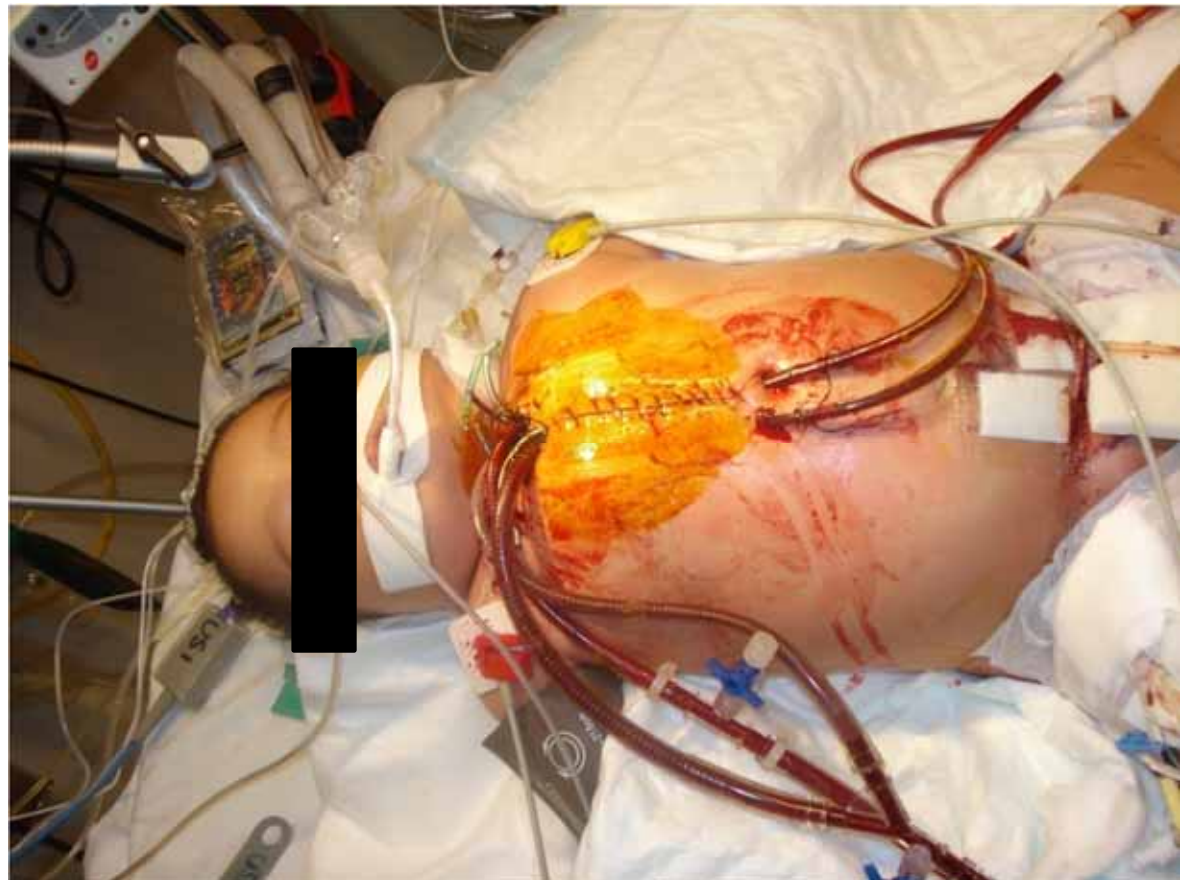
Contra indications (relative)

- 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

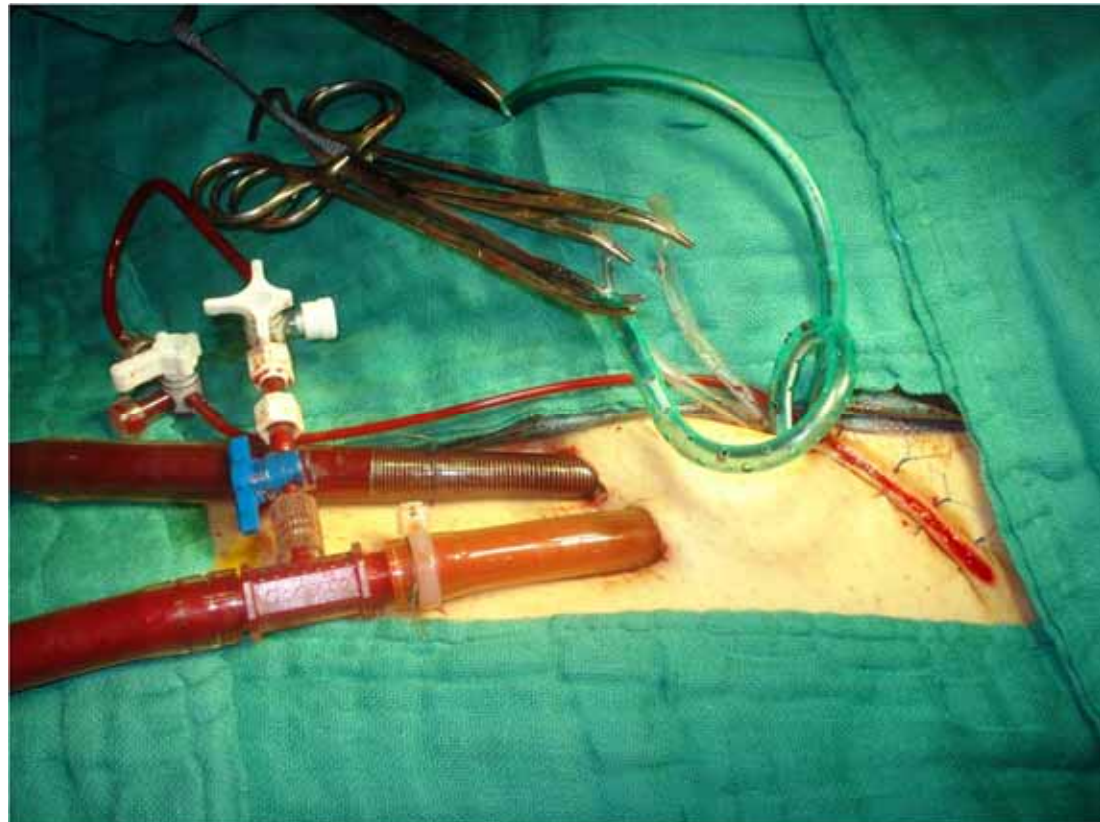
- Central cannulation is generally preferred for postcardiotomy failure (RA- Ao or RA + LA- Ao)



