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Prevention and treatment of pulmonary edema under peripheral veno-arterial ECMO

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Disclosures

No relevant financial disclosures that would be of potential conflict of interest with this presentation

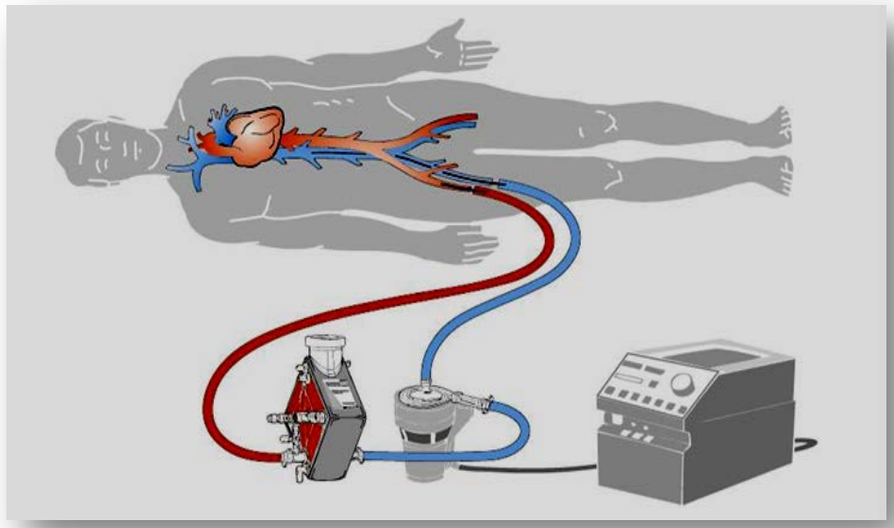
Indications for veno-arterial ECMO

Refractory cardiogenic shock – in potentially reversible heart condition

Refractory cardiogenic shock – bridge to ventricular assist device or transplantation

Cardiac arrest – unsuccessful advance life support (ALS)

Peripheral ECMO – fast, can be implanted at a bed side, efficient as circulatory and pulmonary support, cost-effective.



Complications for veno-arterial ECMO

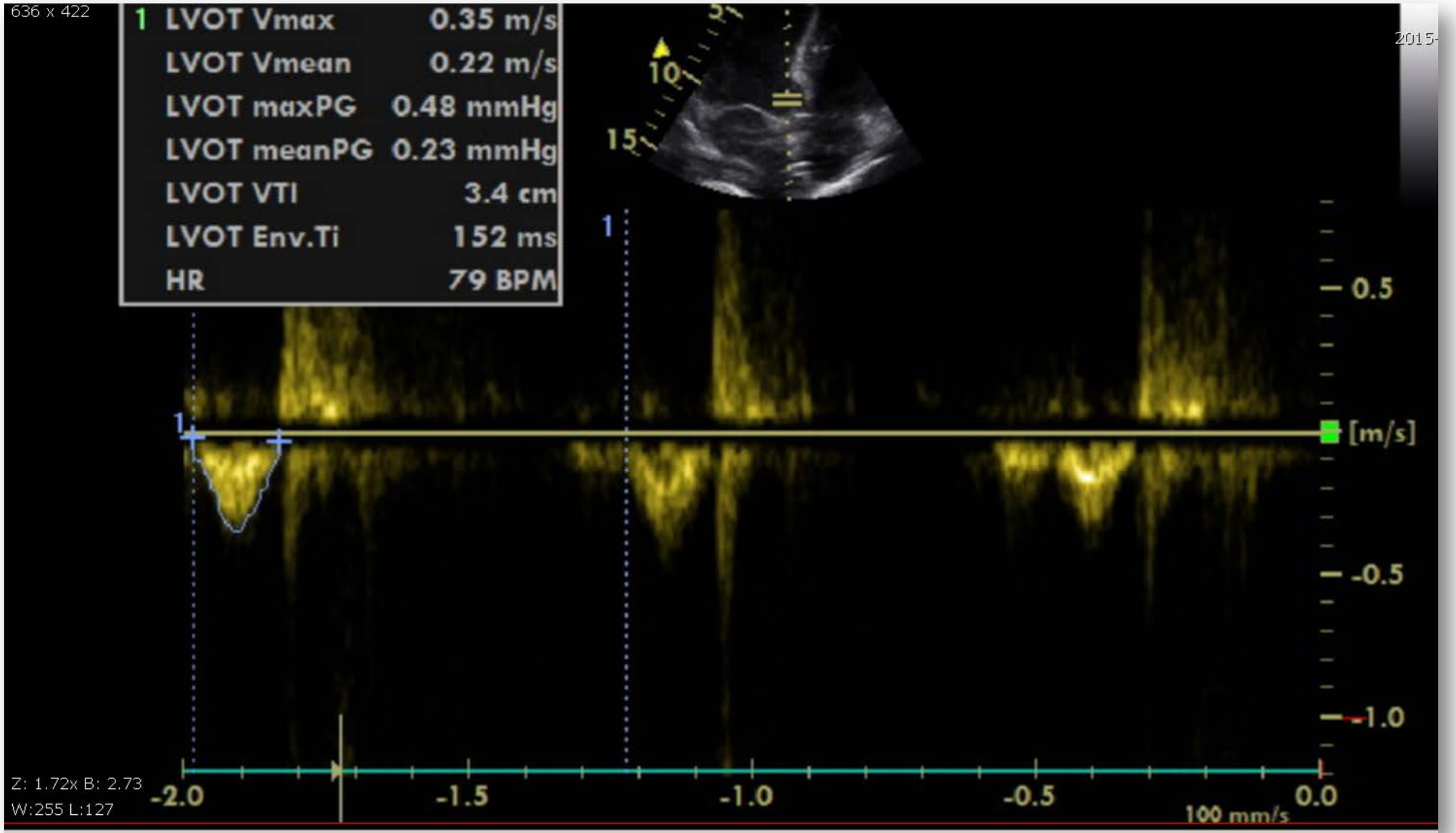
LV blood stagnation

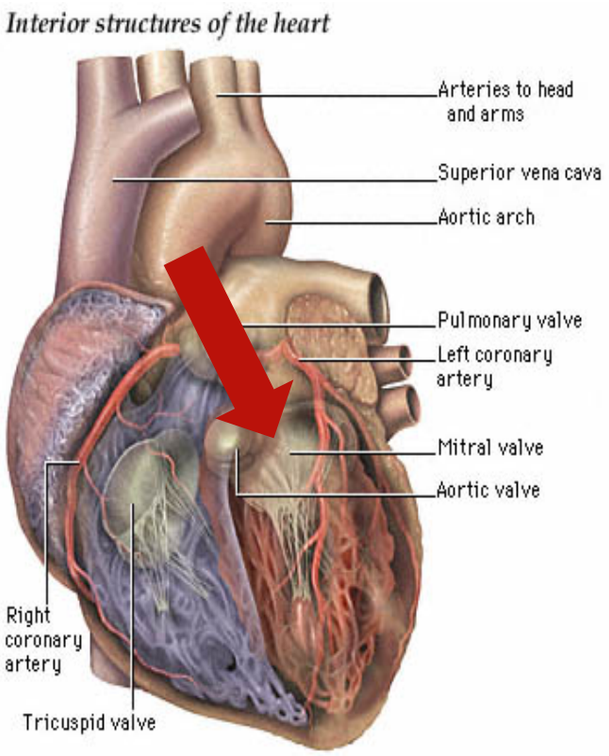
Clot formation (systemic thromboembolic complications, pulmonary vein thrombosis, pulmonary artery thrombosis)

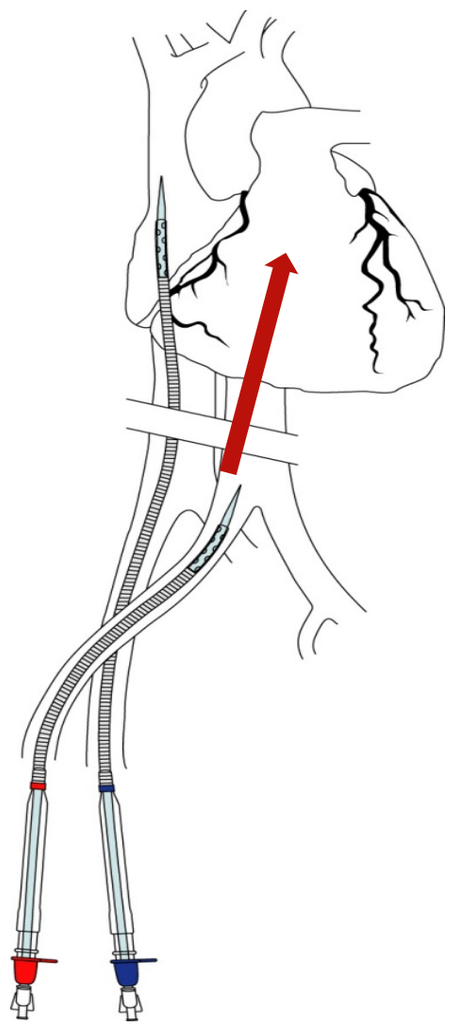
Pulmonary edema

- Late diagnosis
- Severe alteration of alveolar membrane
- No spontaneous regression
- Slow regression if late decompression

