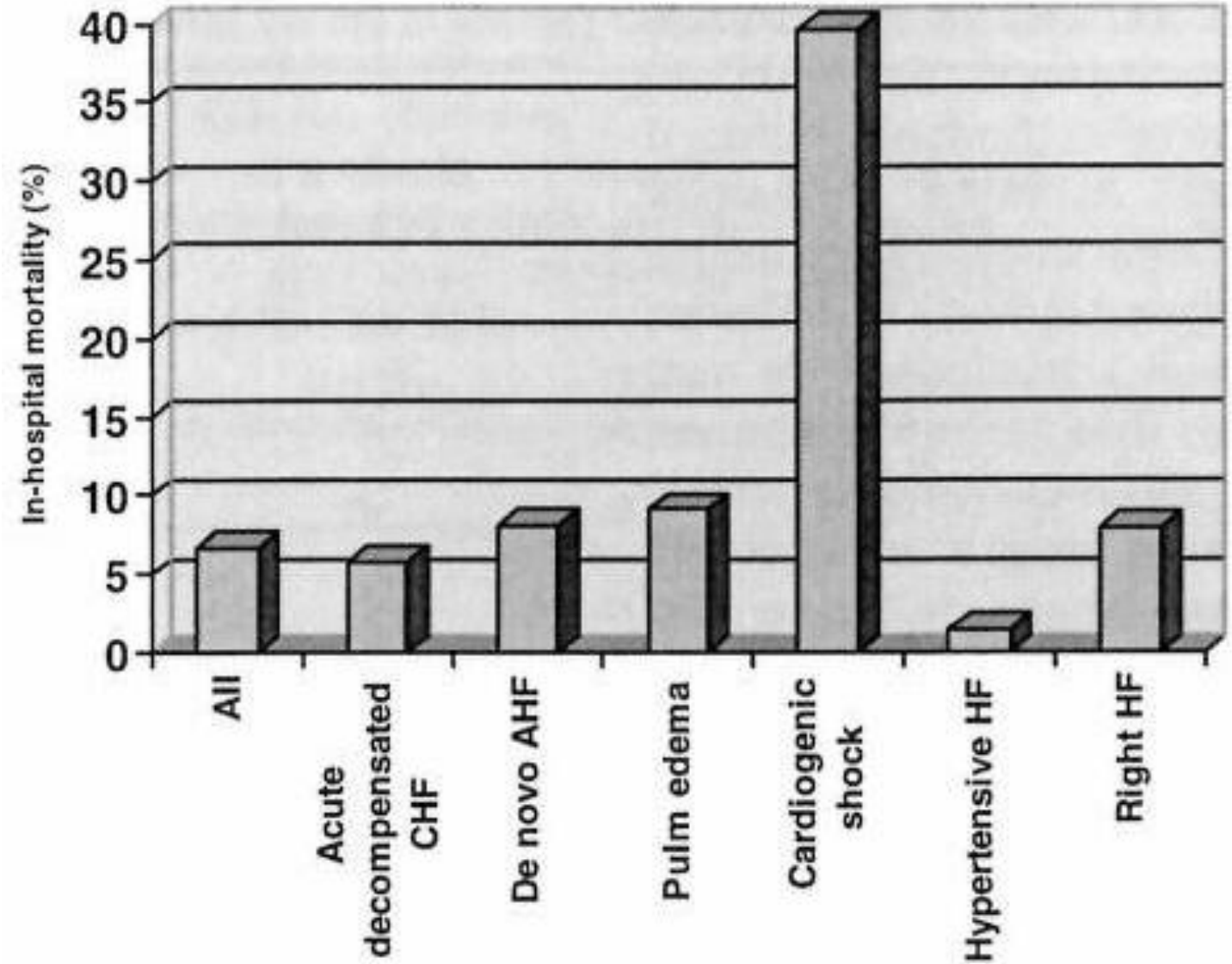
Mekaniska cirkuklationsstöd

Bengt Peterzén
Thorax-Kärlkliniken
Linköping

Sanofi
Medtronic
Vingmed
Orion Pharma

Vimmerby 2019 01 10



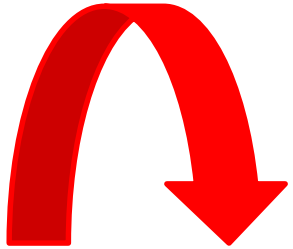
Dar O, Cowie M. Crit Care Med 2008;36:S3-S8.