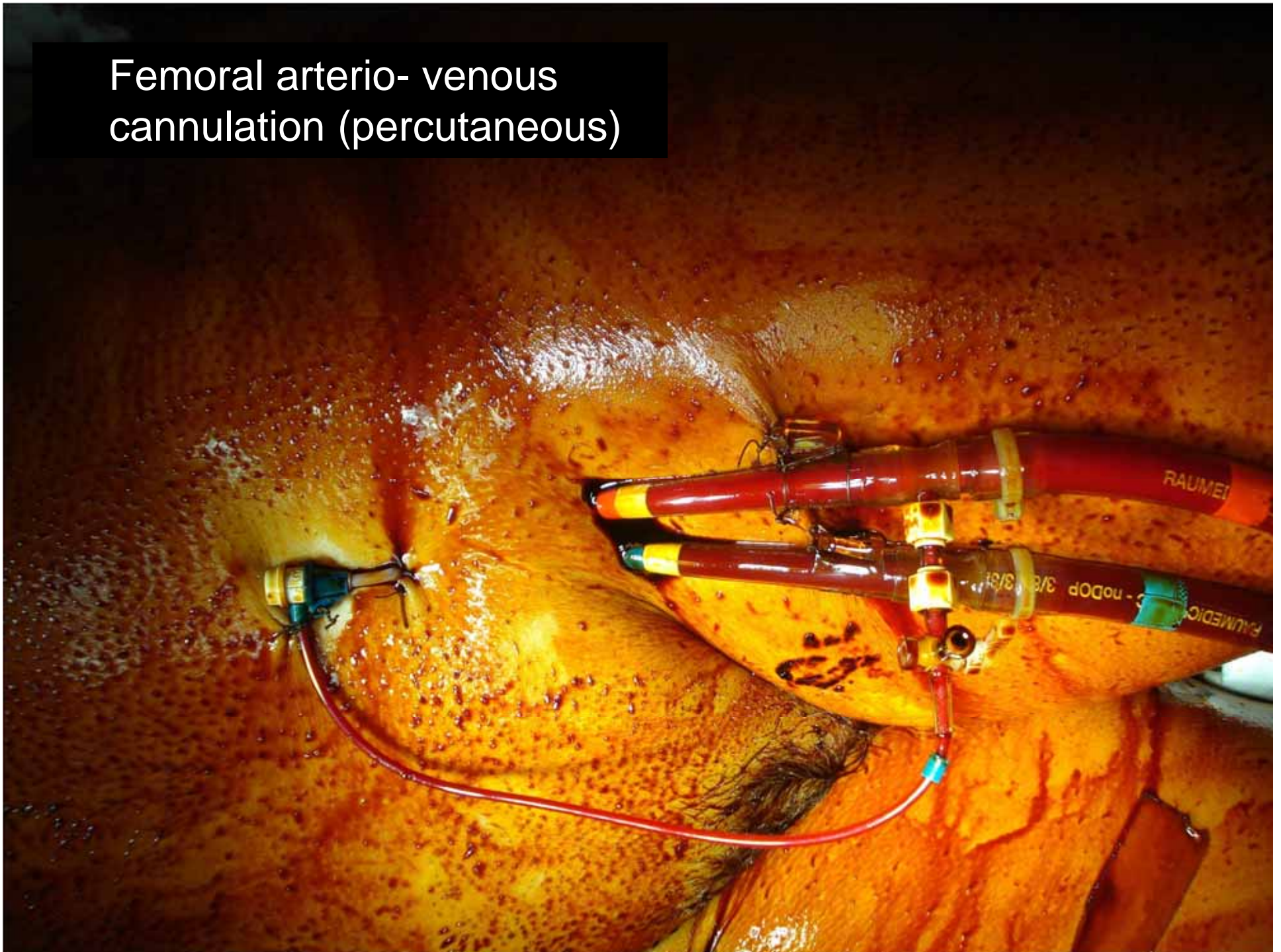
Veno- Arterial ECMO –

Peripheral or central cannulation

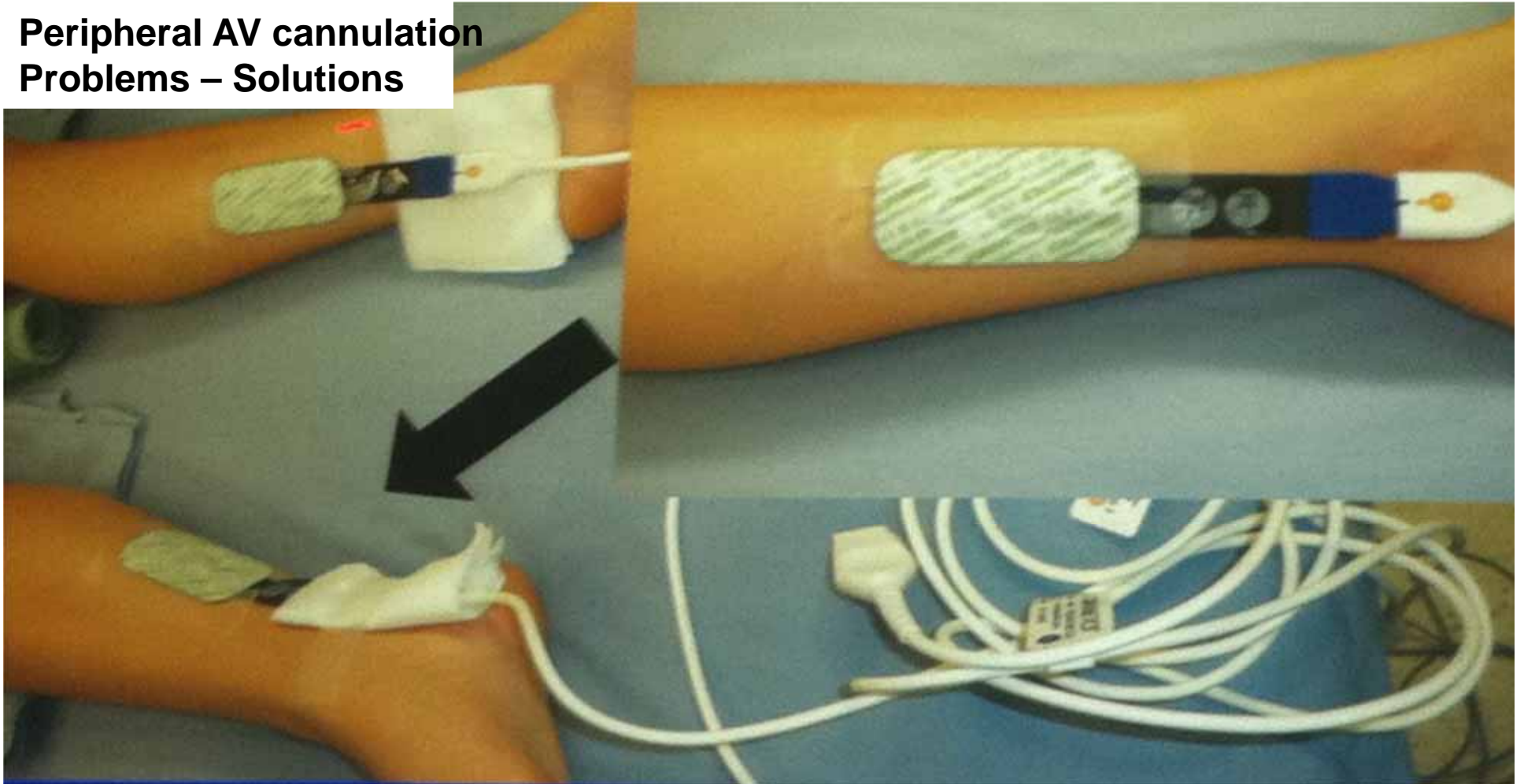
- Peripheral cannulation is preferred for emergency, on the scene implantations
 - Femoral arterio- venous cannulation (surgical)



Femoral arterio- venous cannulation (percutaneous)