LV blood stagnation







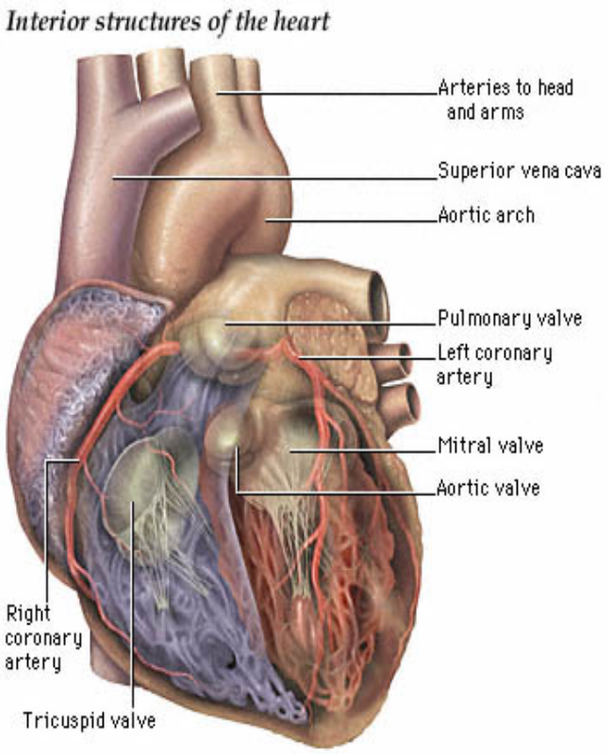
Negative effects of peripheral VA ECMO

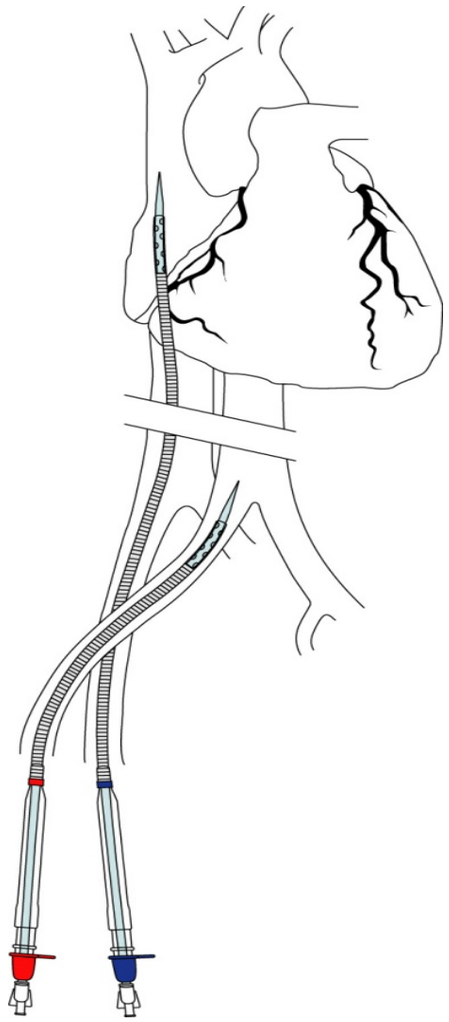
Reinjection of oxygenated blood countercurrent into the descending aorta.

Increased LV afterload.

In 10-20% patients this is associated with severe hydrostatic pulmonary edema

Aggravation by MR (induced by LV dilatation).





Risk factors for left ventricle distention

High pulmonary venous return to the left atrium

Failure of aortic valve opening (severe LV impairment or excessively high SVR)

The presence of aortic valve incompetence

Absence of functional MR (off-loading the distended ventricle)

Eventual ways to unload left ventricle

One of key issues for myocardial recovery

Medical therapy (inotropes, aggressive diuresis, CVVHF)

IABP

Pigtail catheter into LV through femoral aproach

Catheter-based trans-aortic axial flow pump (Impella)

Pulscath

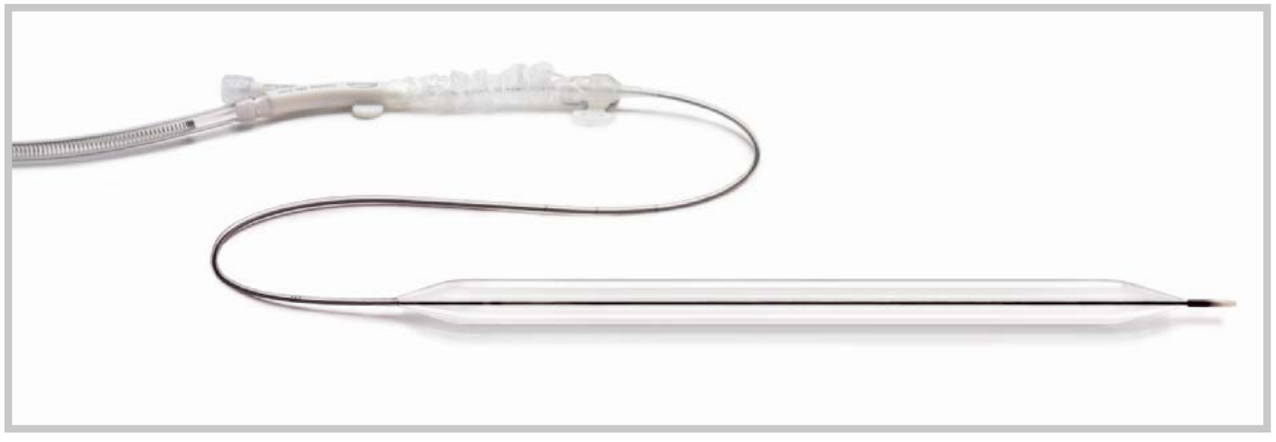
ASD (baloon septostomy) or trans-septal cannula

Pulmonary artery venting

Surgical cannulation of left atrium / transapical venting

Biventricular support (Centrimag)

IABP for LV unloading



Effects of IABP

IABP inflation – diastole

Augmentation of diastolic pressure
Increase coronary perfusion
Increase myocardial oxygen supply

IABP deflation – systole

Decrease afterload
Decrease cardiac work
Decrease myocardial oxygen consumption
Increase cardiac output

IABP Insertion

Percutanous

Sheathless

Surgical insertion

Femoral cut down

Tip of IABP just below the aortic arch, T2-T5 vertebrae

IABP Complications

Vascular complications

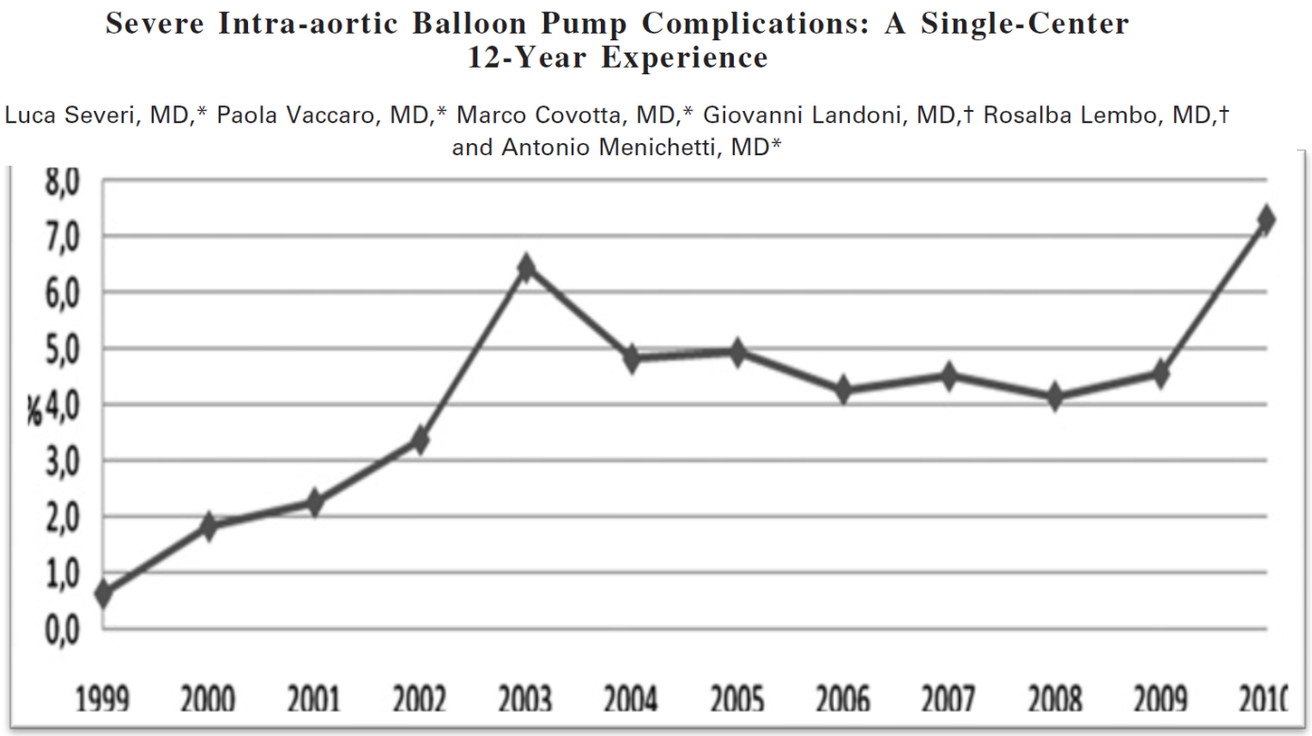
- limb ischemia
- bowel ischemia
- neurologic complications
- bleeding
- aortic perforation / disection