Kardiogen chock

→ Hjärtskada/dysfunktion

→ Hypoperfusion

→ Stas



Inflammation, vital organdysfunktion, apotos, fibros

Systemsjukdom

Mortalitet 40 - 50% trots modern behandling

Akut svår hjärtsvikt – Kardiogen chock

- Behandla bakomliggande orsak

- Begränsa myokardskadan

- Adekvat organperfusion

#

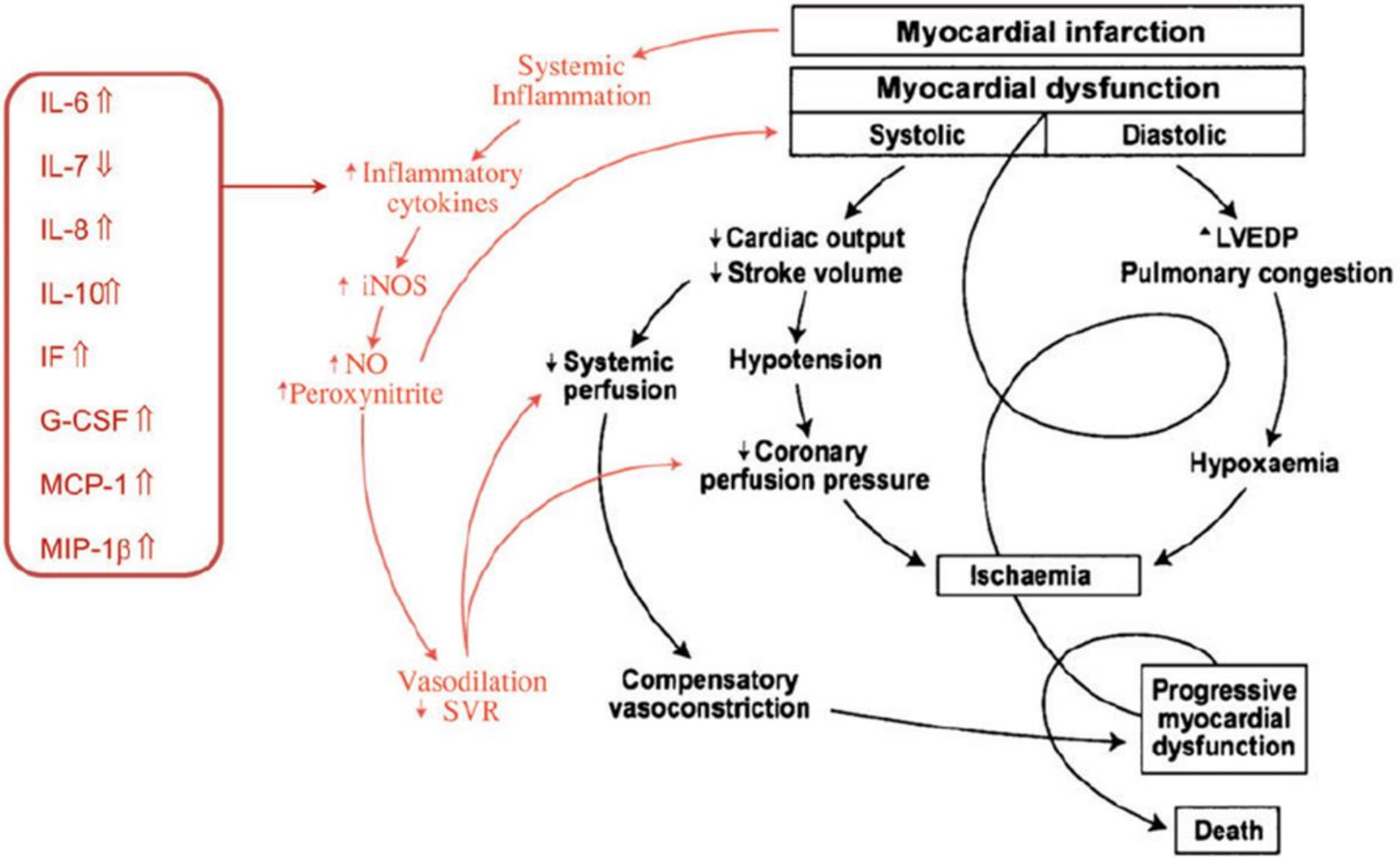
- Tidig mortalitet → MOF

- Sen mortalitet → hjärtsvikt

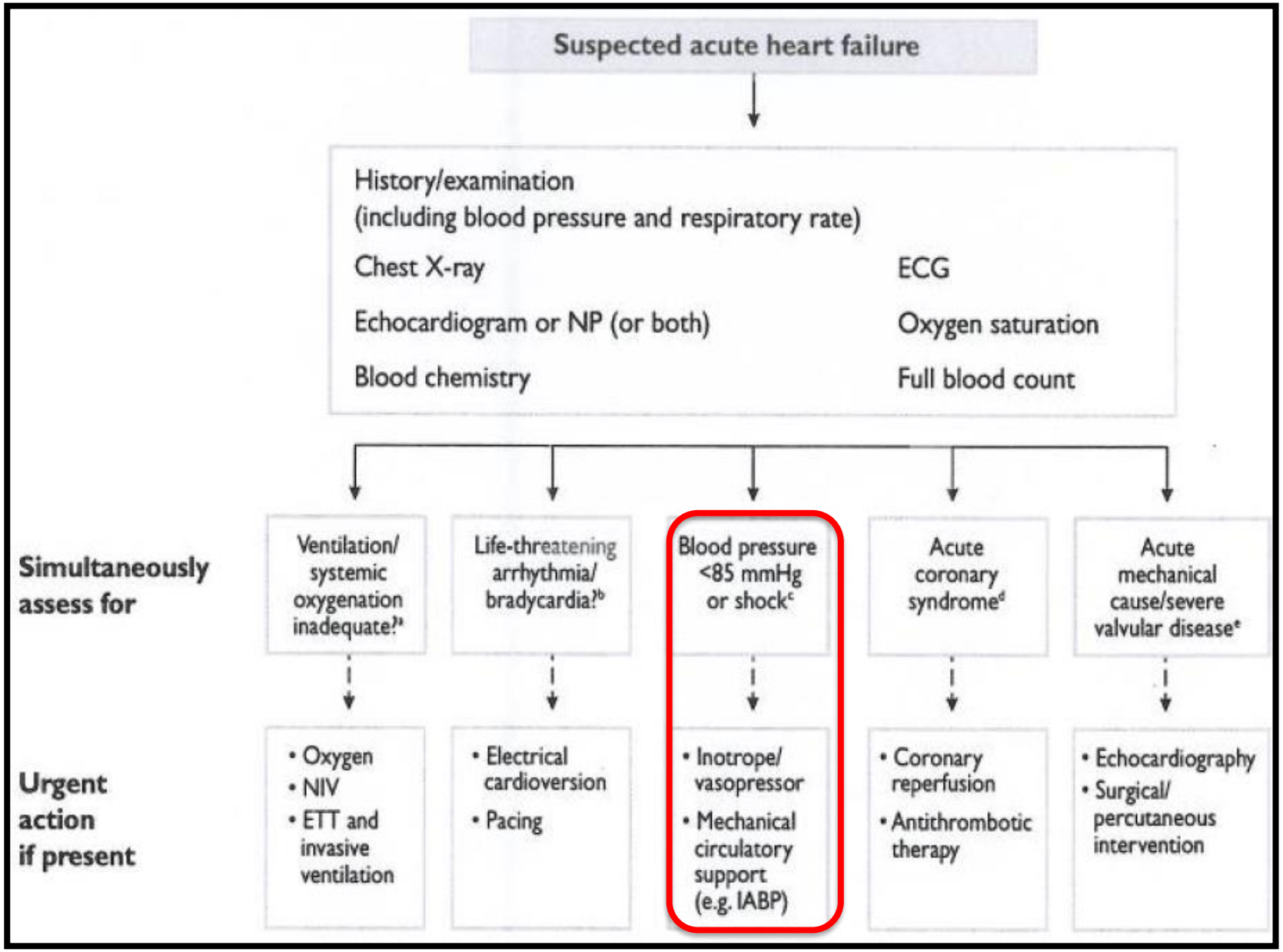
#

- Värdera alltid aktuell ”slutbehandling” innan temporär assist!

AHF - CS



Werdan K, et al. Eur Heart J;35:156-167.



ESC Guidelines 2014

Intensive Care Med
DOI 10.1007/s00134-015-4041-5

REVIEW

A. Mebazaa
H. Tolppanen
C. Mueller
J. Lassus
S. DiSomma
G. Baksyte
M. Cecconi
D. J. Choi
A. Cohen Solal
M. Christ
J. Masip
M. Arrigo
S. Nouira
D. Ojji
F. Peacock
M. Richards
N. Sato
K. Sliwa
J. Spinar
H. Thiele
M. B. Yilmaz
J. Januzzi

Acute heart failure and cardiogenic shock: a multidisciplinary practical guidance

Review

Call to action: Initiation of multidisciplinary care for acute heart failure begins in the Emergency Department

Michael Christ[1] and Christian Mueller[2]

Eur Heart J: Acute Cardiovascular Care 2015;1-9.

Terapeutiska interventioner

→ Sedering

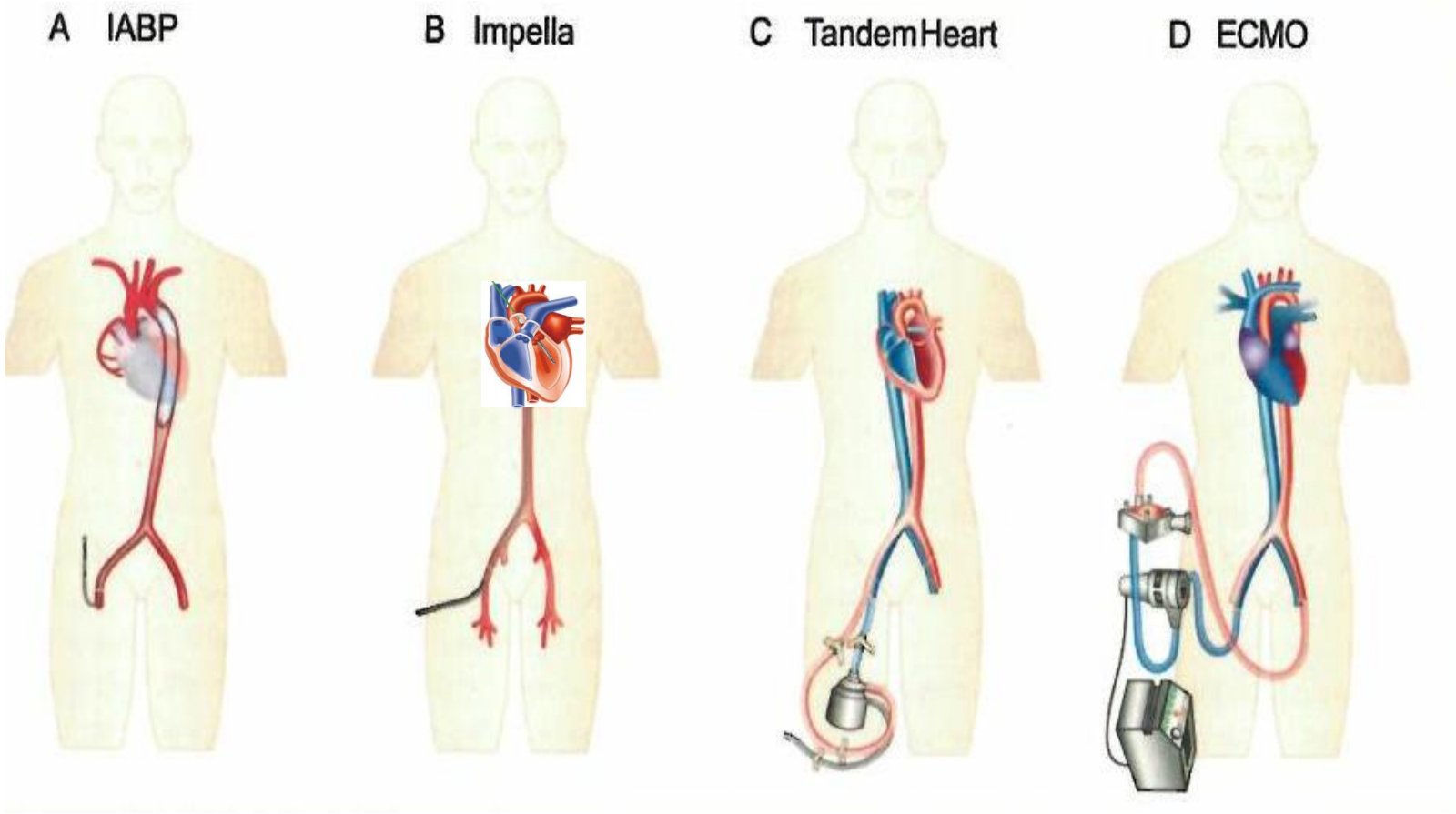
→ Mekanisk ventilation

→ Hemodynamik
- Volym
- Vasodilatation
- Inotropi /inodilatation
- MCS

→ CRRT

→ Nutrition, antibiotika etc.