Peripheral AV cannulation Problems – Solutions

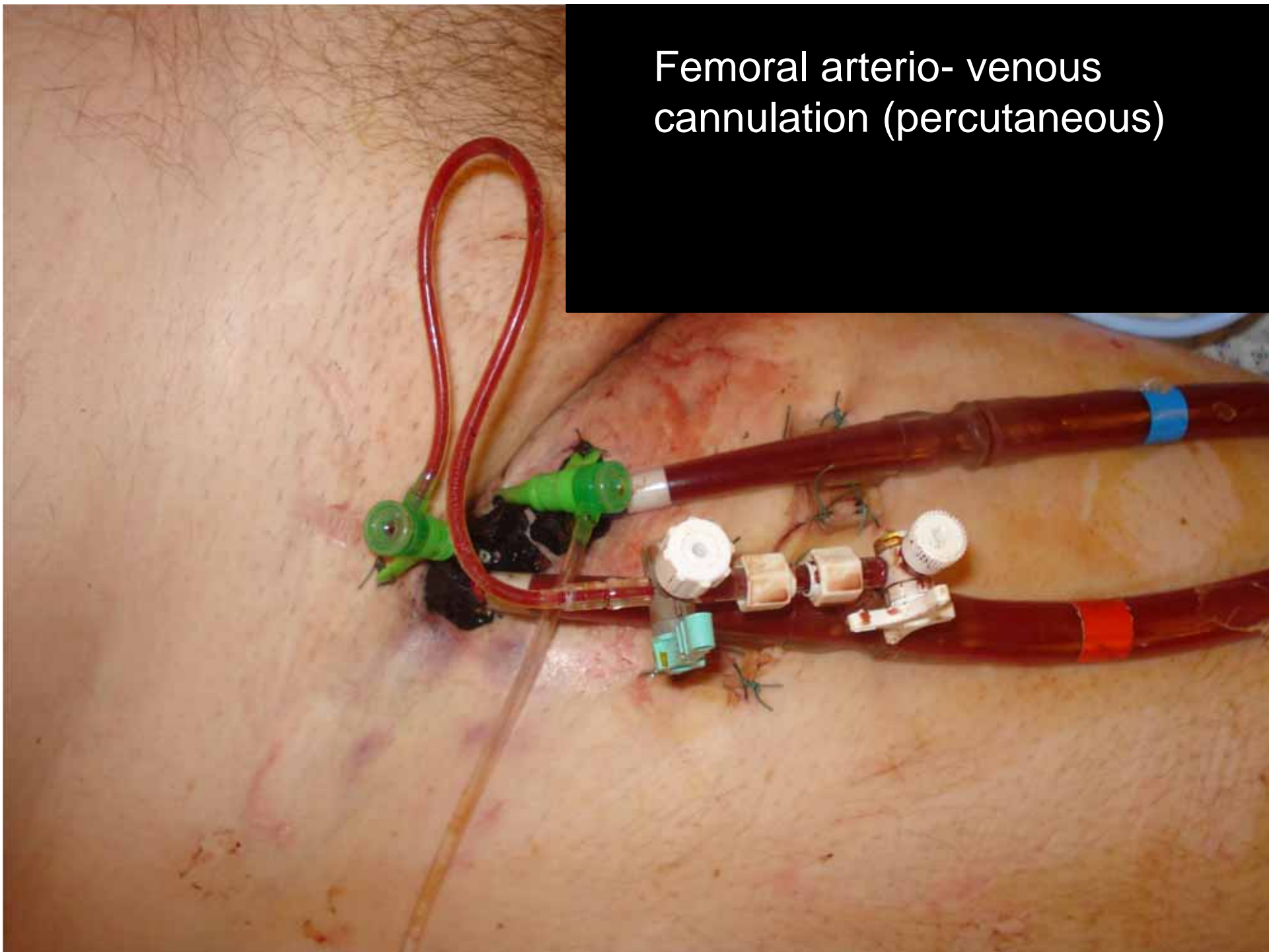


Near infrared spectroscopy for controlling the quality of distal leg perfusion in remote access cardiopulmonary bypass

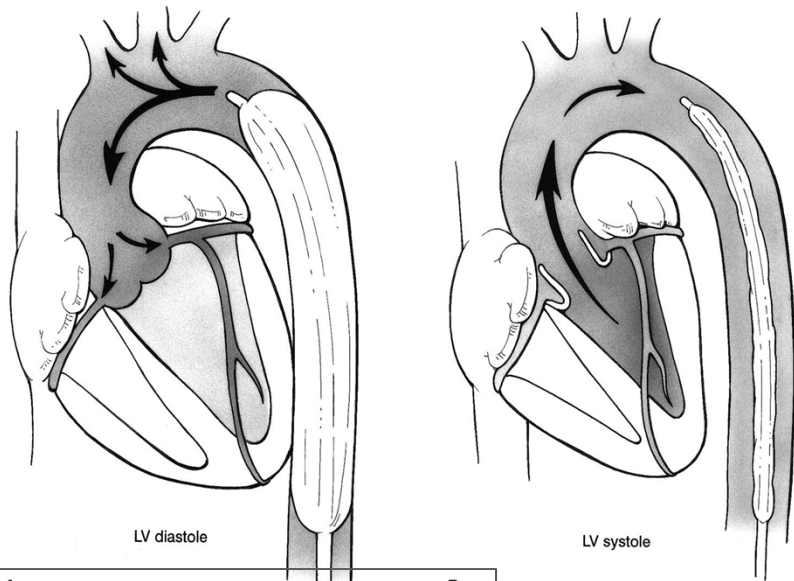
Thomas Schachner^{*}, Nikolaos Bonaros, Johannes Bonatti, Christian Kolbitsch

Innsbruck Medical University, Innsbruck, Austria

Femoral arterio- venous cannulation (percutaneous)