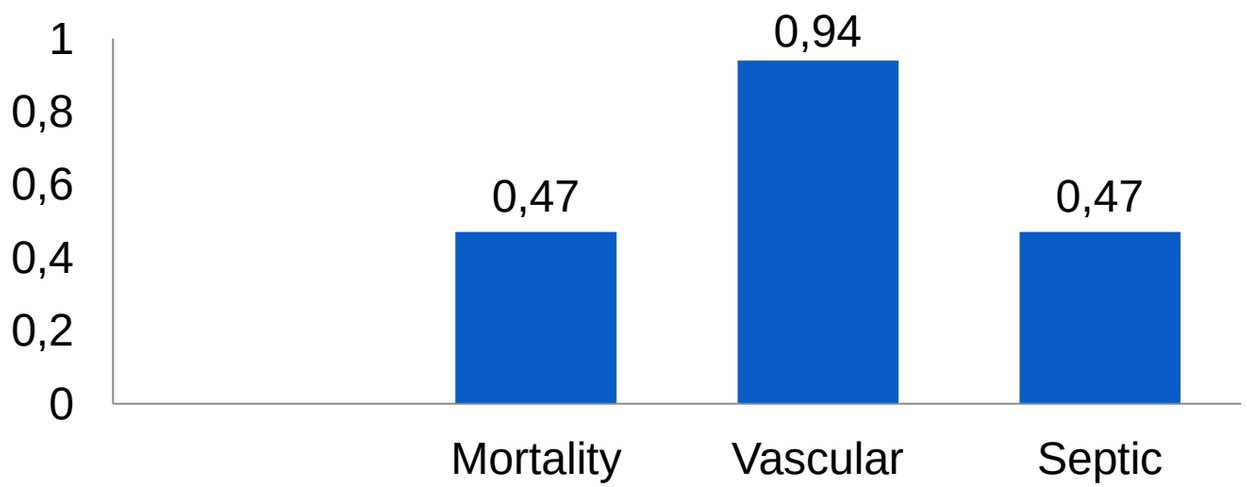
Balloon related

- malpositioned IABP
- catheter fracture

Renal failure

Infection





IABP for LV unloading

Intra-Aortic Balloon Pump Effects on Macrocirculation and Microcirculation in Cardiogenic Shock Patients Supported by Venoarterial Extracorporeal Membrane Oxygenation

Prospective, single centre, observational study

12 consecutive, cardiogenic shock pts treated with peripheral VA ECMO and litle/no residual LV ejection

Measurements were performed before and 30 minutes after interupting and restarting IABP counerpulsation

Crit Care Med 2014; 42 (9): 2075 - 82

IABP for LV unloading

Intra-Aortic Balloon Pump Effects on Macrocirculation and Microcirculation in Cardiogenic Shock Patients Supported by Venoarterial Extracorporeal Membrane Oxygenation

Echocardiographic data				
LV end-diastolic dimension (mm)	52±14	55±13	47±13[c]	0.003[d]
LV end-systolic dimension (mm)	50±14	51±13	42±13[c]	0.05[d]
Velocity-time integral (mm)	25±13	25±14	26±15	0.85
Cardiac output (L/min)	0.79±0.46	0.77±0.78	0.81±0.74	0.85
Diastolic velocity				
Transmitral early peak (cm/s)	49±19	61±25	51±26	0.07
Transmitral late peak (A) (cm/s)	32±13	31±9	31±12	0.10
Transmitral early/late peak	1.26±0.38	1.95±0.66	1.33±0.36	0.003
Lateral mitral early annular (cm/s)	6.4±2.8	6.4±2.5	5.8±1.9	0.44
Transmitral early peak/lateral mitral early annular	8.6±4.0	9.8±2.6	9.2±4.3	0.31
Systolic mitral annulus velocity (cm/s)	4.9±2.5	5.0±2.9	4.9±2.3	0.90

Crit Care Med 2014; 42 (9): 2075 - 82

IABP for LV unloading

Intra-Aortic Balloon Pump Effects on Macrocirculation and Microcirculation in Cardiogenic Shock Patients Supported by Venoarterial Extracorporeal Membrane Oxygenation

Conclusion:

Restoring pulsatility and decreasing cardiac afterload with IABP in patients receiving peripheral VA ECMO were associated with lower LVEDD and pulmonary artery pressures, without affecting microcirculation variables in cardiogenic shock patients with no or little residual LV ejection.

Crit Care Med 2014; 42 (9): 2075 - 82

Pigtail catheter for LV unloading

Proposal for bail-out procedures - Assisted circulation

Left ventricle unloading by percutaneous pigtail during extracorporeal membrane oxygenation

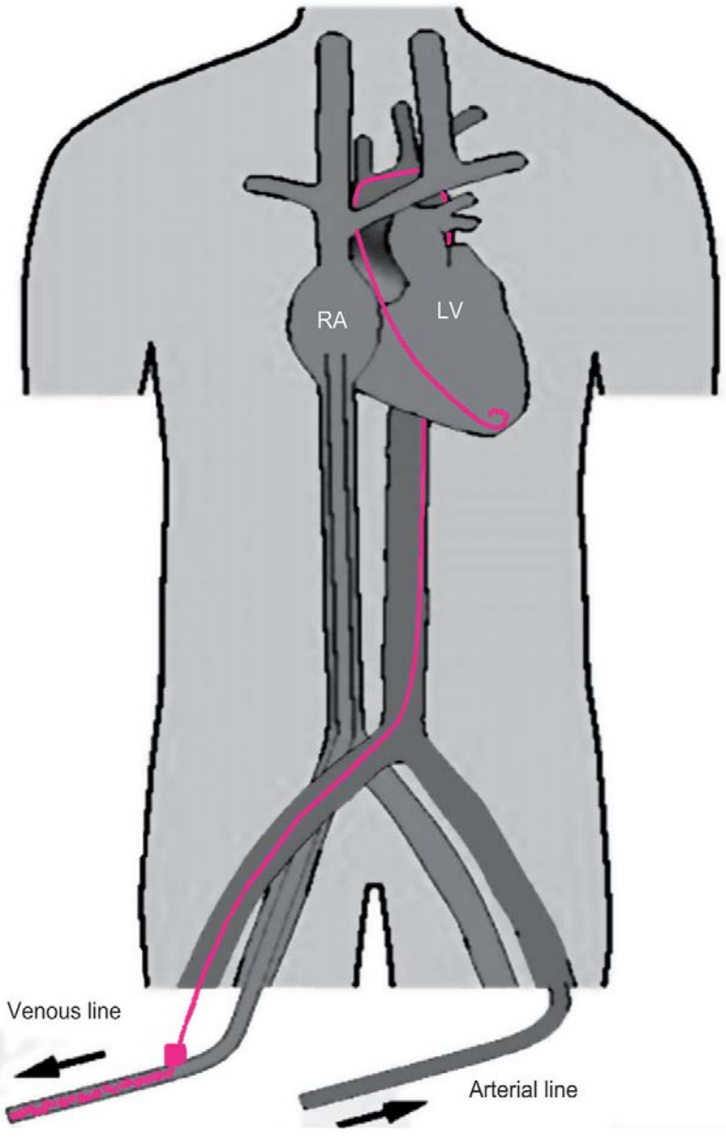
Alessandro Barbone[a,*], Pietro Giorgio Malvindi[a], Pietro Ferrara[b], Giuseppe Tarelli[a]