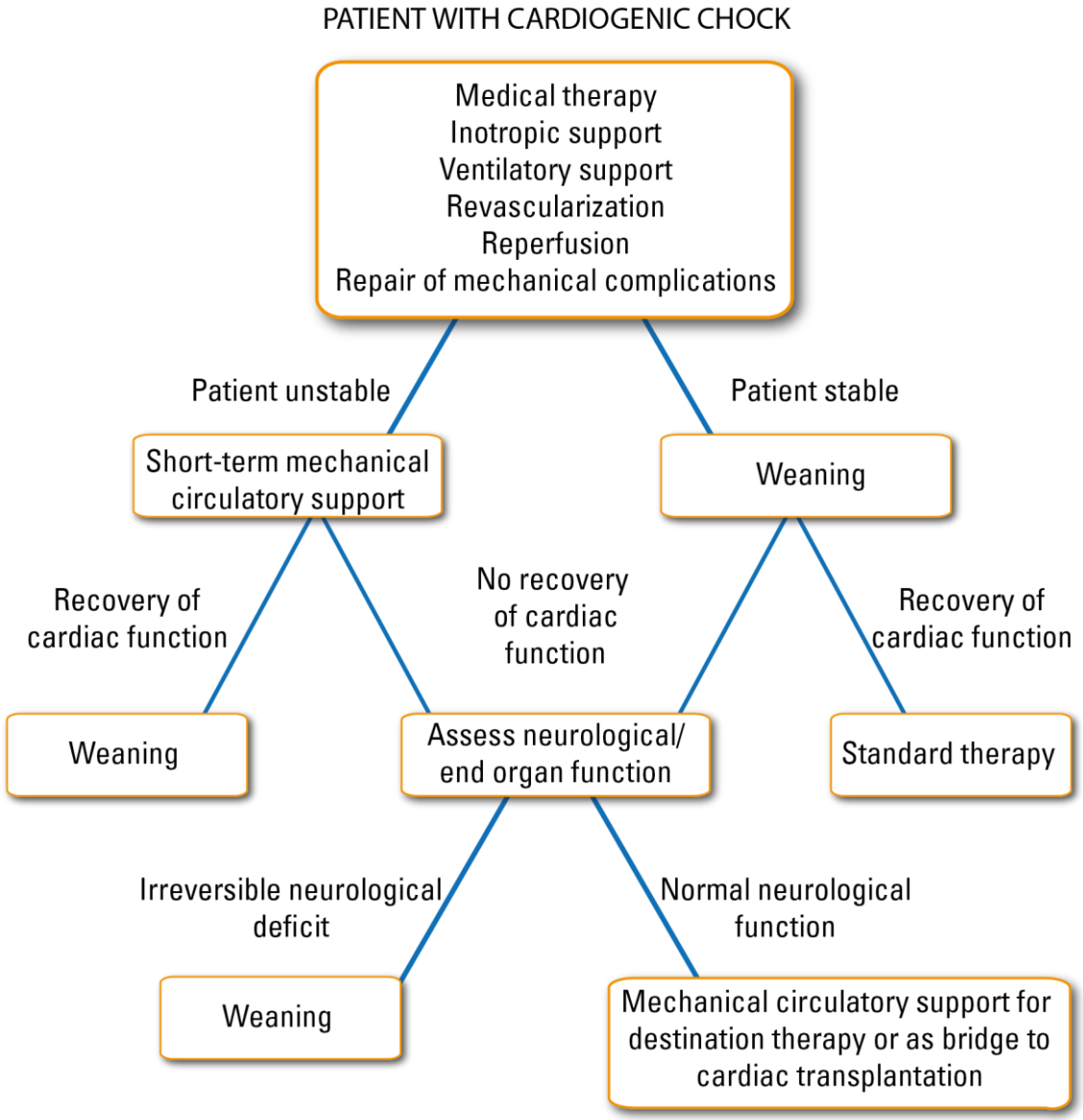
Temporära cirkulationsstöd



Behandla det som är sjukt!!!

Temporära cirkulationsstöd

- Sänliggande
- Sederad
- Mekanisk ventilation
- Max ca 3 veckor



ESC/EACTS . Eur J Cardiothorac Surg. 2014;46:517-92. Eur Heart J 2014;35:2541-619.

MCS

BTD = bridge to decision

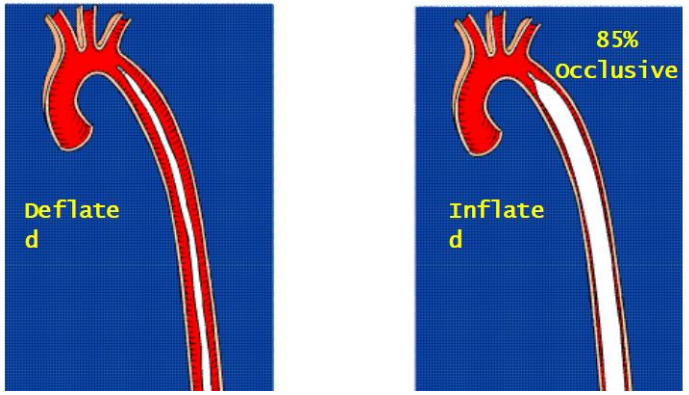
BTR = bridge to recovery

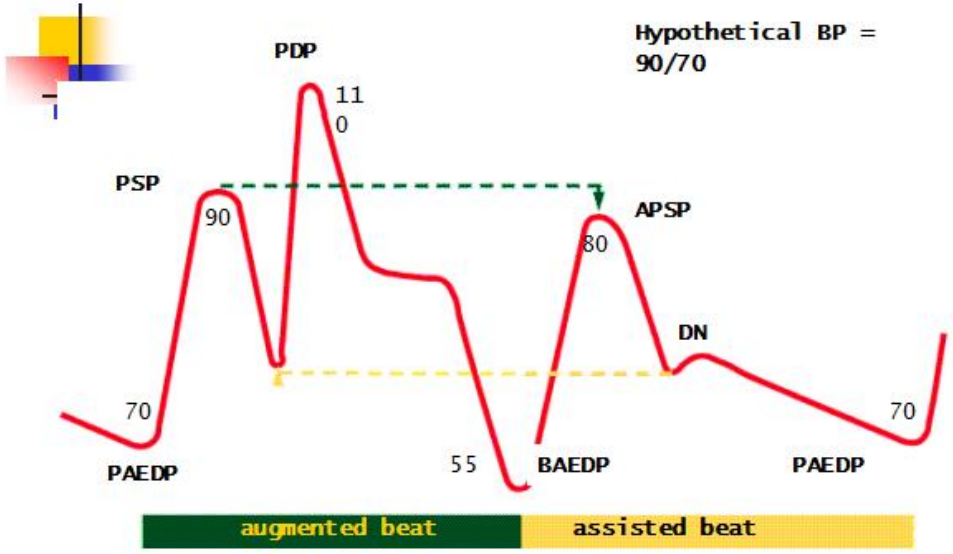
BTB = bridge to bridge

BTT = bridge to translpantation

DT = destiantion theraphy

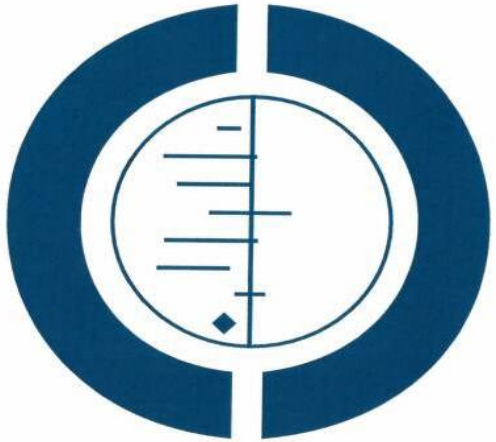
IAB OCCLUSIVITY





Intra-aortic balloon pump counterpulsation (IABP) for myocardial infarction complicated by cardiogenic shock (Review)