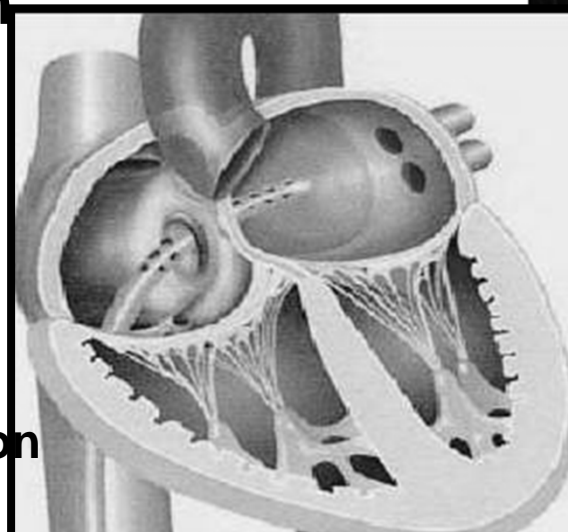


PERIPHERAL CANNULATION AND LV DECOMPRESSION



A
Intra-aortic balloon counterpulsation
B

Peripheral AV cannulation
Problems – Solutions



Percutaneous balloon atrial septostomy

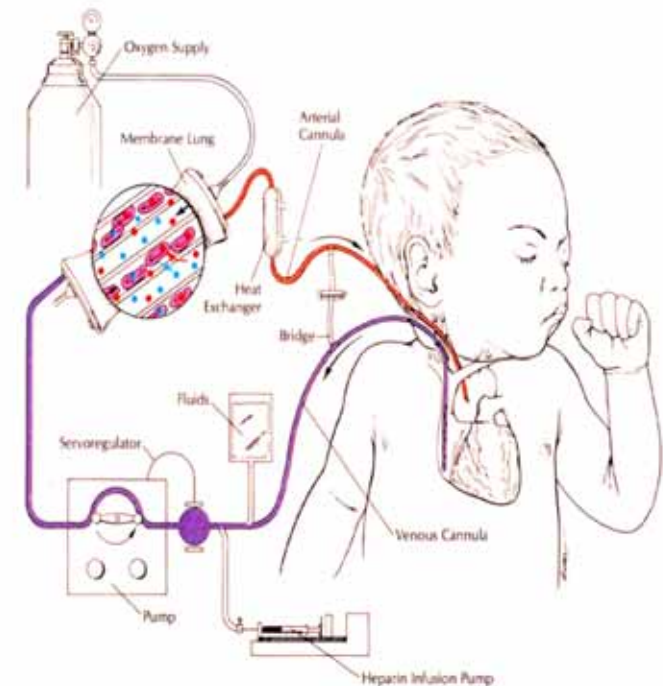


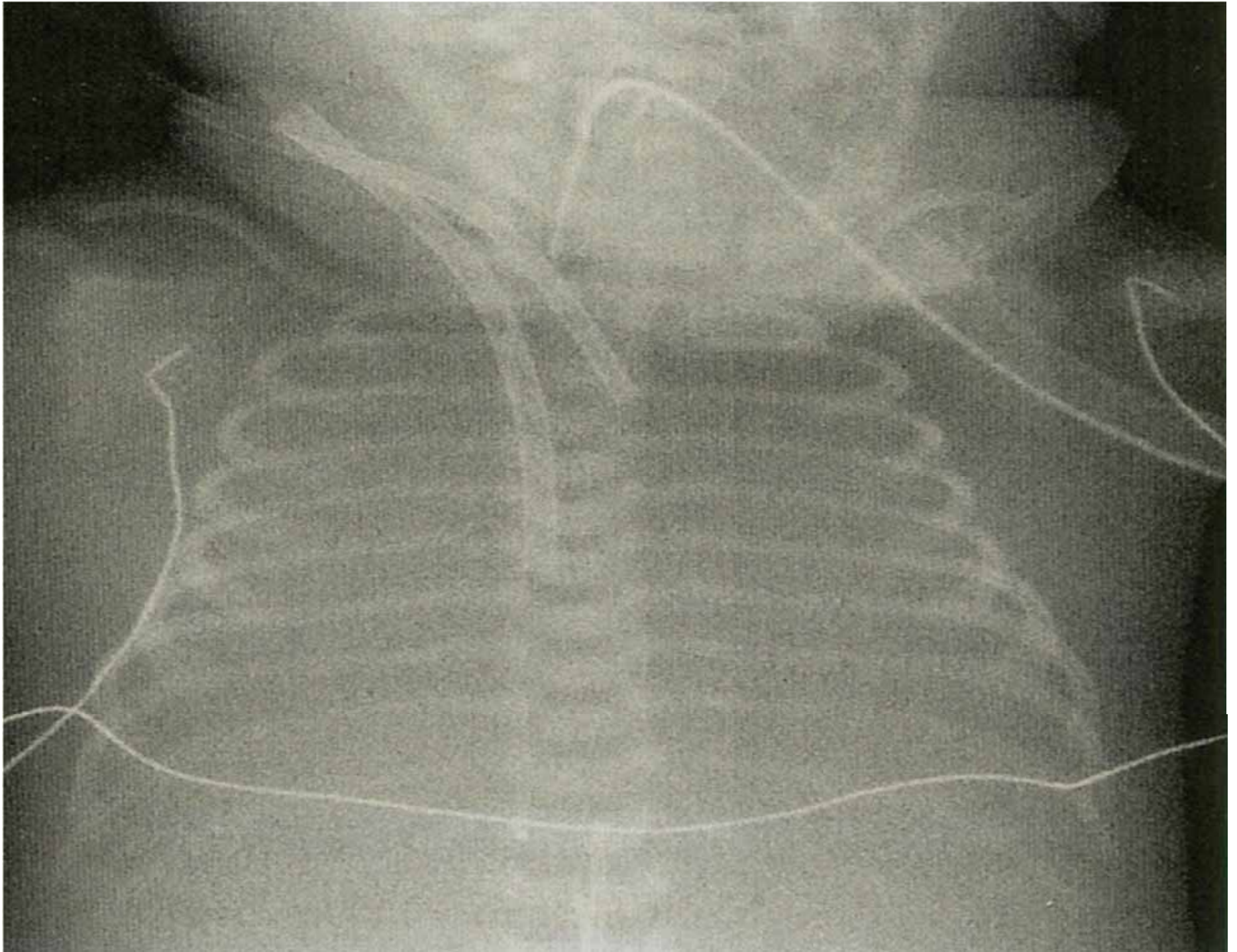
Percutaneous tr-septal LA canula

Veno- Arterial ECMO –

Peripheral or central cannulation

- Pediatric patients less than 15 kg
 - Carotid artery- jugular vein cannulation



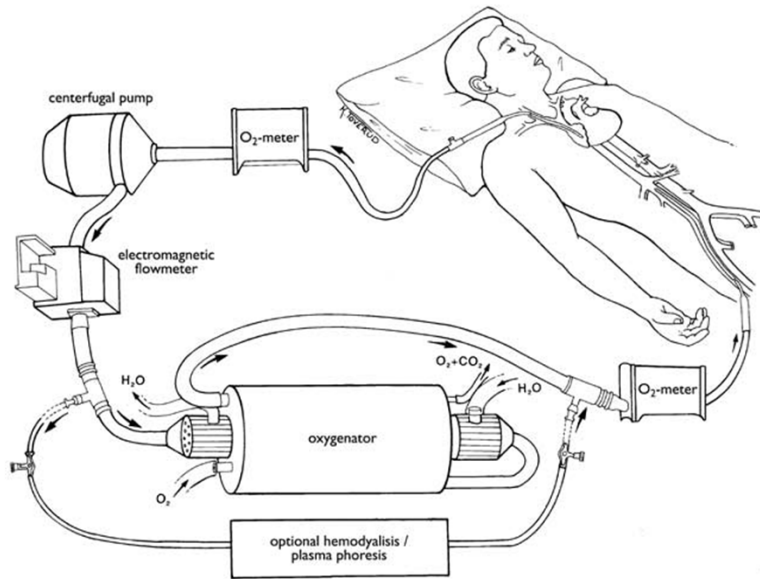


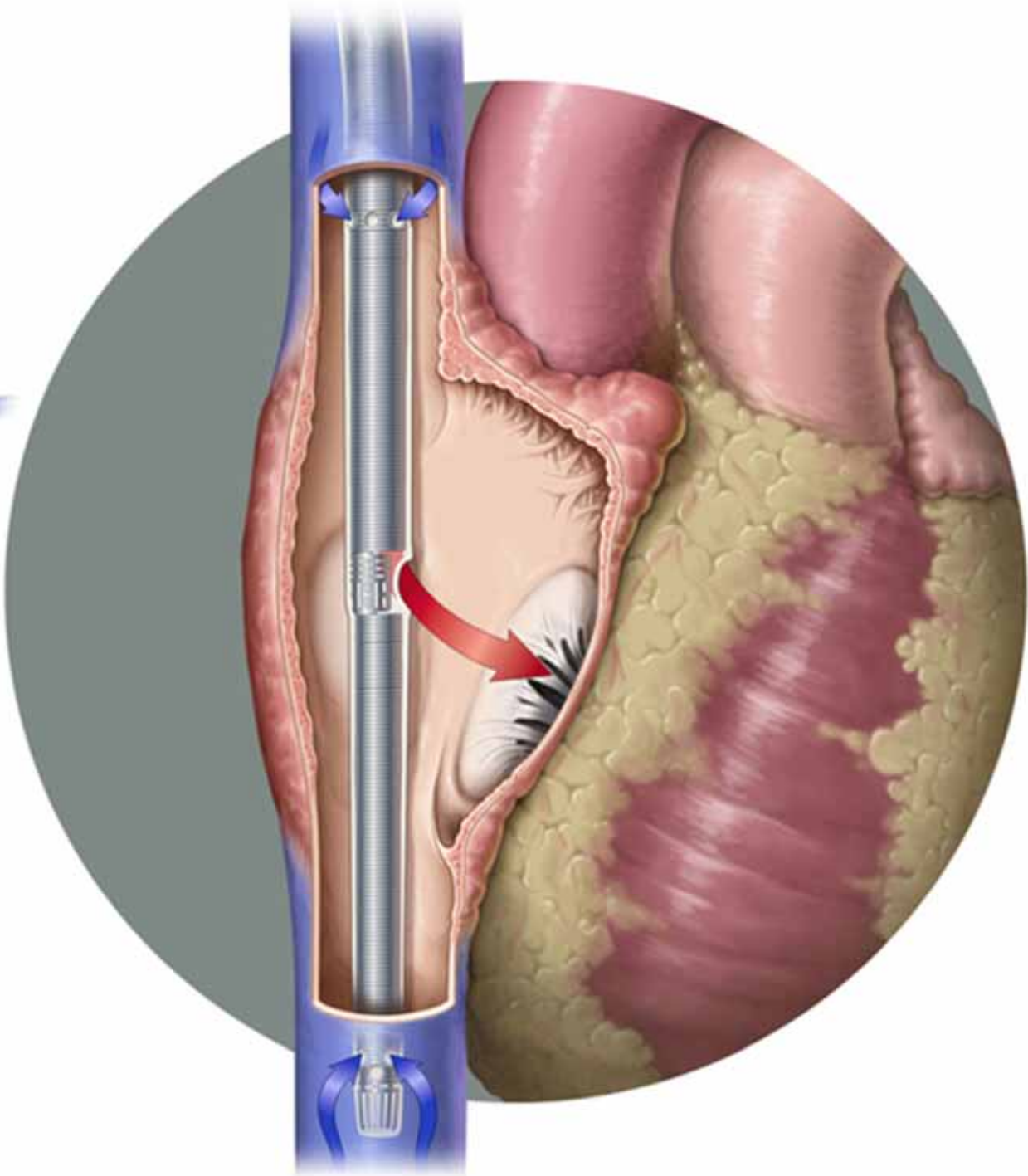
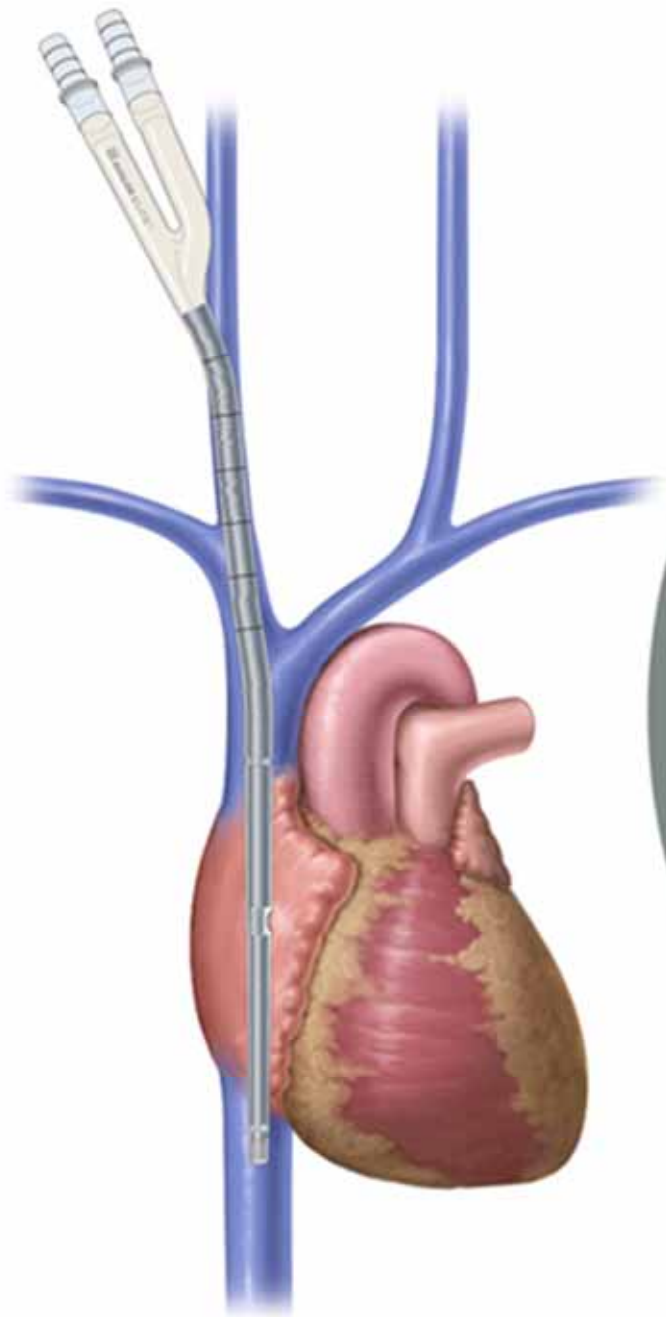
Veno-venous ECMO –