Three pts case series

7 FR Pig Tail catheter (110 cm)

Guided by TEE

3/8x3/8 conector with luer exit



Interactive Cardiovasc Thorac Surg 2011; 13 : 293 - 295

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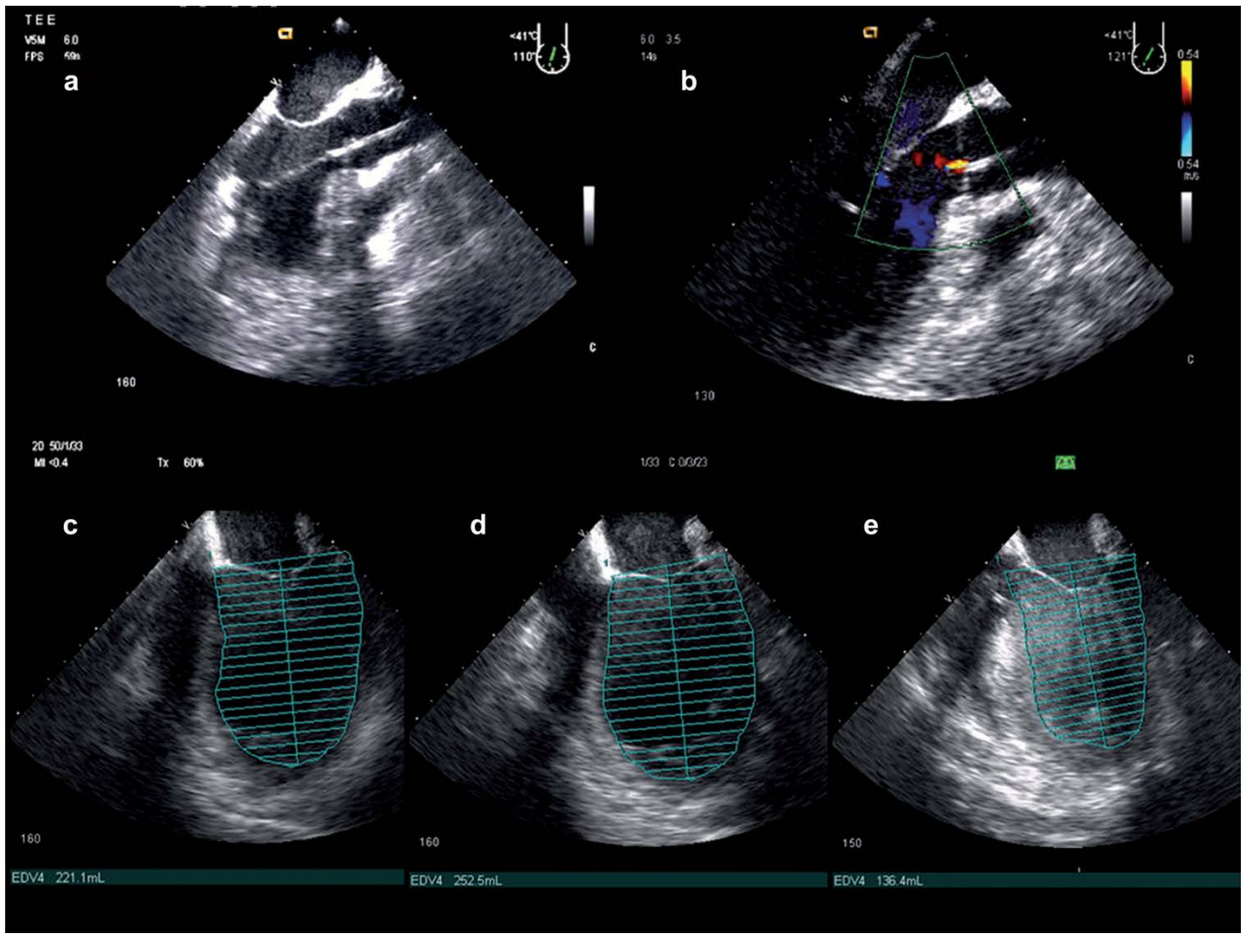
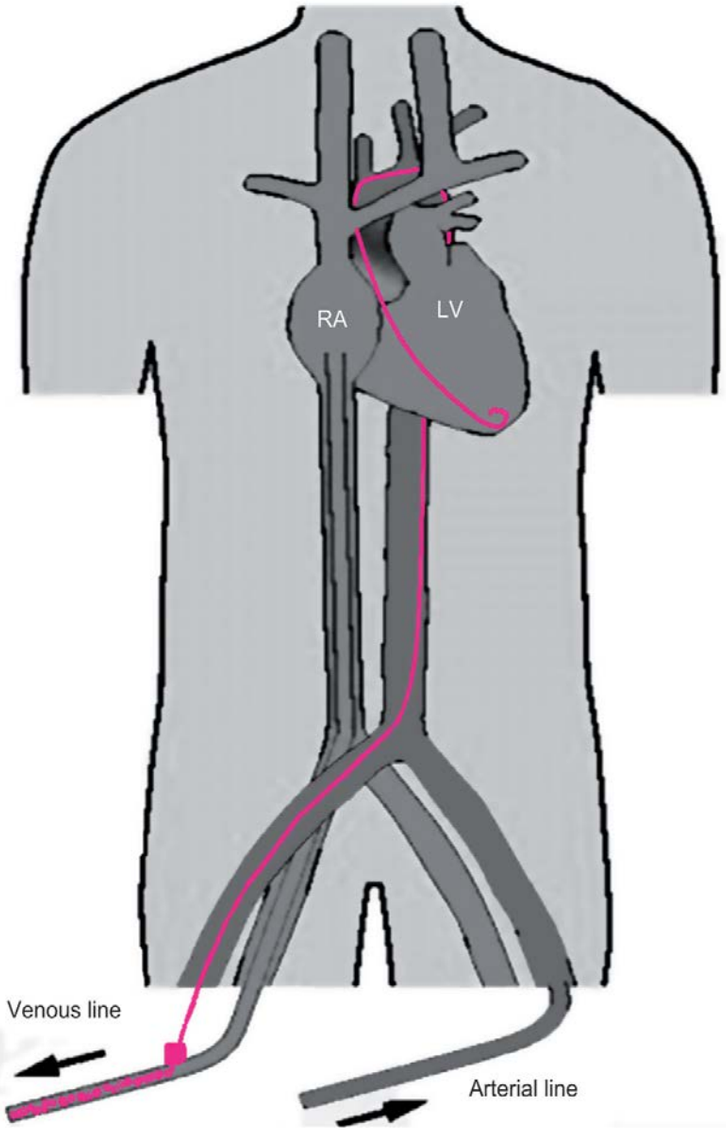
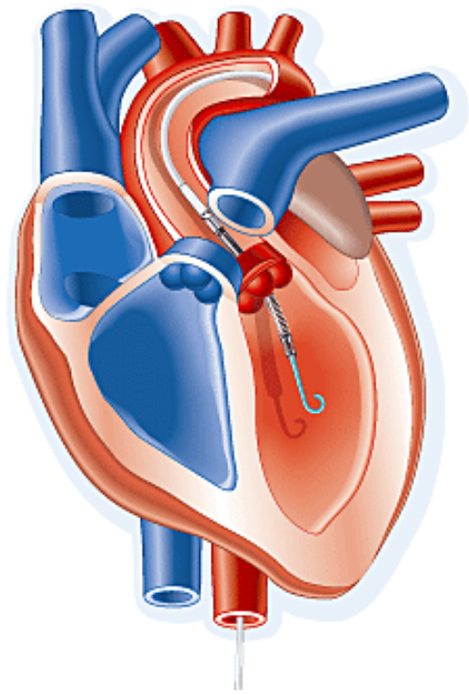




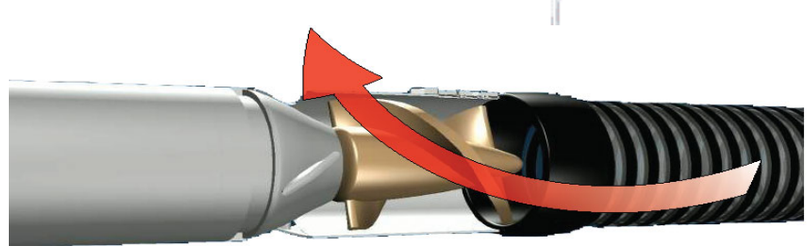
Interactive Cardiovasc Thorac Surg 2011; 13 : 293 - 295

Impella 2.5 for LV unloading



Impella to Unload the Left Ventricle During Peripheral Extracorporeal Membrane Oxygenation