Unverzagt S, Buerke M, de Waha A, Haerting J, Pietzner D, Seyfarth M, Thiele H, Werdan K, Zeymer U, Prondzinsky R

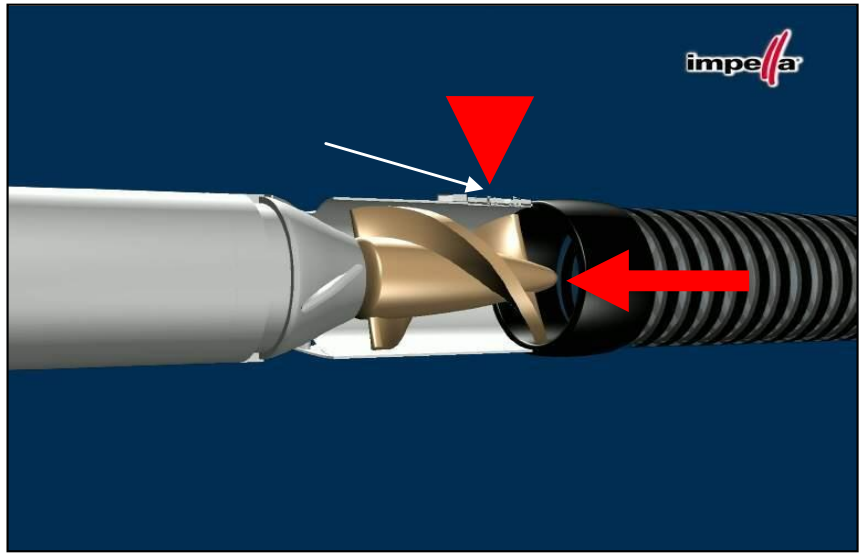


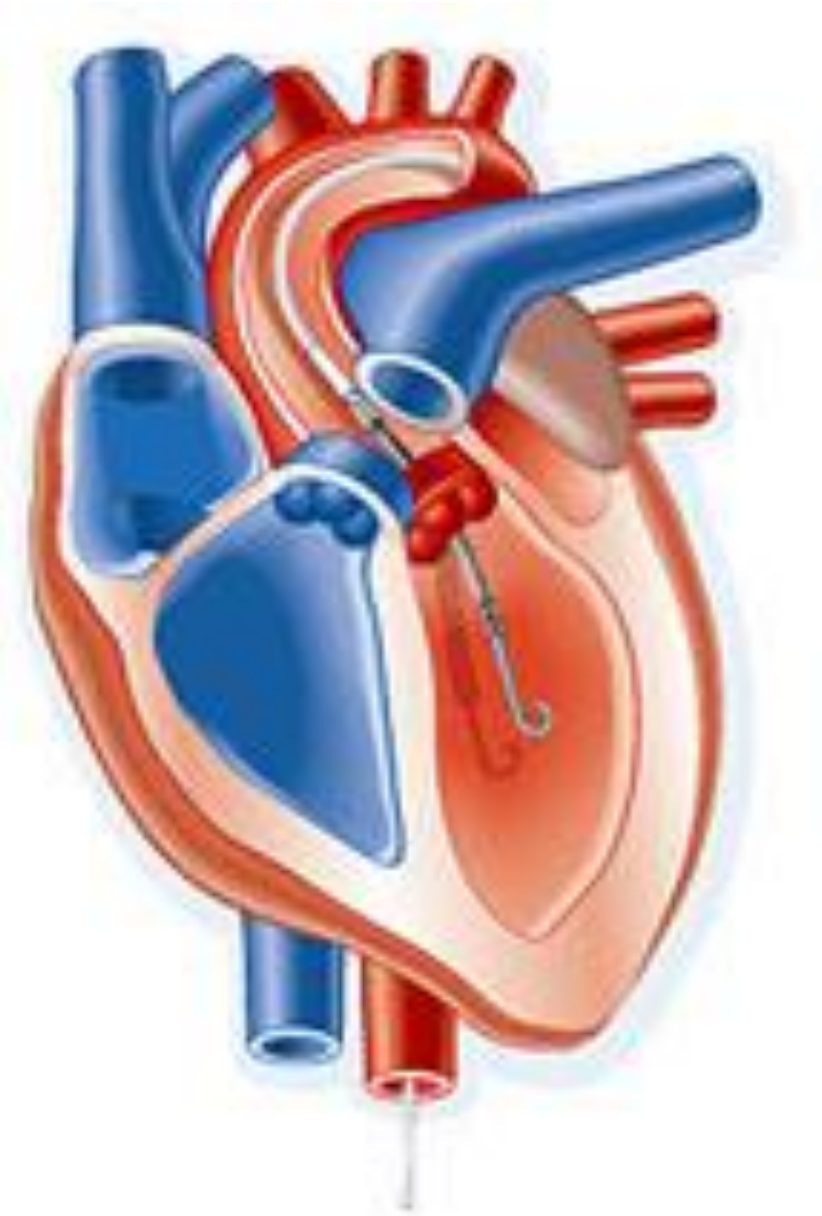
THE COCHRANE COLLABORATION®

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in *The Cochrane Library* 2015, Issue 3

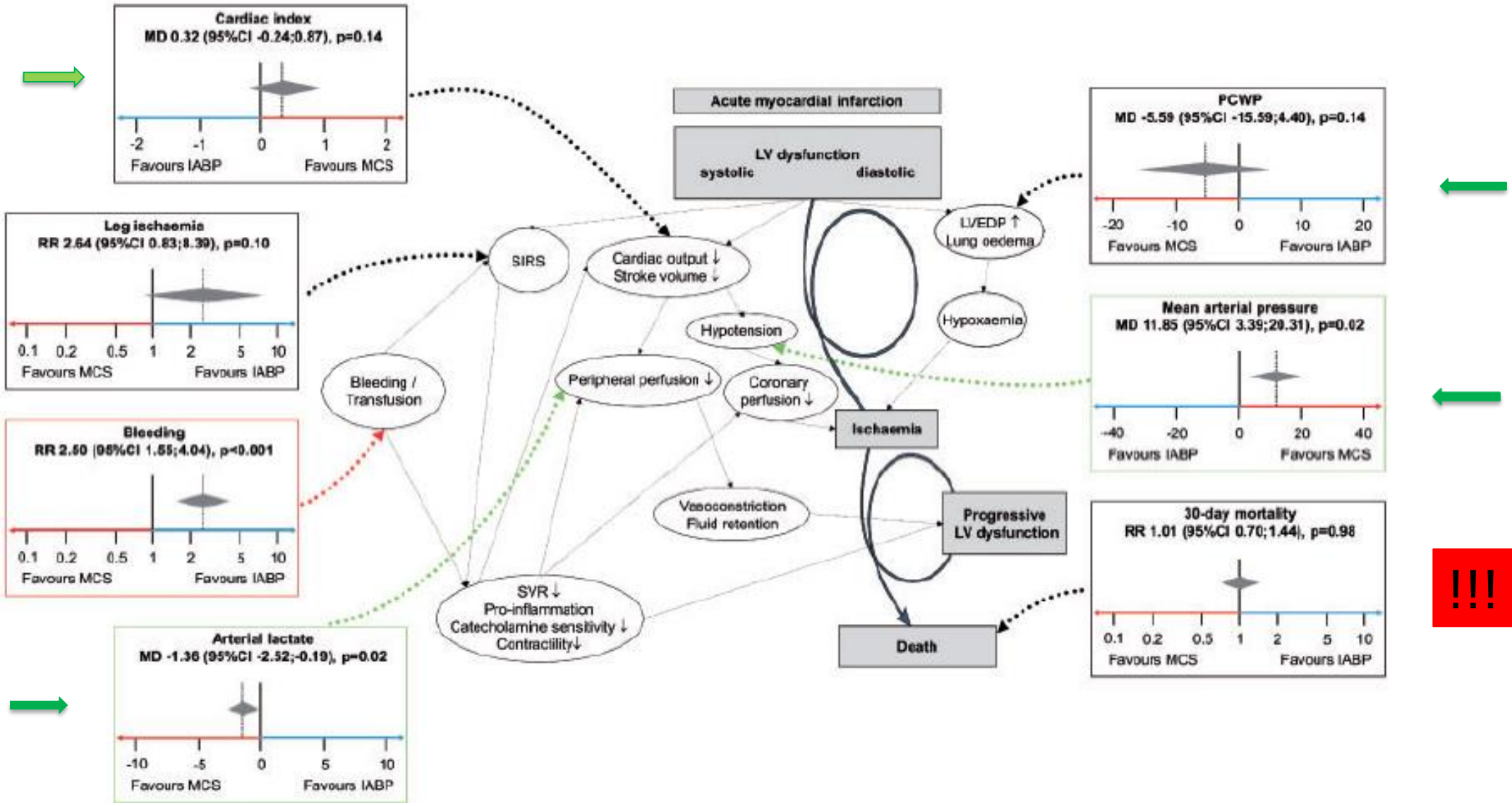
Sammanfattning:
Tillgängliga data påvisar positiva hemodynamiska effekter. Emellertid finns det inga randomiserade data för minskad mortalitet av IABP vid CS orsakad av AMI