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

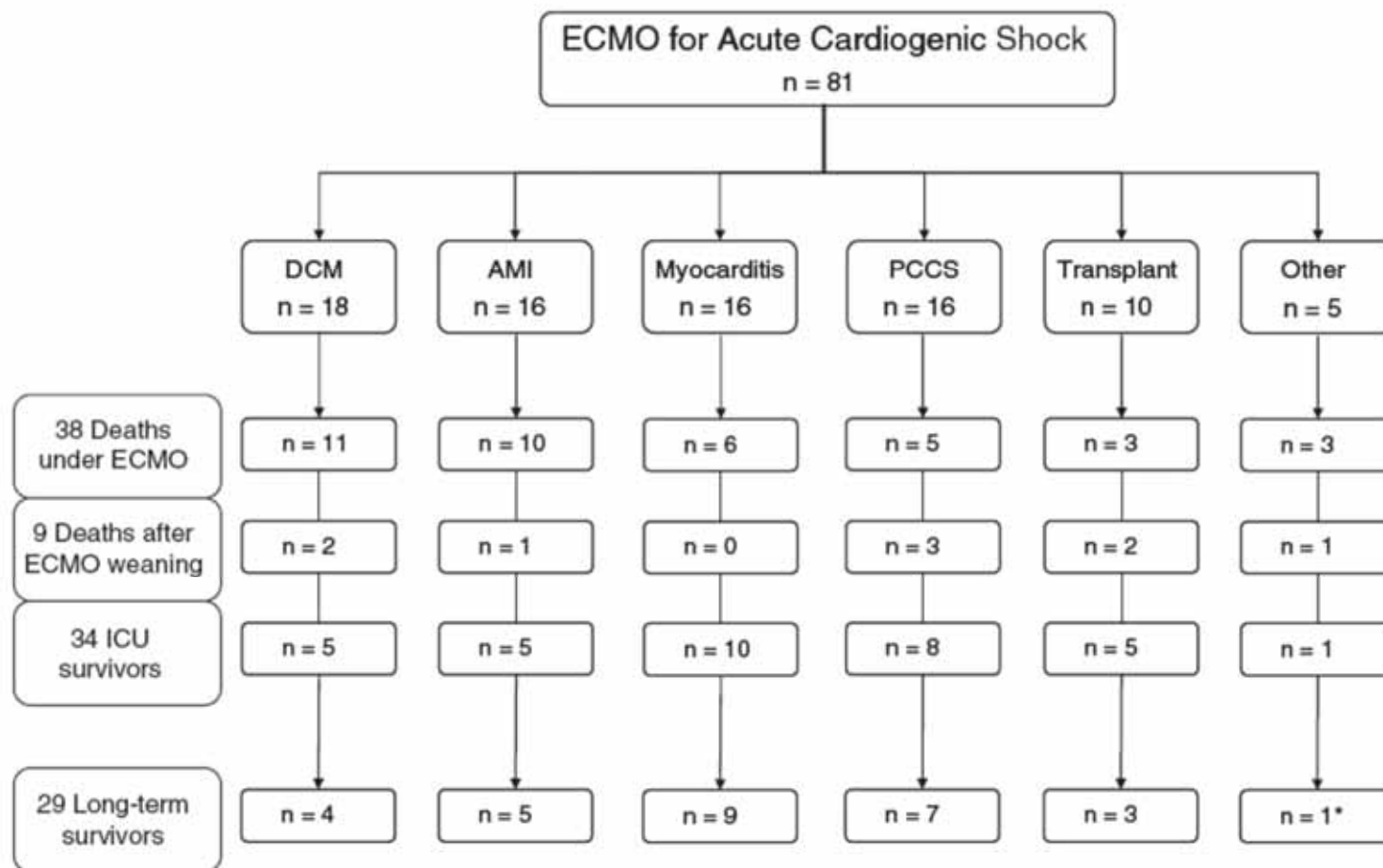
Acute cardiac failure

- 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
 - » *Crit Care Med.* 2011;39(1):1.
 - » *Lancet.* 2008;372(9638):554.
 - 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*

Crit Care Med 2008 Vol. 36, No. 5

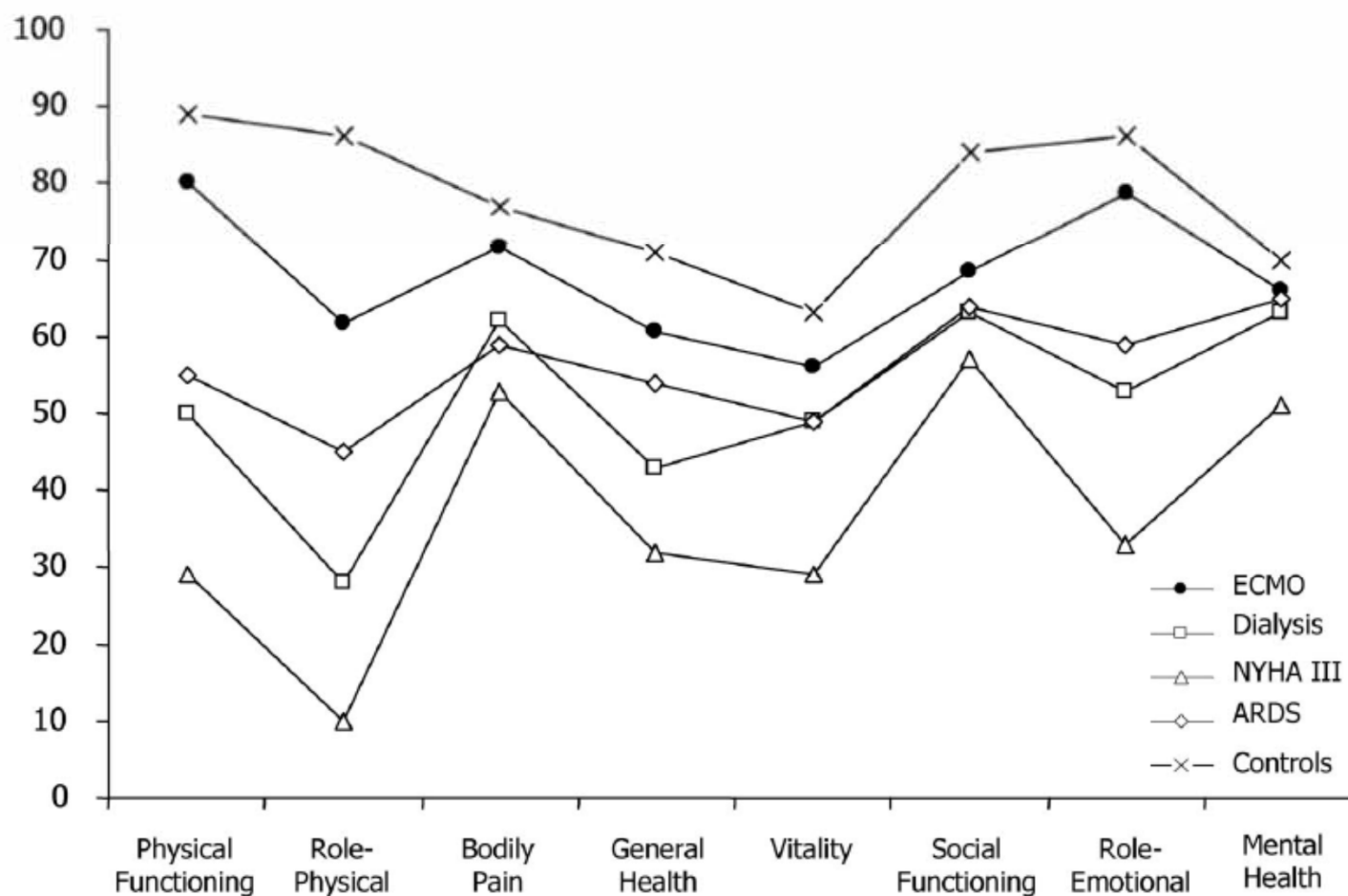
Alain Combes, MD, PhD; Pascal Leprince, MD, PhD; Charles-Edouard Luyt, MD, PhD; Nicolas Bonnet, MD; Jean-Louis Trouillet, MD; Philippe Léger, MD; Alain Pavie, MD; Jean Chastre, MD