Allen Cheng, Michael F. Swartz, and H. Todd Massey



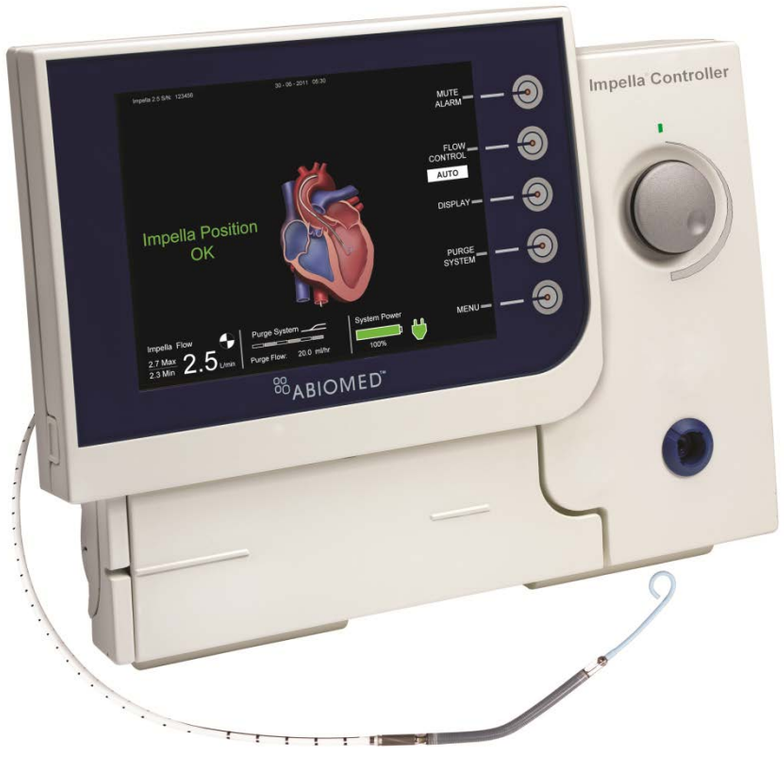
The world smallest heart pump

9 Fr catheter, 12 Fr micro-axial pump

Delivers 2,5 L/min of forward flow

Increases cardiac output

Reduction O_2 demand / increase O_2 supply



ASAIO 2011; 59 (5): 533 - 536

Impella 2.5 for LV unloading

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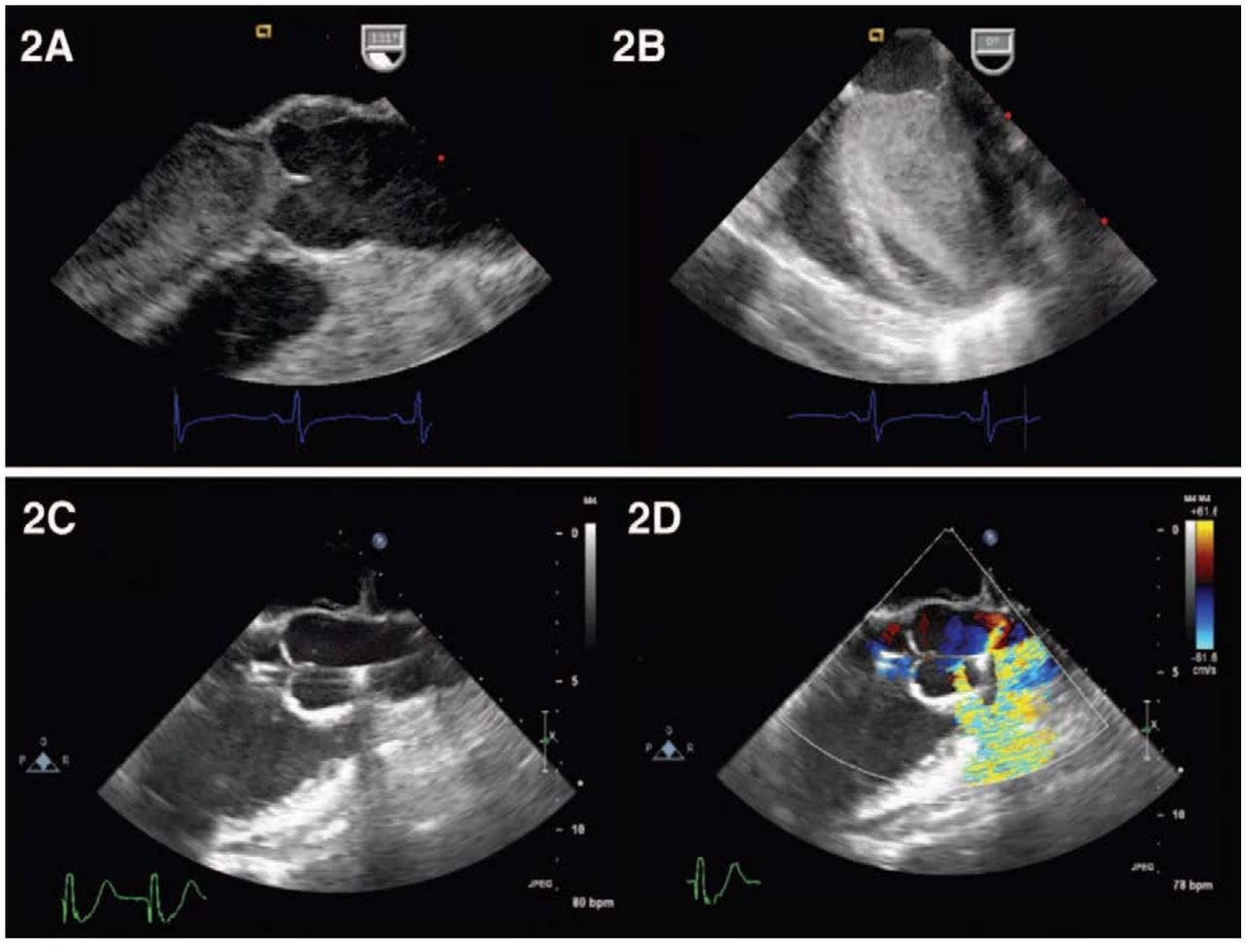
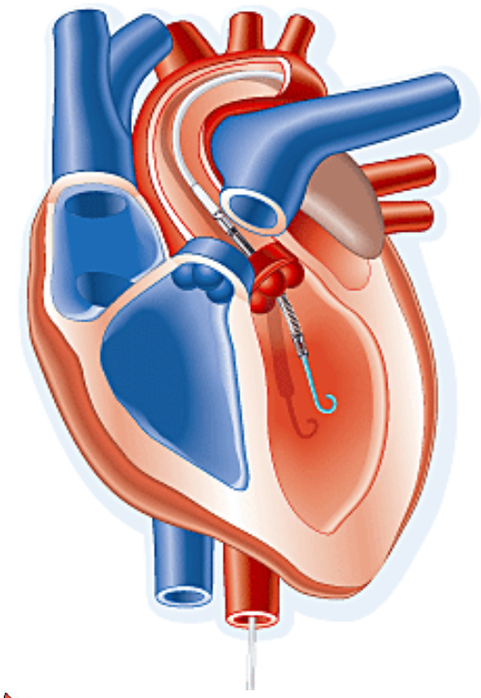
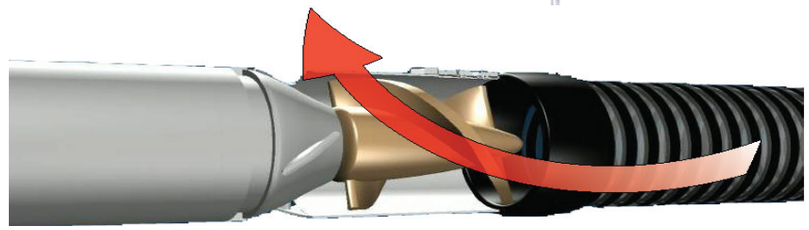
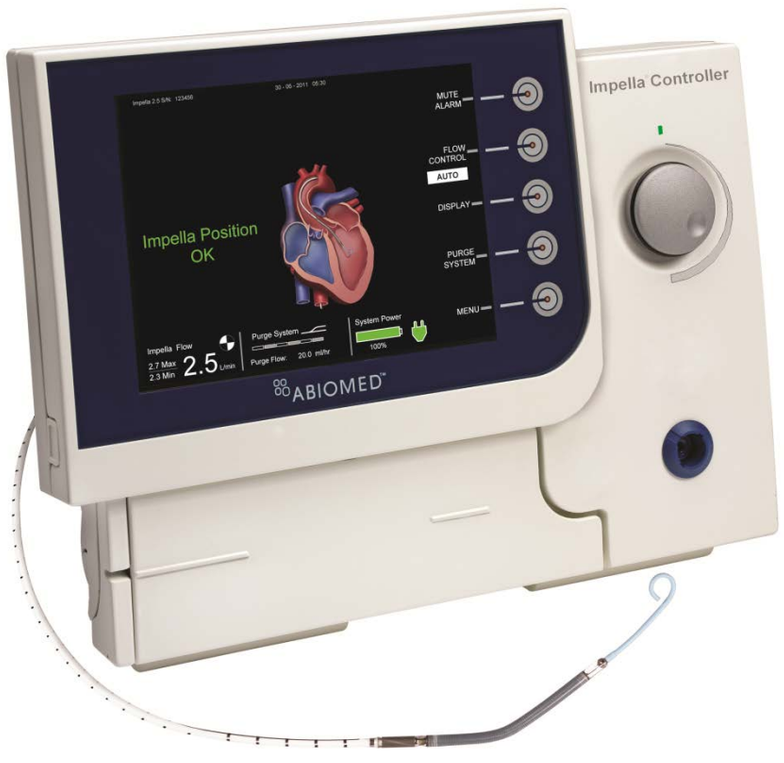


ASAIO 2011; 59 (5): 533 - 536







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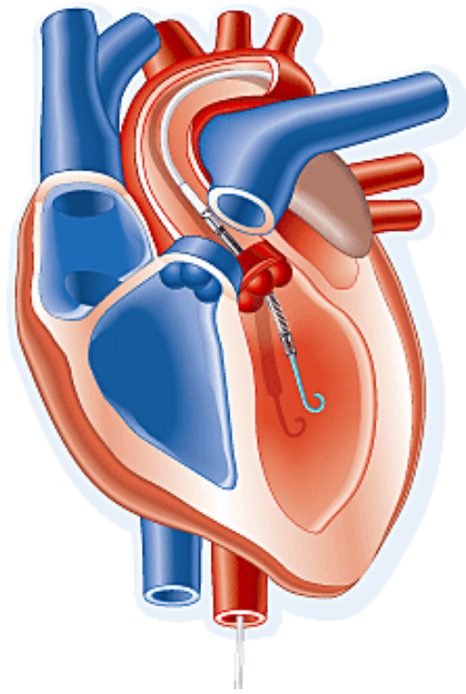