Impella - LVAD





- LV avlastning (volym och tryck)
- LV - ”arbete” 
- O2 konsumtion 
- Koronarperfusion 
- Vital organperfusion 



Thiele H, et al. Eur Heart J 2017 38, 3523-3531.

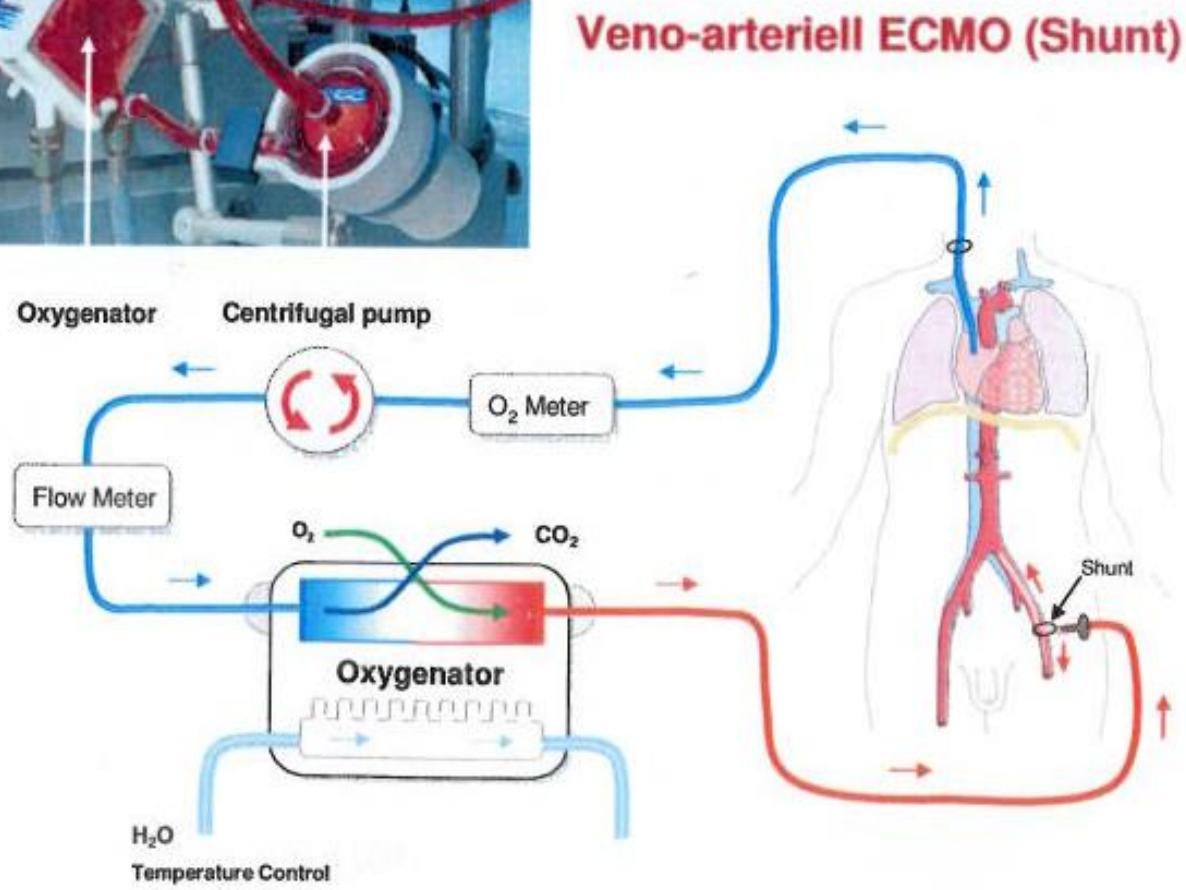
ECMO – Extra Corporeal Membran Oxygenering

- Temporär ”biventrikulär” assist med en oxygenator

#

- VA ECMO - venoarteriell --> hjärt- eller hjärt- och lungsvikt

- VV ECMO – venovenös --> isolerad lungsvikt



Svennevig JL, et al. ECMO-behandling Rikshospitalet, Oslo. 2010-2011.

Indikationer

- Postkardiotomi chock
- AMI
- Myokardit
- Kardiomyopatier
- RV-svikt
- Maligna arytmier
- Bevittnat hjärtstopp?!
- Hypotermi

→ Patientselektion och tidig intervention!

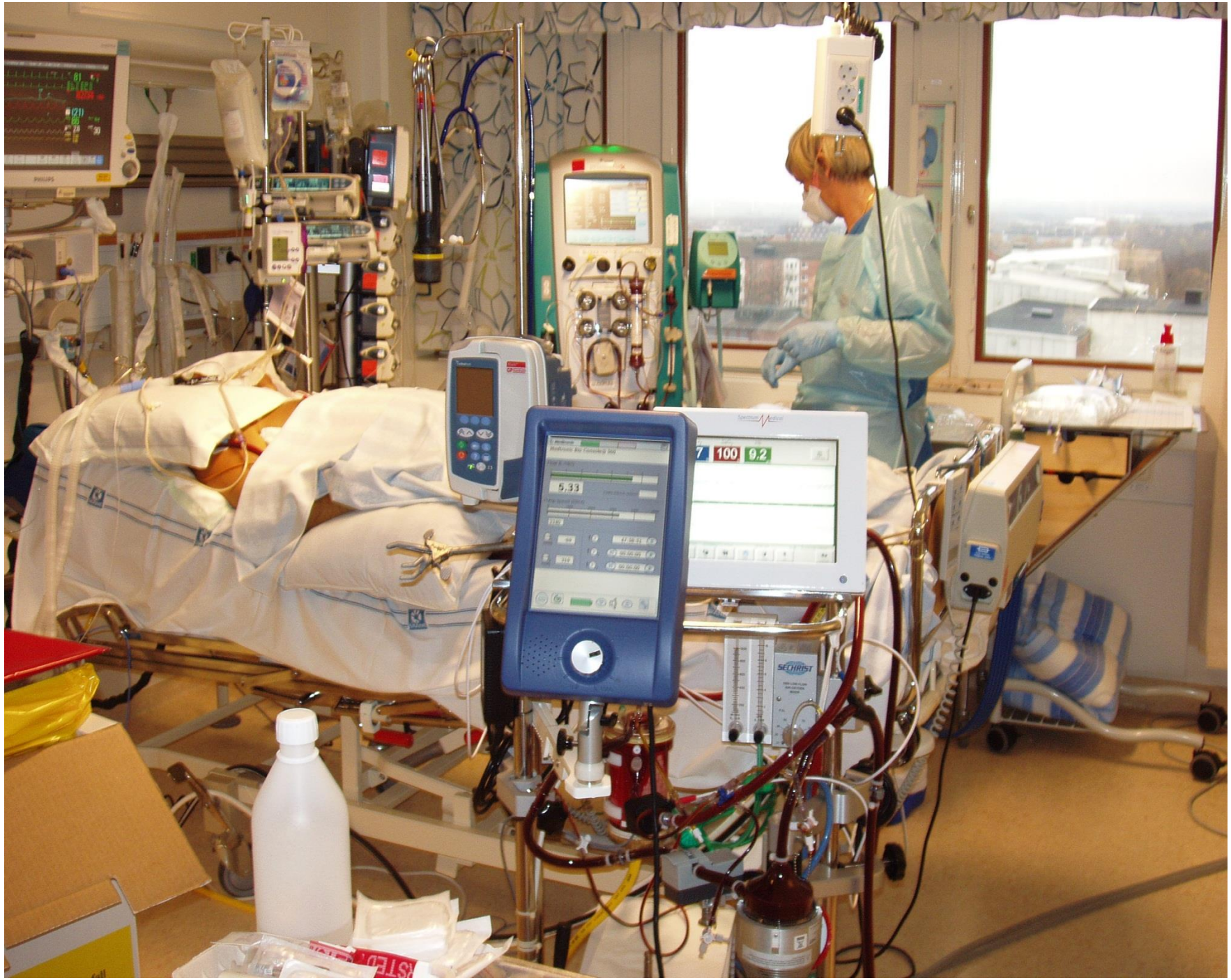
Table 4 Factors associated with in-hospital mortality of the cardiac-RESCUE program on univariate analysis