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Outcomes

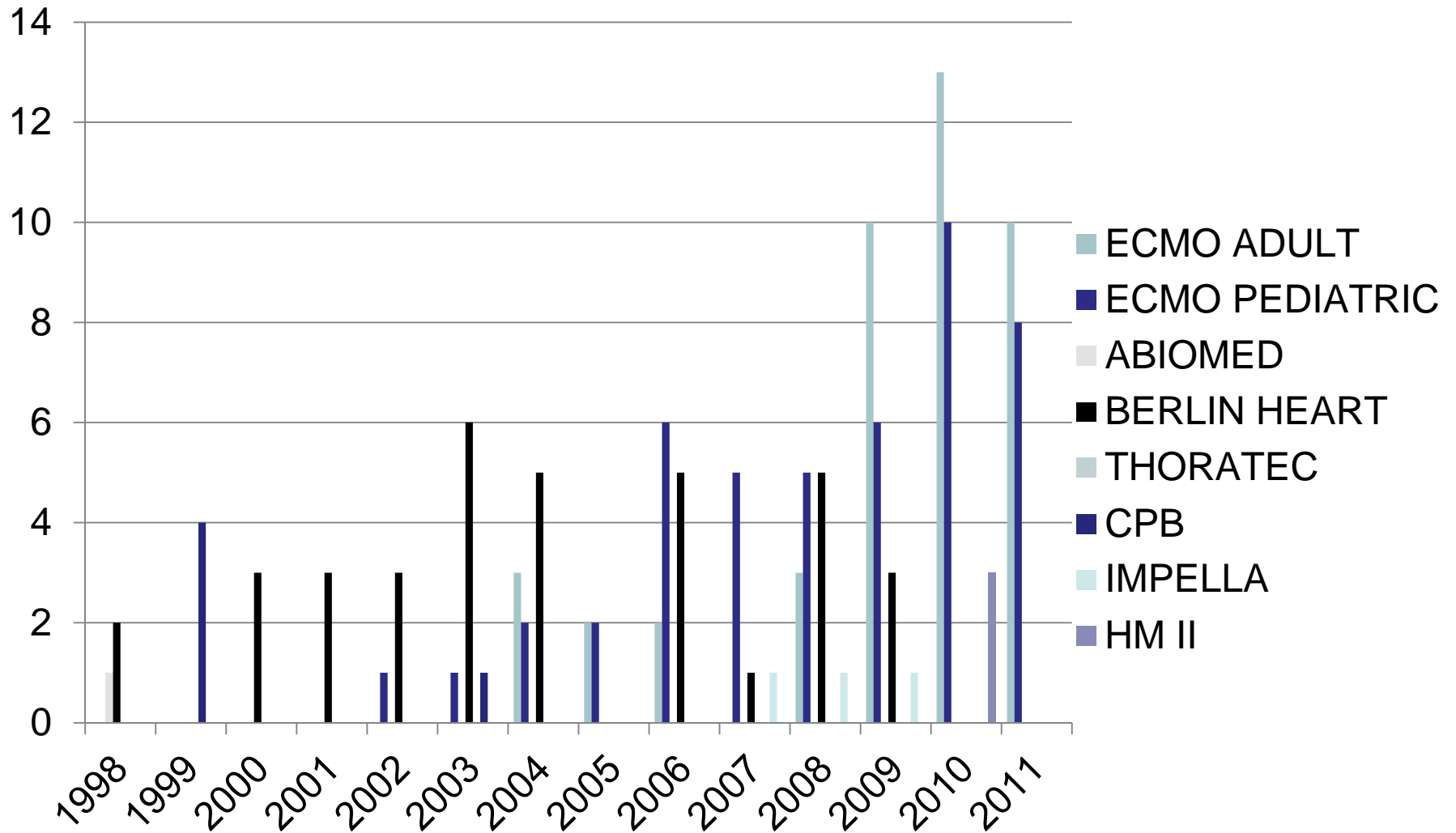
Acute respiratory failure

- 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).

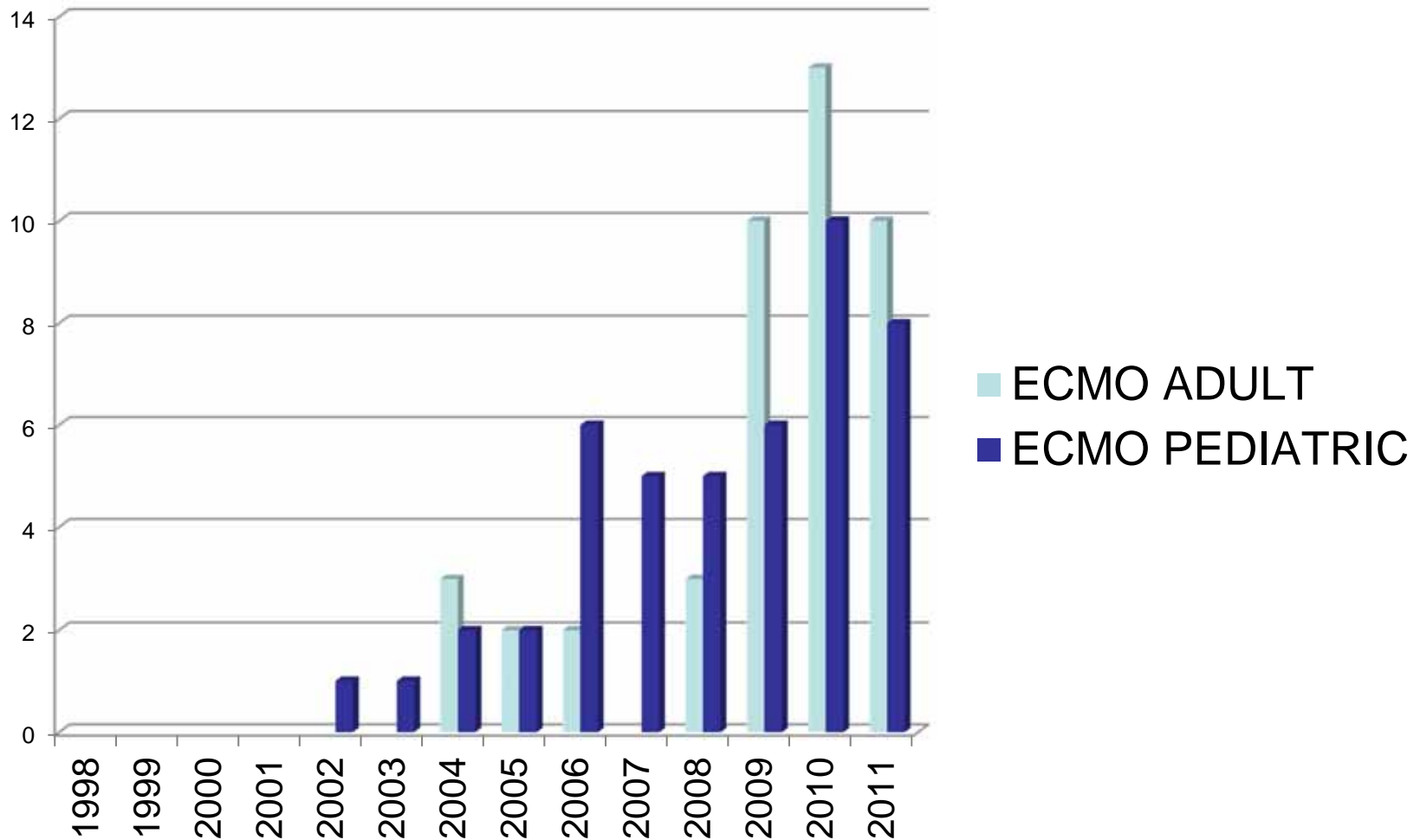
Complications with ECMO

- Bleeding
- Stroke
- Infection
- Blood vessel injury
- Mechanical (Malfunction of ECMO equipment)