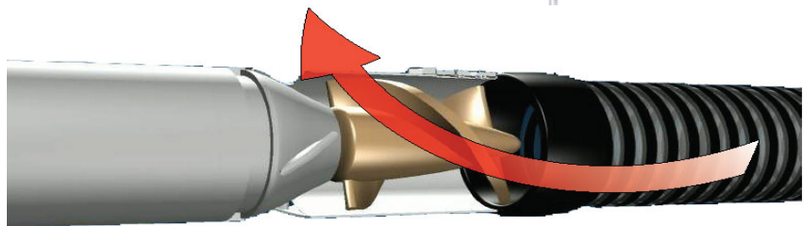

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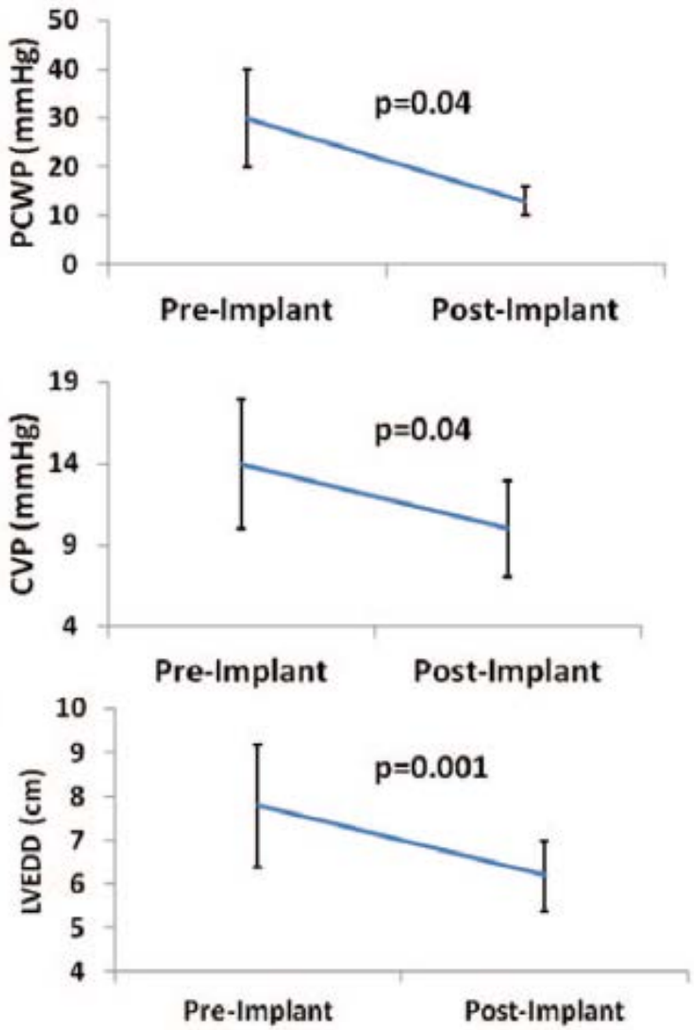
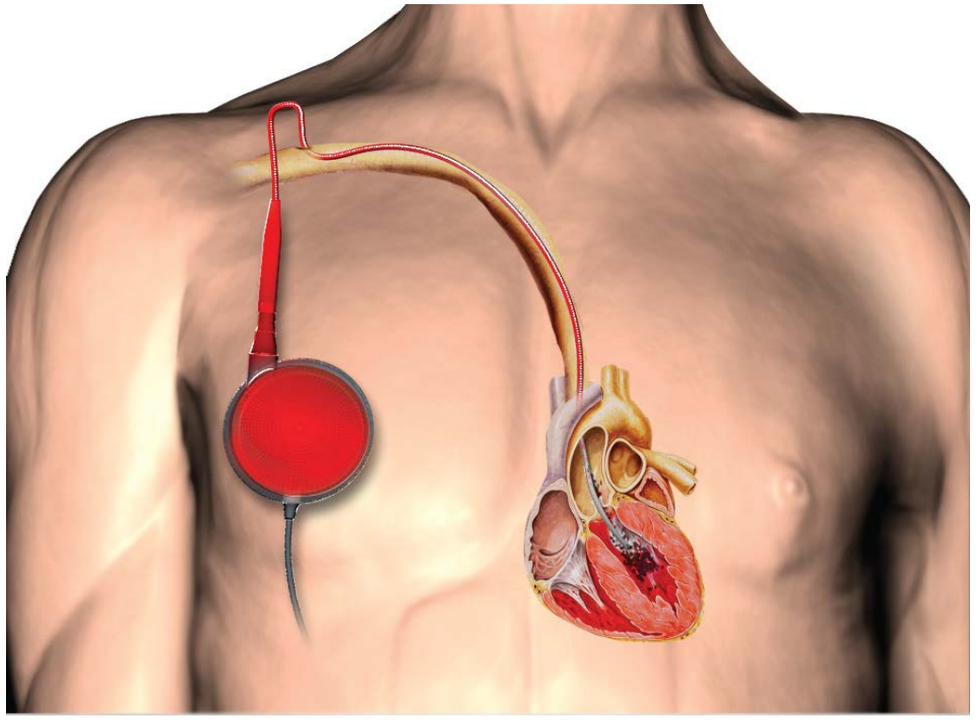


ASAIO 2011; 59 (5): 533 - 536

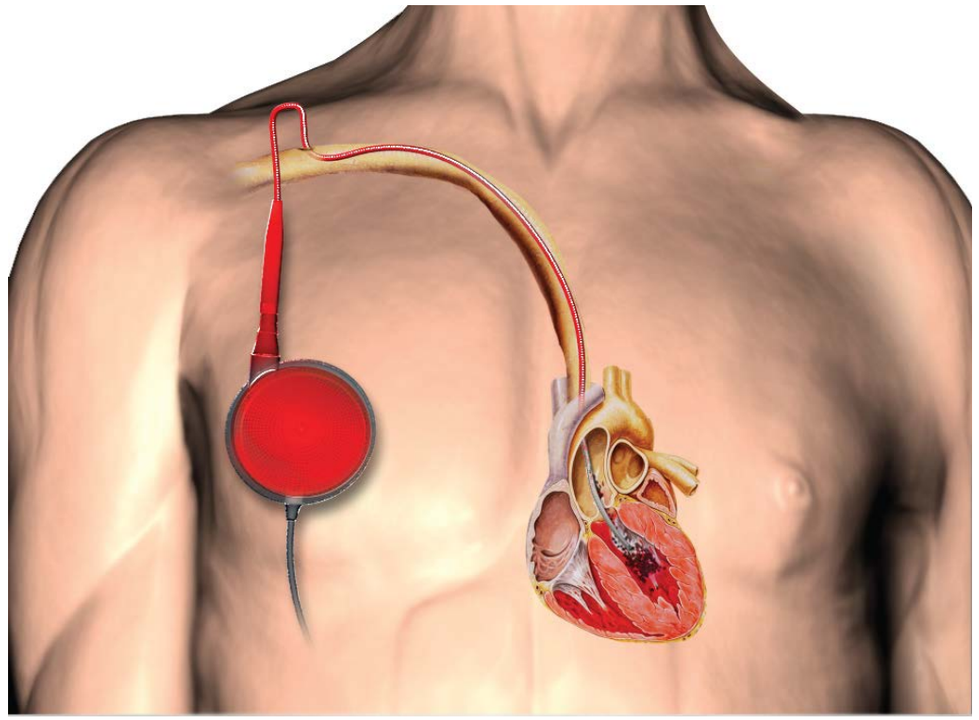
PulseCath for LV unloading



PulseCath for LV unloading

During systole blood is aspired from the left ventricle to the membrane pump.

During diastole blood is ejected via Puls Cath valve into the aorta



PulseCath, a new short-term ventricular assist device: our experience in off-pump coronary artery bypass graft surgery

Alessio Amico[a], Mario Siro Brigiani[b], Albino Vallabini[a], Beniamino Ferrante[a], Angelo Marzovillo[a], Domenico Loizzi[a] and Carmine Carbone[a]

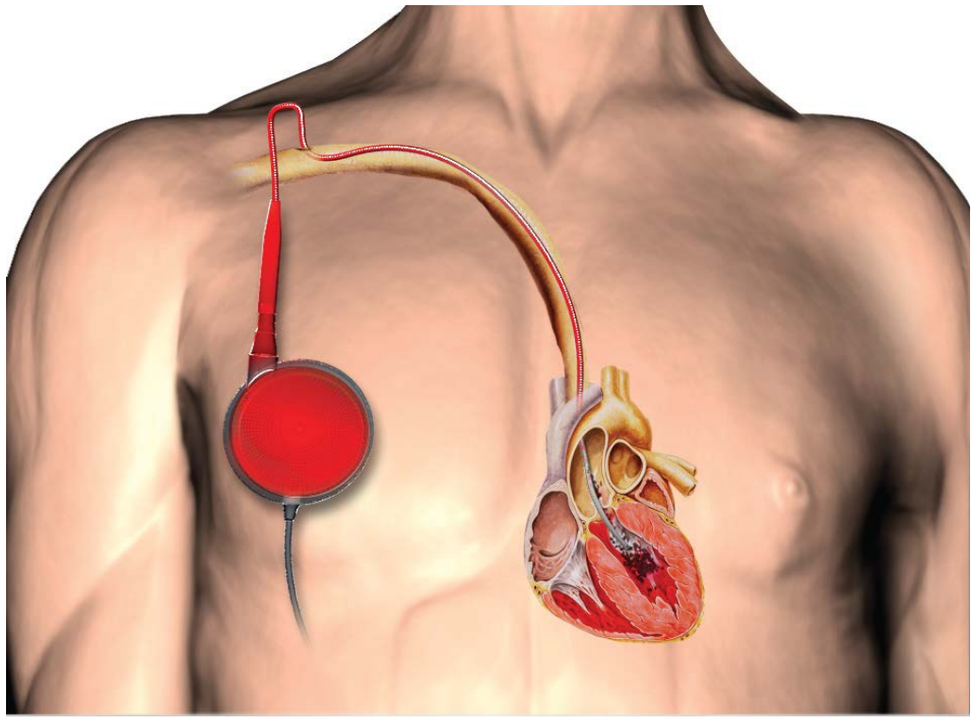
Journal of Cardiovascular Medicine 2008, Vol 9 No 4

Work in progress report - Assisted circulation

PulseCath iVAC 3L™ hemodynamic performance for simple assisted flow

Interactive CardioVascular and Thoracic Surgery 12 (2011) 912-913

PulseCath for LV unloading



PA venting for LV unloading

Percutaneous Left-Heart Decompression During Extracorporeal Membrane Oxygenation: An Alternative to Surgical and Transeptal Venting in Adult Patients

Leonello Avalli,* Elena Maggioni,* Fabio Sangalli,* Giorgio Favini,† Francesco Formica,‡ and Roberto Fumagalli*

Peripheral ECMO for cardiogenic skock
10% LVEF, thrombus at the apex
21 Fr inflow, 15 FR outflow cannulas
Swan-Ganz catheter
6 Fr angiographic catheter – into PA
Amplatz Ultra Stiff Wire Guide
15 Fr 50 cm venous catheter - PA