Variables	OR	95% CI	*P*-value
Age >60 years	1.90	1.03–3.49	0.04
Recent history of CPR	2.12	1.27–3.54	0.003
ECMO initiation under CPR	4.12	2.17–7.83	<0.0001
Oligo-anuria	2.61	1.38–4.94	0.002
Inotropic score >20	2.06	1.22–3.46	0.007
pH ≥ 7.30	0.38	0.20–0.73	0.002
Dilated cardiomyopathy vs. non-dilated non-ischaemic acute cardiomyopathy	1.67	0.78–3.57	0.18
AMI vs. non-dilated non-ischaemic acute cardiomyopathy	1.54	0.86–2.78	0.15

CPR, cardiopulmonary resuscitation; ECMO, extracorporeal membrane oxygenation; AMI, acute myocardial infarction.

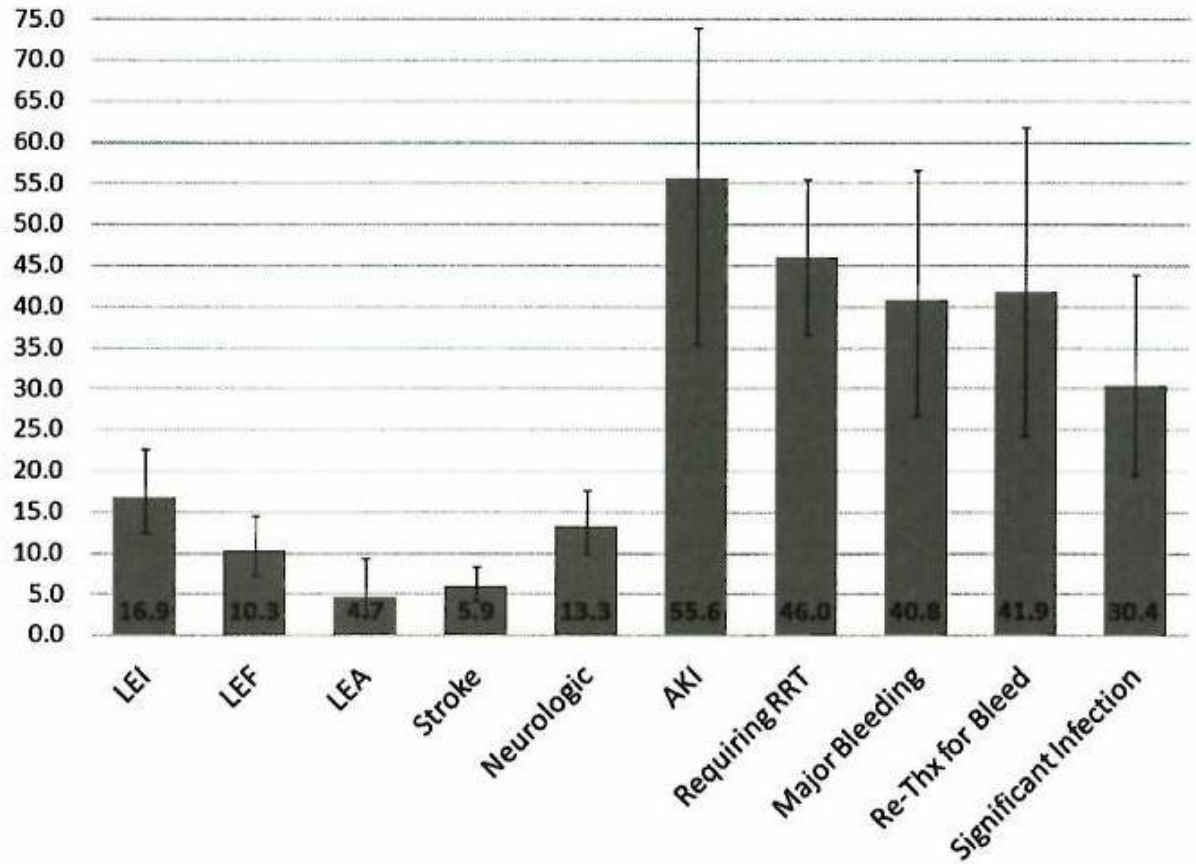
Paris med omgivning 87 pts. / 37 centra
Tid till ECMO 20 (4-87) min
Mortalitet 55%

Beurtheret S, et al. Eur Heart J 2012;April; 1-9.


PHILIPS
100
9.2
5.33
SECHRIST

Ann Thorac Surg
2014;97:610–6

Fig 1. Pooled estimate rate and 95% confidence interval (%) for complications of extracorporeal membrane oxygenation. (AKI = acute kidney injury; LEA = lower extremity amputation; LEF = lower extremity fasciotomy or compartment syndrome; LEI = lower extremity ischemia; Re-Thx = rethoracotomy for bleeding or tamponade; RRT = renal replacement therapy.)