HUG- CLINICAL EXPERIENCE

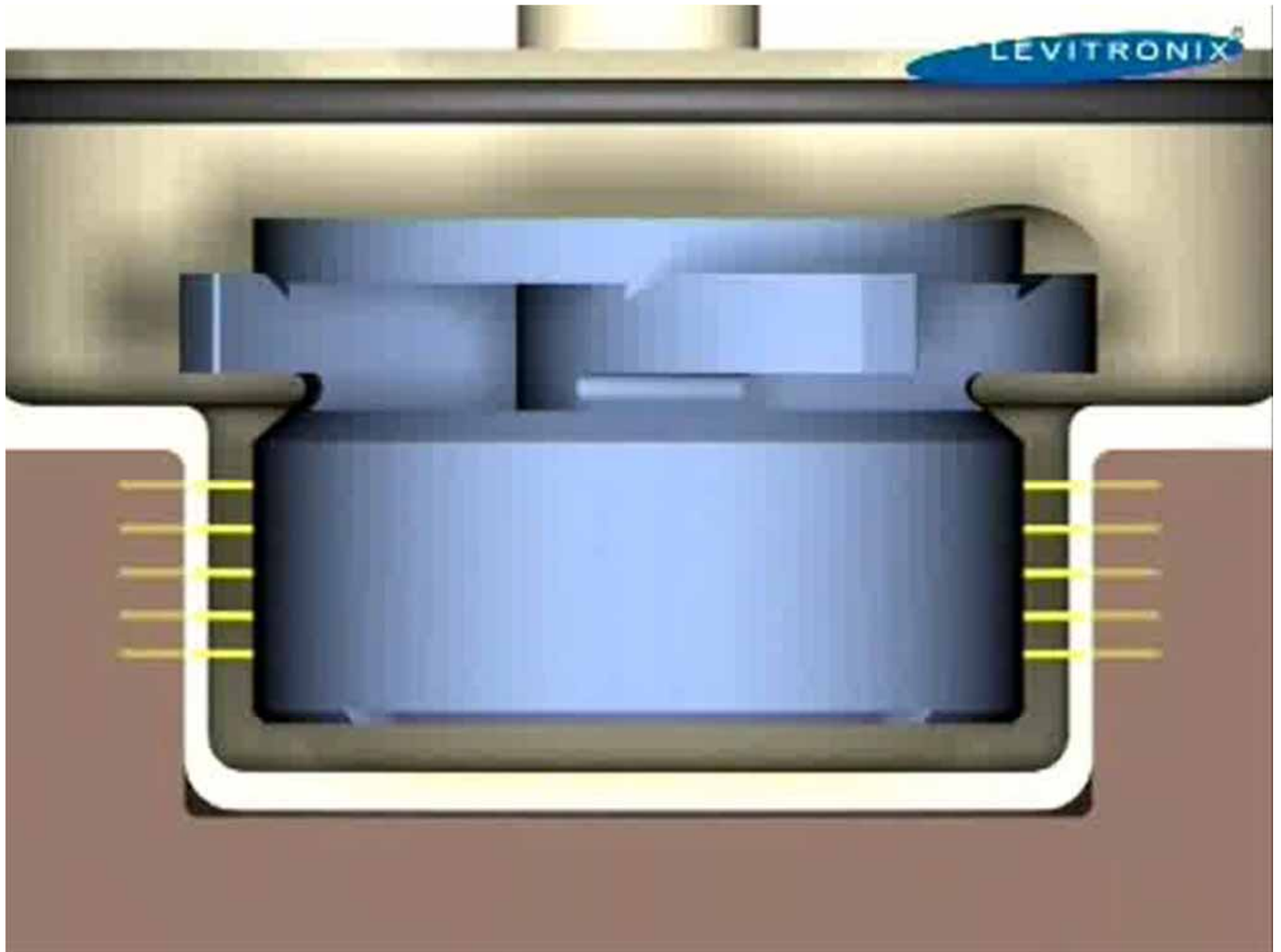


HUG- CLINICAL EXPERIENCE



LEVITRONIX CENTRIMAG





ASAIO Journal 2010

Lifebridge B²T—A New Portable Cardiopulmonary Bypass System

MARKUS KRANE,* DOMENICO MAZZITELLI,* ULI SCHREIBER,* ALEXANDER MENDOZA GARZIA,† SIGMUND BRAUN,‡ BERNHARD VOSS,*
CATALIN C. BADIU,* GERNOT BROCKMANN,* RÜDIGER LANGE,* AND ROBERT BAUERNSCHMITT*