ASAIO 2011; 57: 00 - 00

PA venting for LV unloading

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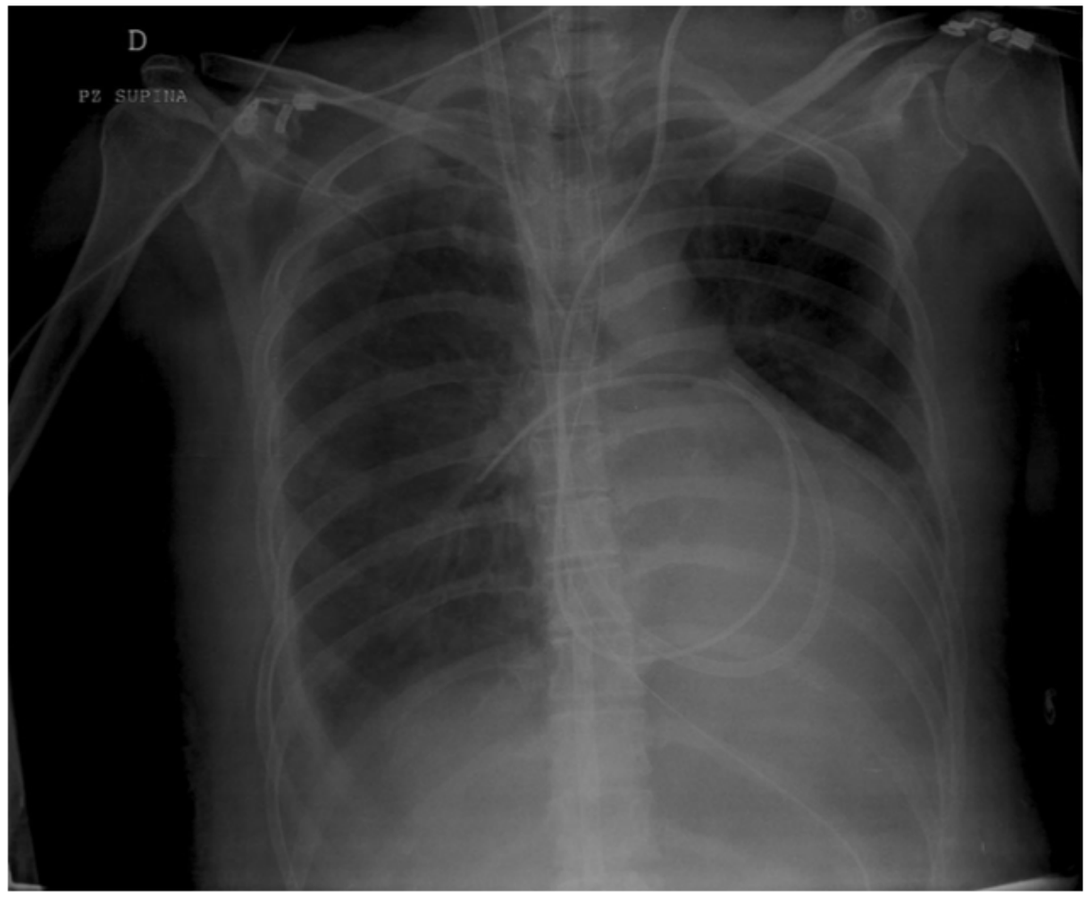
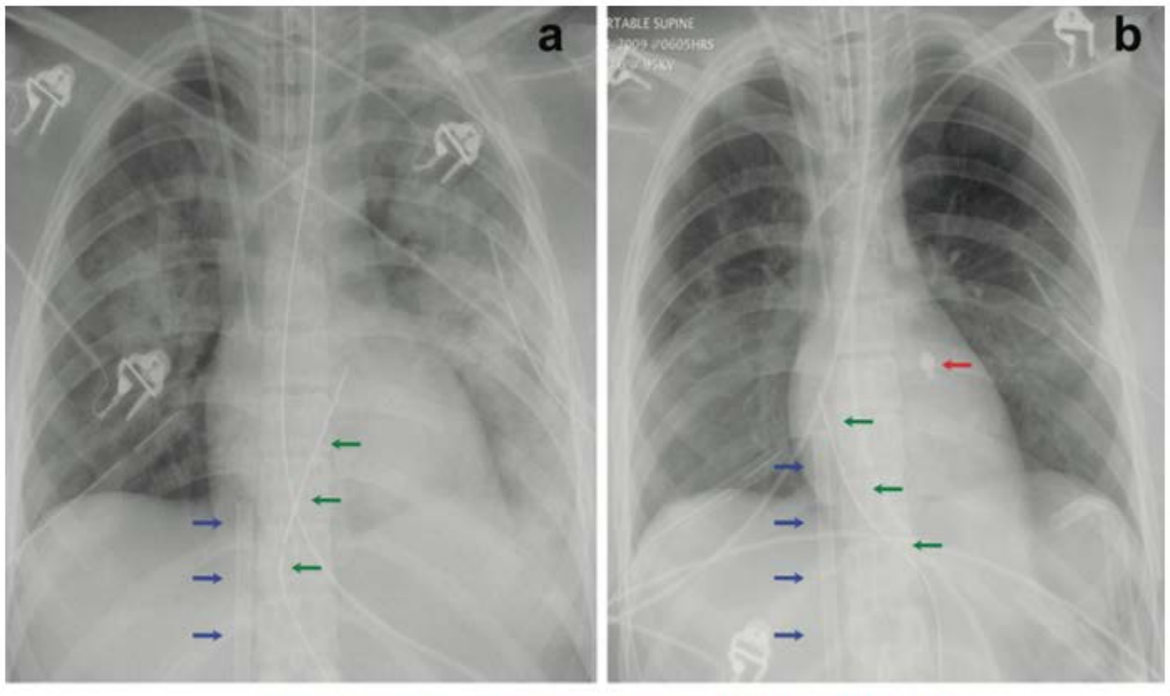


ASAIO 2011; 57: 00 - 00

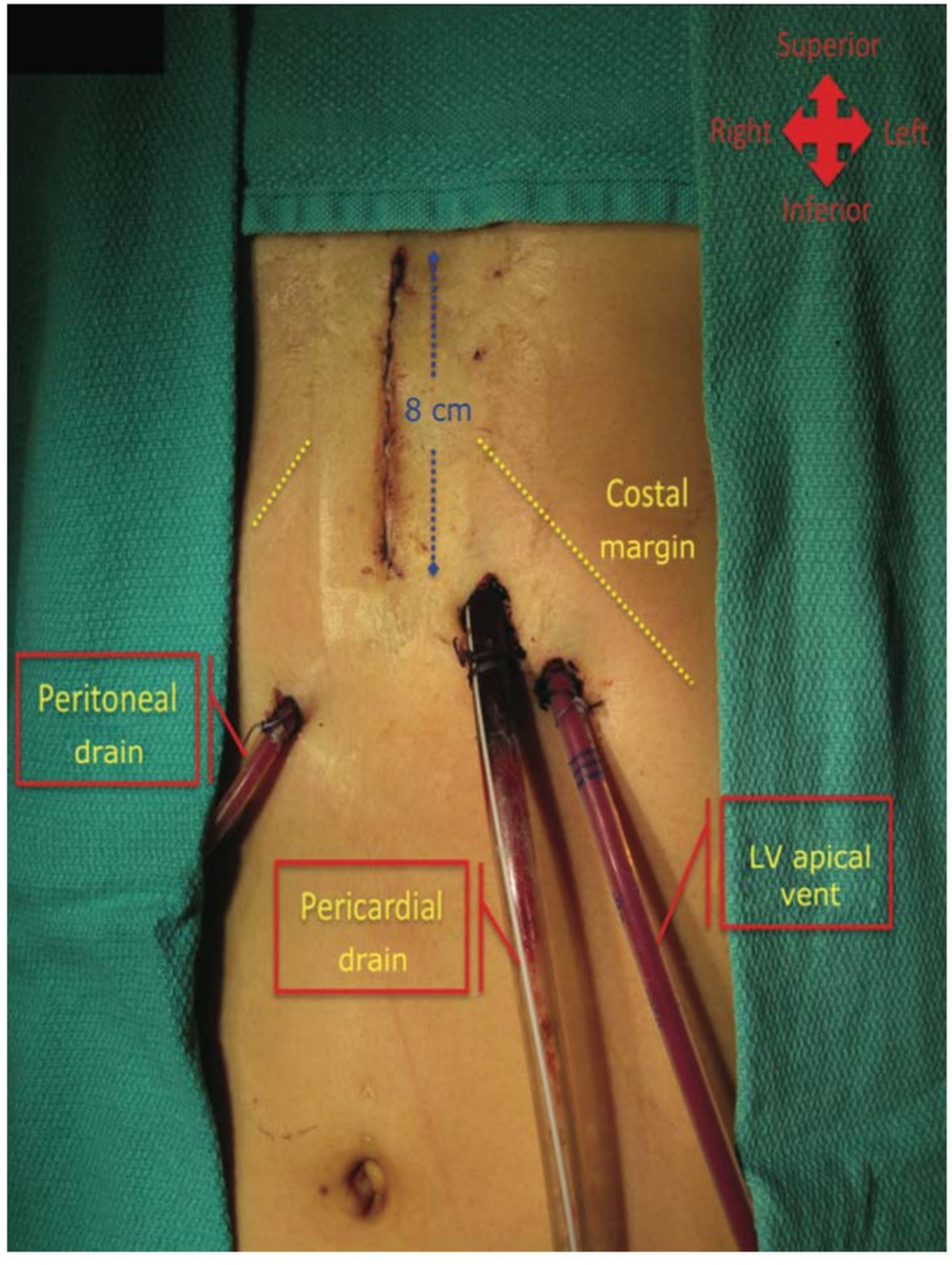
Minimally invasive surgical LV venting

Minimally invasive left-heart decompression during venoarterial extracorporeal membrane oxygenation: an alternative to a percutaneous approach