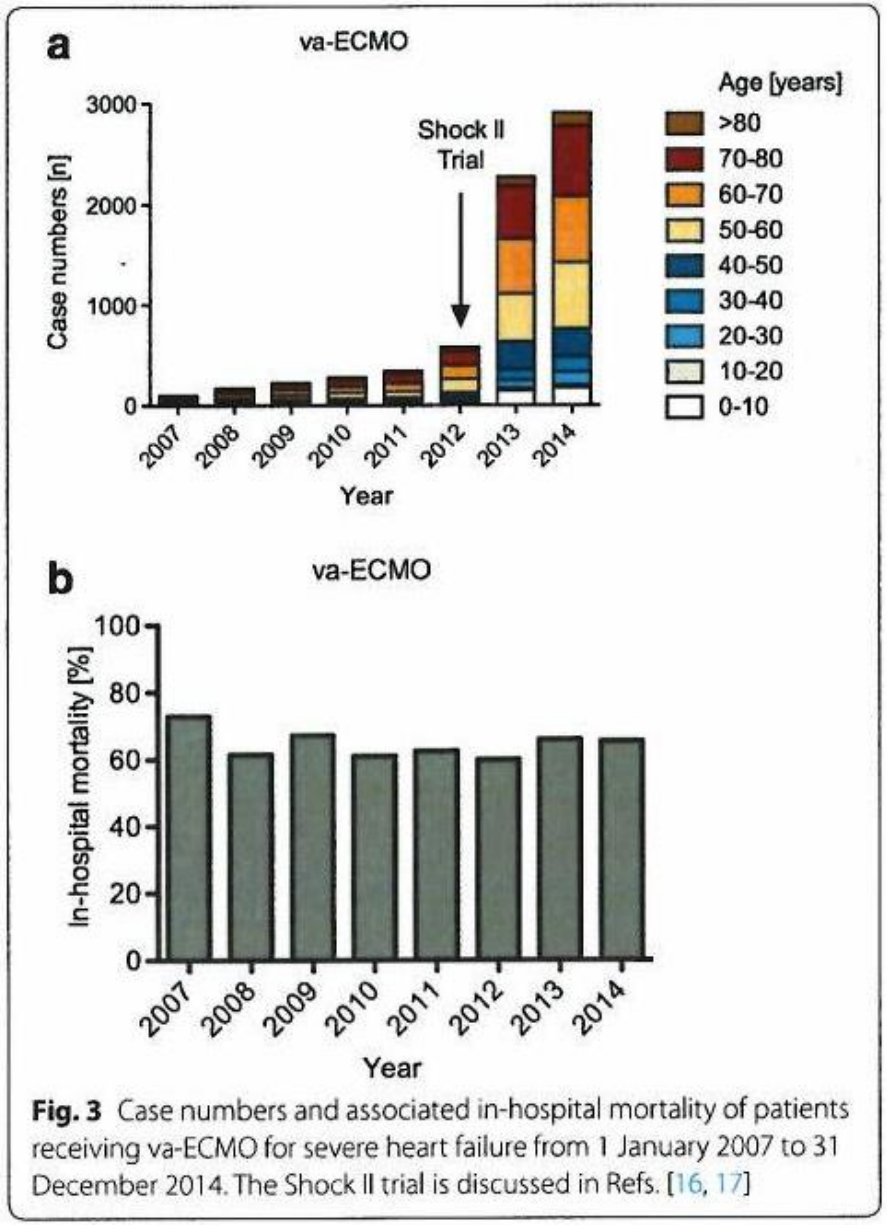


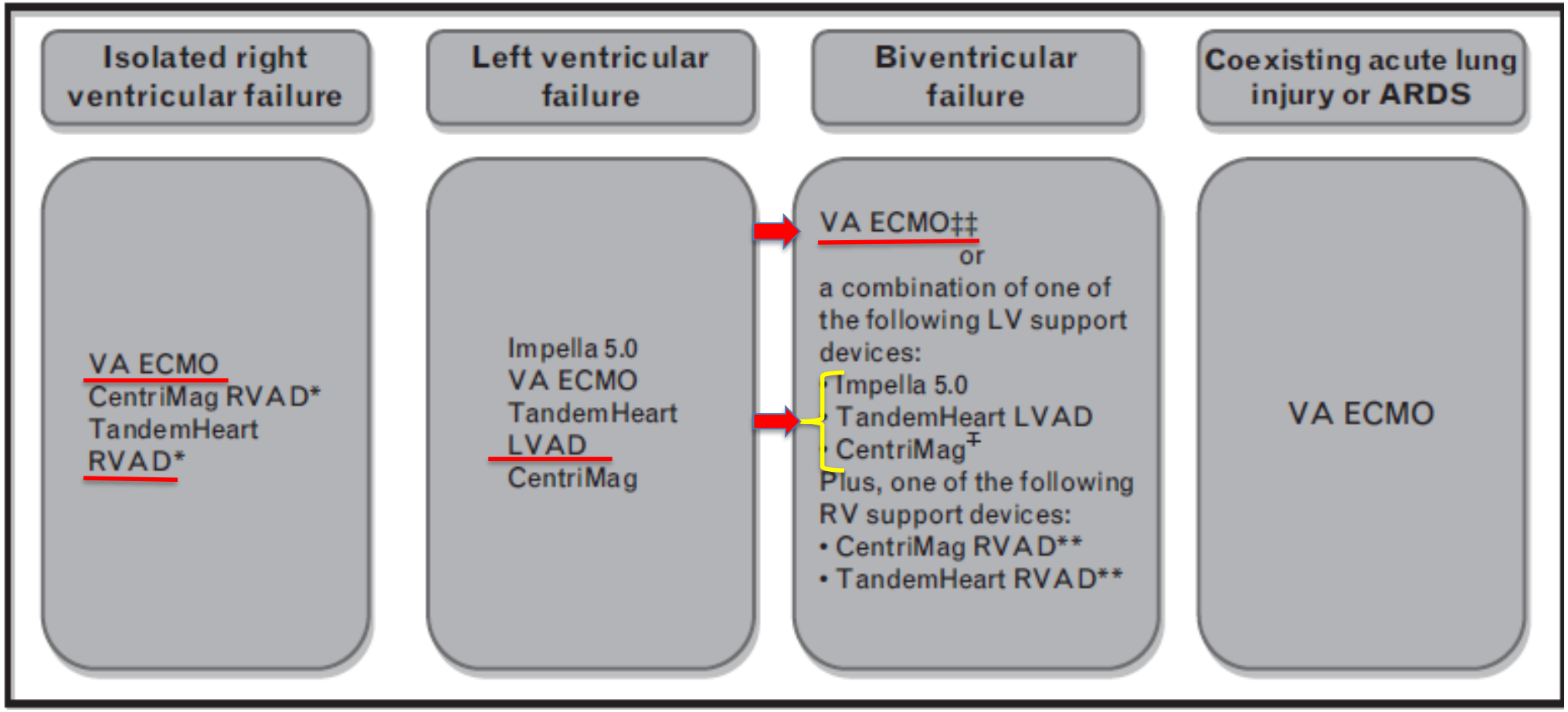
Fig. 3 Case numbers and associated in-hospital mortality of patients receiving va-ECMO for severe heart failure from 1 January 2007 to 31 December 2014. The Shock II trial is discussed in Refs. [16, 17]

Karagianndis C, et al. Intensive Care Med 2016;42:889-896.

REVIEW

Heart rescue: the role of mechanical circulatory support in the management of severe refractory cardiogenic shock

Gabriel T. Sayer[a], *Joshua N. Baker*[b], *and Kimberly A. Parks*[a]



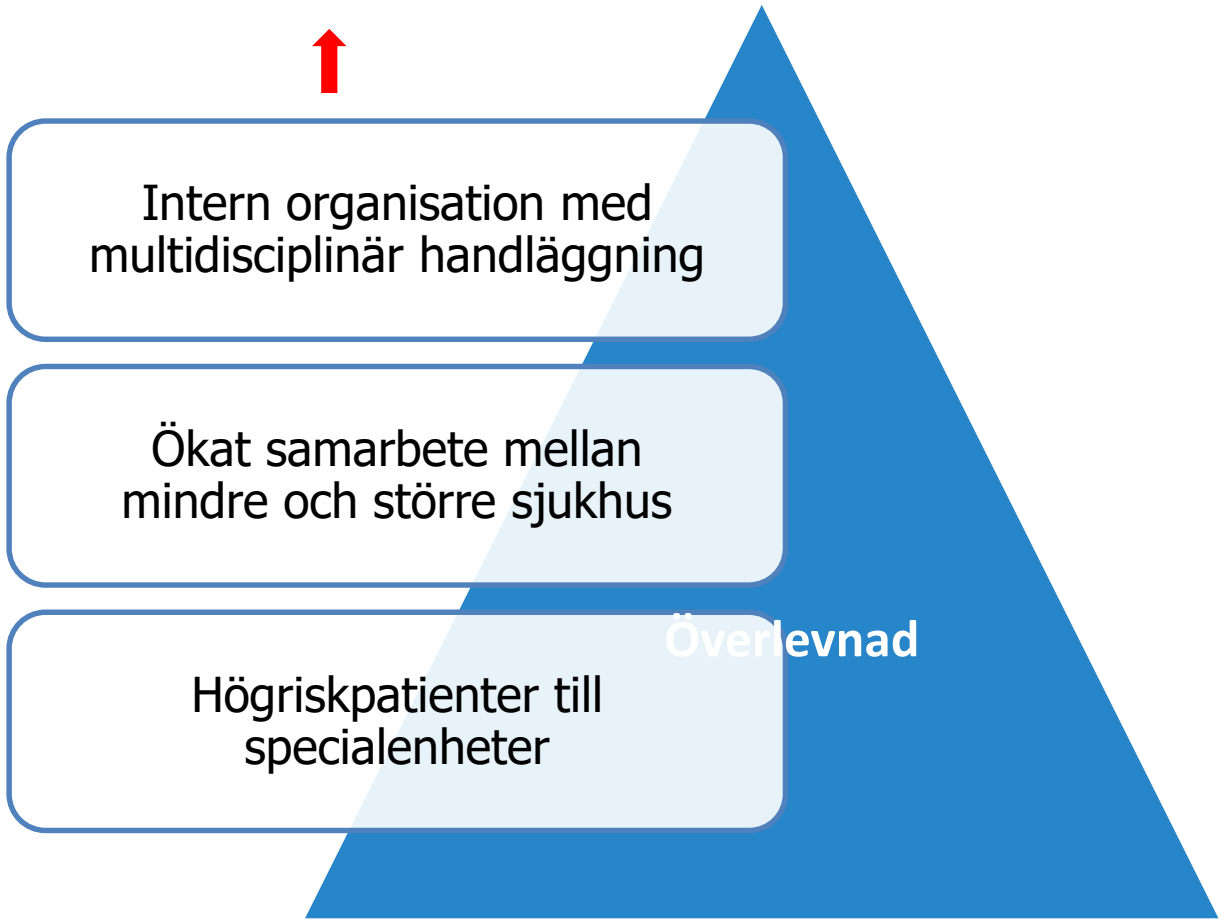
Recommendations regarding management of patients with cardiogenic shock