CARDIOHELP – MAQUET

*Positive anything is better
than negative nothing*

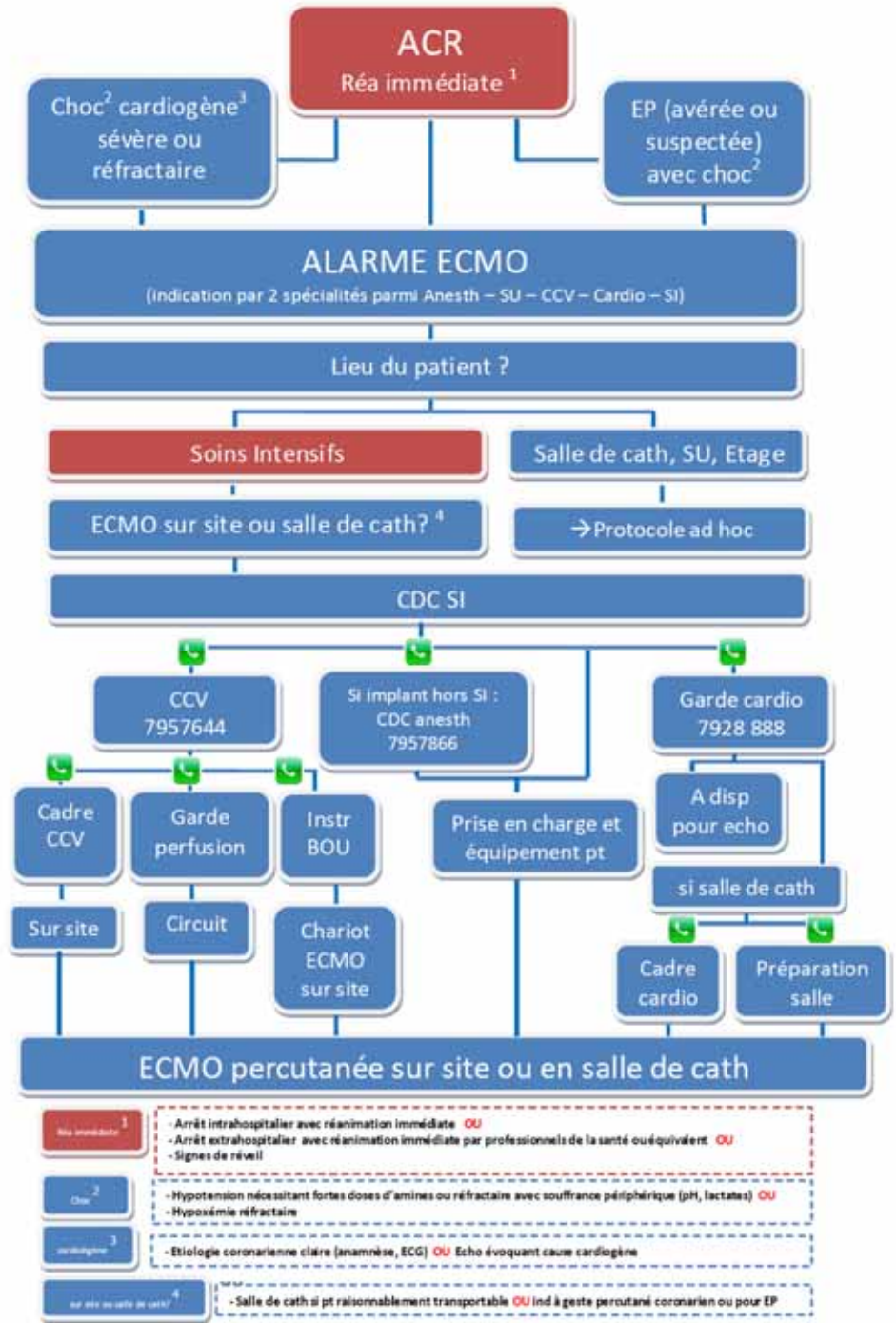








University Hospitals of Geneva
ALARM ECMO
 Protocol



Thinks to do

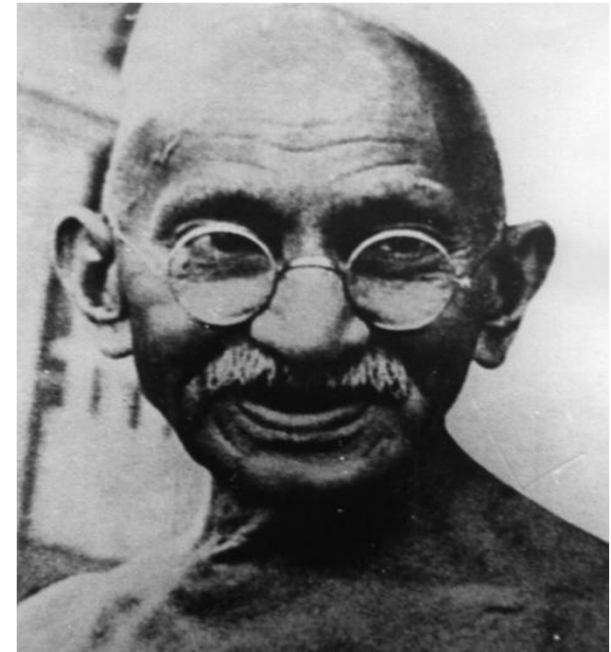
- Having a team

“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

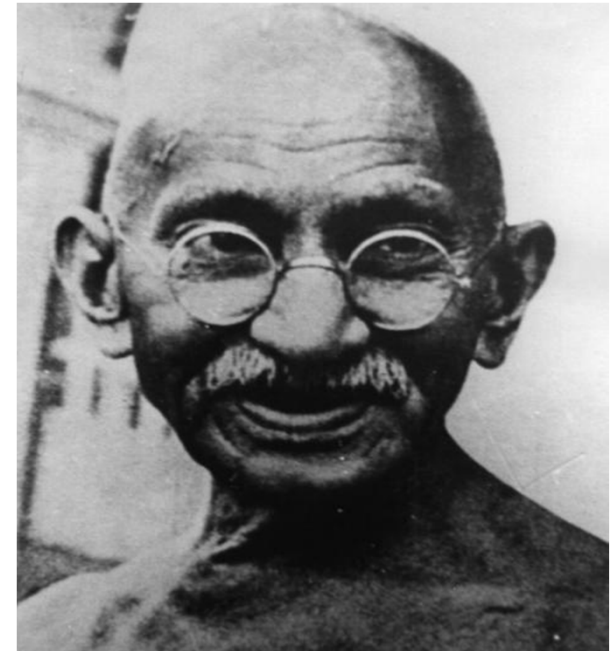


Mahatma Gandhi
(1869-1948)

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

Pneumatique pump supported pulsatile flow



Bridge to transplantation or destination therapy

HEART MATE II

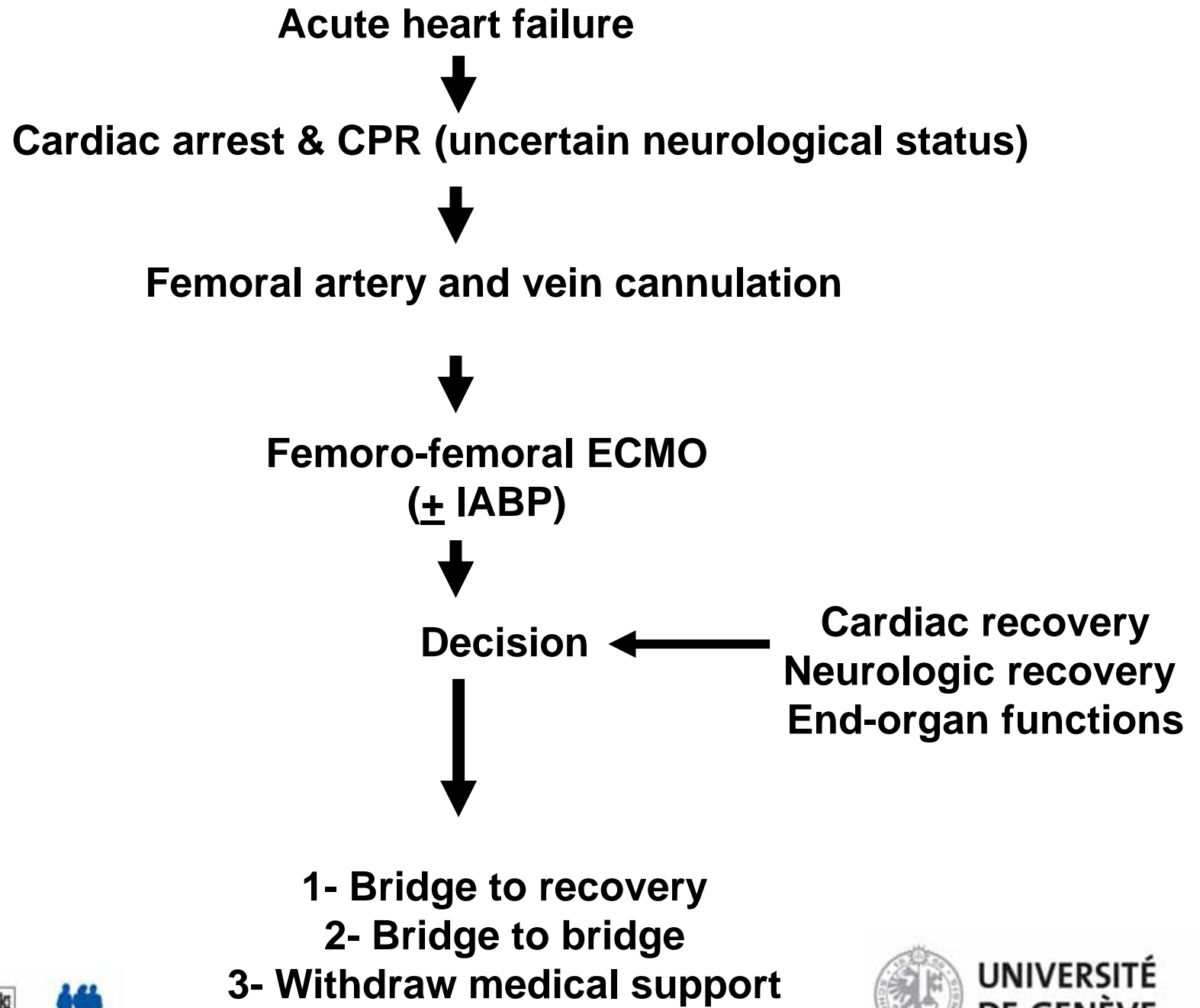
Continuous flow rotary pump



Thinks to do

- Having a team
- Having a VAD
- **Plans for the disasters**

A



B

Acute heart failure



Inotropic support and IABP



Coronary catheterisation



Coronary artery disease

- 1- PCI
- 2- Surgery

Normal coronary arteries



ECMO

a- Successful
CPB weaning

b- Fail to wean CPB



ECMO

Bridge to recovery
Bridge to bridge
Bridge to transplantation

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



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