Mina Guirgis[a], Kanwal Kumar[a,b], Alan H. Menkis[a], Darren H. Freed[a,b,*]



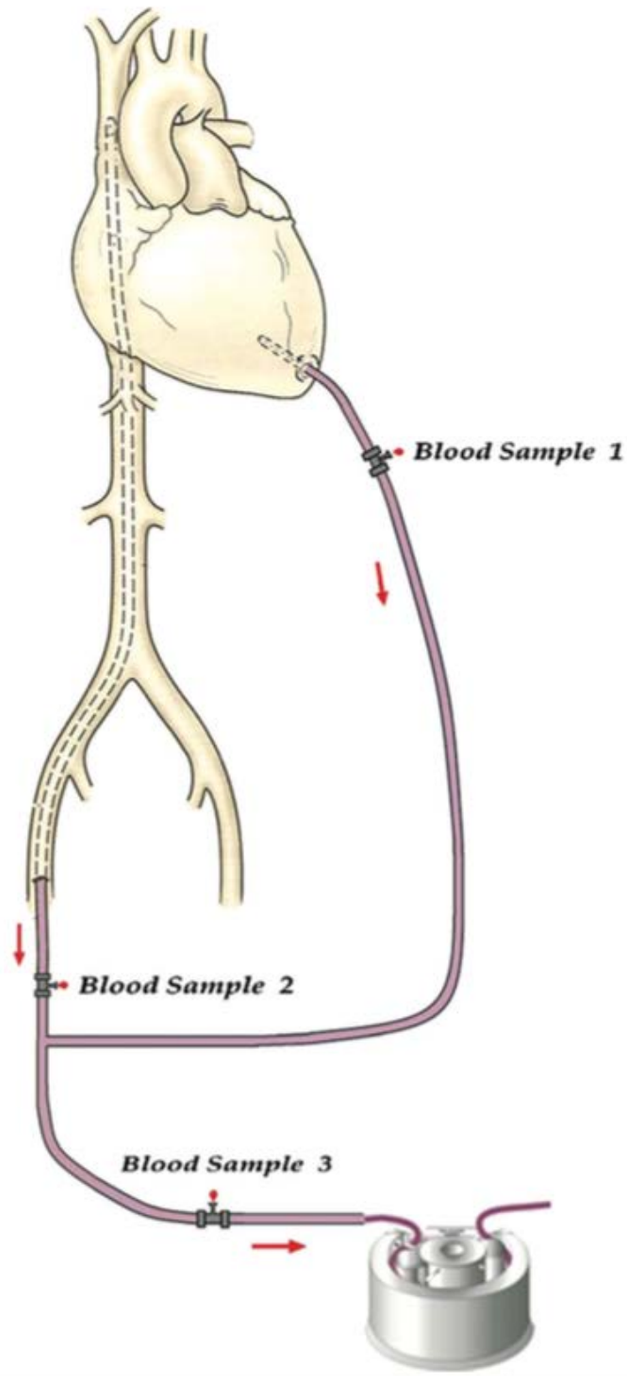
ICVTS 2010; 10 : 672- 674



Minimally invasive surgical LV venting

Management of transapical left venting during adult peripheral extracorporeal membrane oxygenation

Giuseppe Rescigno*, Carlo Aratari, Marco L. S. Matteucci, Francesco Massi, Filippo Capestro, Alessandro D'Alfonso and Lucia Torracca

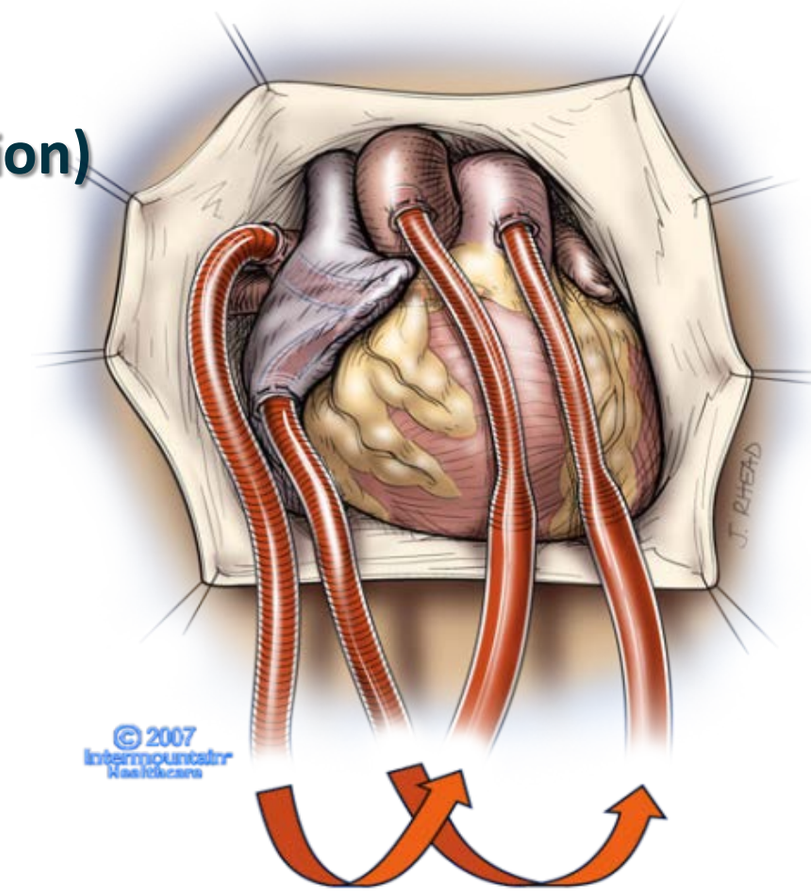


Three pts case series

	Inflow cannula	Arterial cannula	LV drainage
1st patient	23 Fr	24 Fr	24 Fr
2nd patient	21 Fr	20 Fr	24 Fr
3rd patient	19 Fr	20 Fr	24 Fr

Mechanical Circulatory Support; 2011 (2): 5981

Biventricular VAD (intra-thoracic implantation)



Outcomes, long-term quality of life, and psychologic assessment of fulminant myocarditis patients rescued by mechanical circulatory support*

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

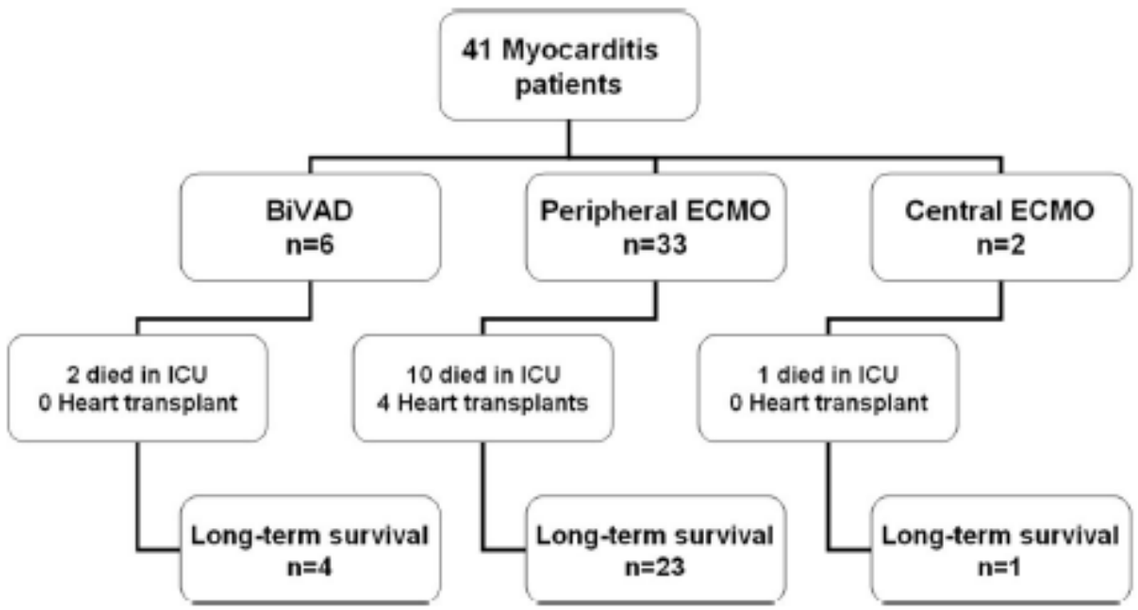


Figure 1. Outcomes of the 41 patients with fulminant myocarditis rescued by mechanical circulatory assistance. *BiVAD*, Thoratec paracorporeal ventricular assist device; *ECMO*, extracorporeal membrane oxygenation; *ICU*, intensive care unit.

Crit Care Med 2011; 39 : 1029- 1035

Summary

Peripheral veno-arterial ECMO through increase in SVR may have an impact on pulmonary circulation, leading to refractory pulmonary edema

Pulmonary edema does not regress spontaneously

Unloading of left ventricle is one of key point not only for myocardial recovery, but also survival.

Variety of technics have been proposed to treat peripheral VA ECMO induced pulmonary edema

IABP could be an efficient tool to prevent occurrence of pulmonary edema during peripheral veno-arterial ECMO

Thank You For Your Attention!