Recommendations	Class [a]	Level [b]	Ref [c]
In all patients with suspected cardiogenic shock, immediate ECG and echocardiography are recommended.	I	C	
All patients with cardiogenic shock should be rapidly transferred to a tertiary care center which has a 24/7 service of cardiac catheterization, and a dedicated ICU/CCU with availability of short-term mechanical circulatory support.	I	C	
In patients with cardiogenic shock complicating ACS an immediate coronary angiography is recommended (within 2 hours from hospital admission) with an intent to perform coronary revascularization.	I	C	
Continous ECG and blood pressure monitoring are recommended.	I	C	
Invasive monitoring with an arterial line is recommended.	I	C	
Fluid challenge (saline or Ringer's lactate, >200 ml/15–30 min) is recommended as the first-line treatment if there is no sign of overt fluid overload.	I	C	
Intravenous inotropic agents (dobutamine) may be considered to increase cardiac output.	IIb	C	
Vasopressors (norepinephrine preferable over dopamine) may be considered if there is a need to maintain SBP in the presence of persistent hypoperfusion.	IIb	B	558
IABP is not routinely recommended in cardiogenic shock.	III	B	585, 586
Short-term mechanical circulatory support may be considered in refractory cardiogenic shock depending on patient age, comorbidities and neurological function.	IIb	C	

Eur Heart J 2016;37:2129-2200. ESC Guidelines.

Organisation – logistik

Överlevand från ca 50% → > 80% till Htx



Recommendations	Class[a]	Level[b]	Ref[c]
It is recommended that regular aerobic exercise is encouraged in patients with HF to improve functional capacity and symptoms.	I	A	321, 618–62
It is recommended that regular aerobic exercise is encouraged in stable patients with HFrEF to reduce the risk of HF hospitalization.	I	A	618, 61
It is recommended that patients with HF are enrolled in a multidisciplinary care management programme to reduce the risk of HF hospitalization and mortality.	I	A	622–62
Referral to primary care for long-term follow-up may be considered for stable HF patients who are on optimal therapy to monitor for effectiveness of treatment, disease progression and patient adherence.	IIb	B	626, 62
Monitoring of pulmonary artery pressures using a wireless implantable haemodynamic monitoring system (CardioMems) may be considered in symptomatic patients with HF with previous HF hospitalization in order to reduce the risk of recurrent HF hospitalization.	IIb	B	628, 62
Multiparameter monitoring based on ICD (IN-TIME approach) may be considered in symptomatic patients with HFrEF (LVEF ≤35%) in order to improve clinical outcomes.	IIb	B	630

Samuels LS, et al. Ann Thorac Surg 2001;71:S67-72. Smedira NG, et al. Ann Thorac Surg 2001;71:S60-6. Dang NC, et al. JTCVS 2005;130:693-8. Leshnower BG, et al. Ann Thorac Surg 2006;81:1365-71.

Take home messeage AHF

1. Komplex patofysiologi

2. Svag evidens för någon intervention → individualiserad behandling

3. Organisation & multidisciplinär handläggning

- Mortalitetsdesignade studier → finns EJ!!!
- IABP ringa ökning av CO och kammaravlastning
- VAD vs IABP → bättre hemodynamik, ökad morbiditet, samma mortalitet
- VAD → inflammation, blödning, ischemi → organdysfunktion
- Timing VAD → avgörande

Behandlingsprinciper - makrocirkulation

1. Volymsoptimering

2. Stas → arteriell / venös dilatation

3. Hypoperfusion → inodilatation, vasopressor

   (Cardiac Power Index = CO x MAP / K) [watt)

4. Mekaniskt cirkulationsstöd (MCS)

Mirkocirkulation - inflammation

- NO-blockad --> nej

- Cytokin, interleukin, TNF@-blockad --> nej

- Endotelinblockad – sen effekt

- Koagulation – ev.

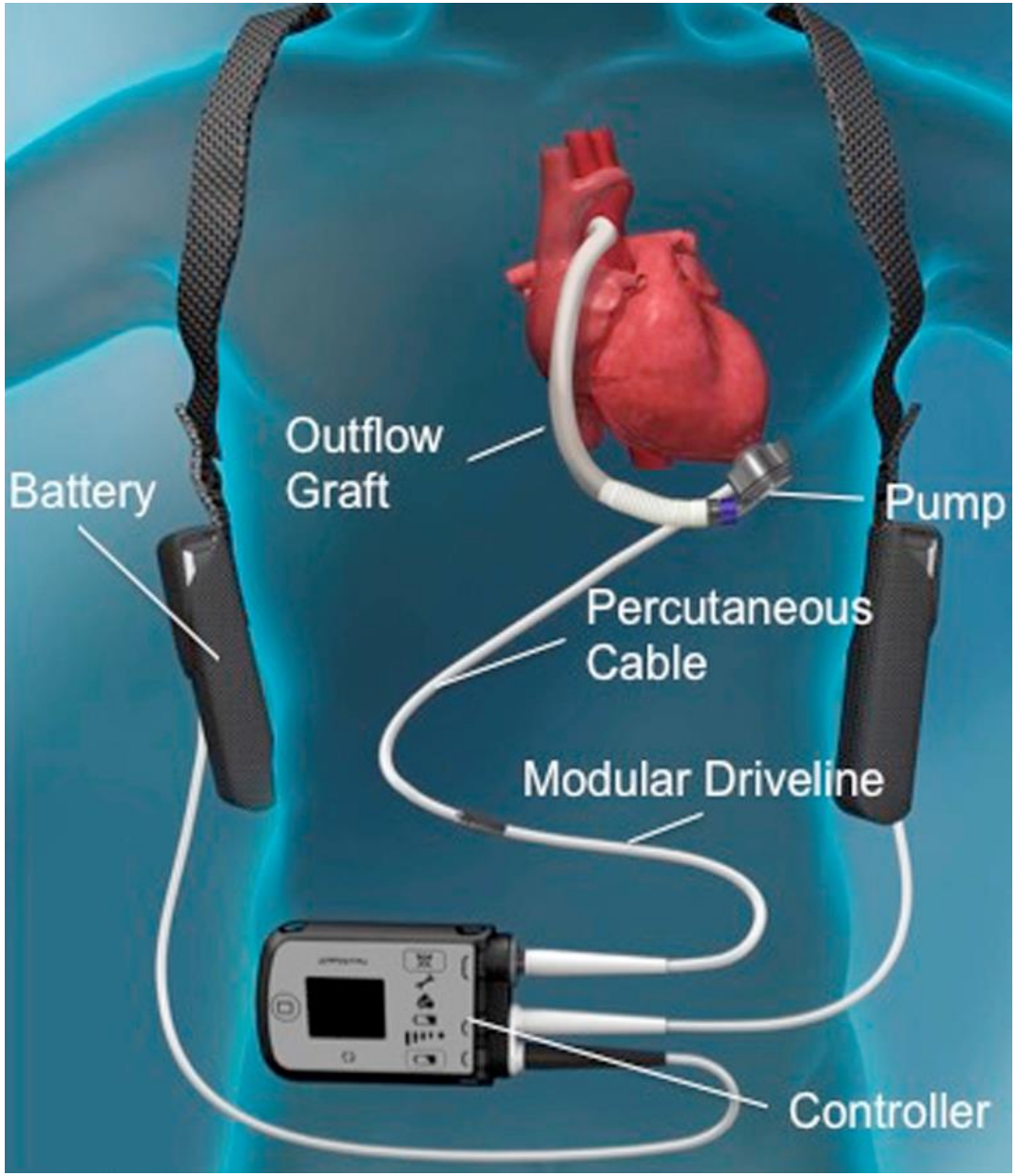
REVIEW

Heart rescue: the role of mechanical circulatory support in the management of severe refractory cardiogenic shock

Gabriel T. Sayer[a], Joshua N. Baker[b], and Kimberly A. Parks[a]

RV svikt	LV svikt	Biventrikulär svik
VA ECMO	LVAD	VA ECMO
RVAD	IABP	+
IABP		LVAD / IABP

HeartMate III



- Implanterbara
- Mobilisering
- Rehab
- Nutrition
- Poliklinisering

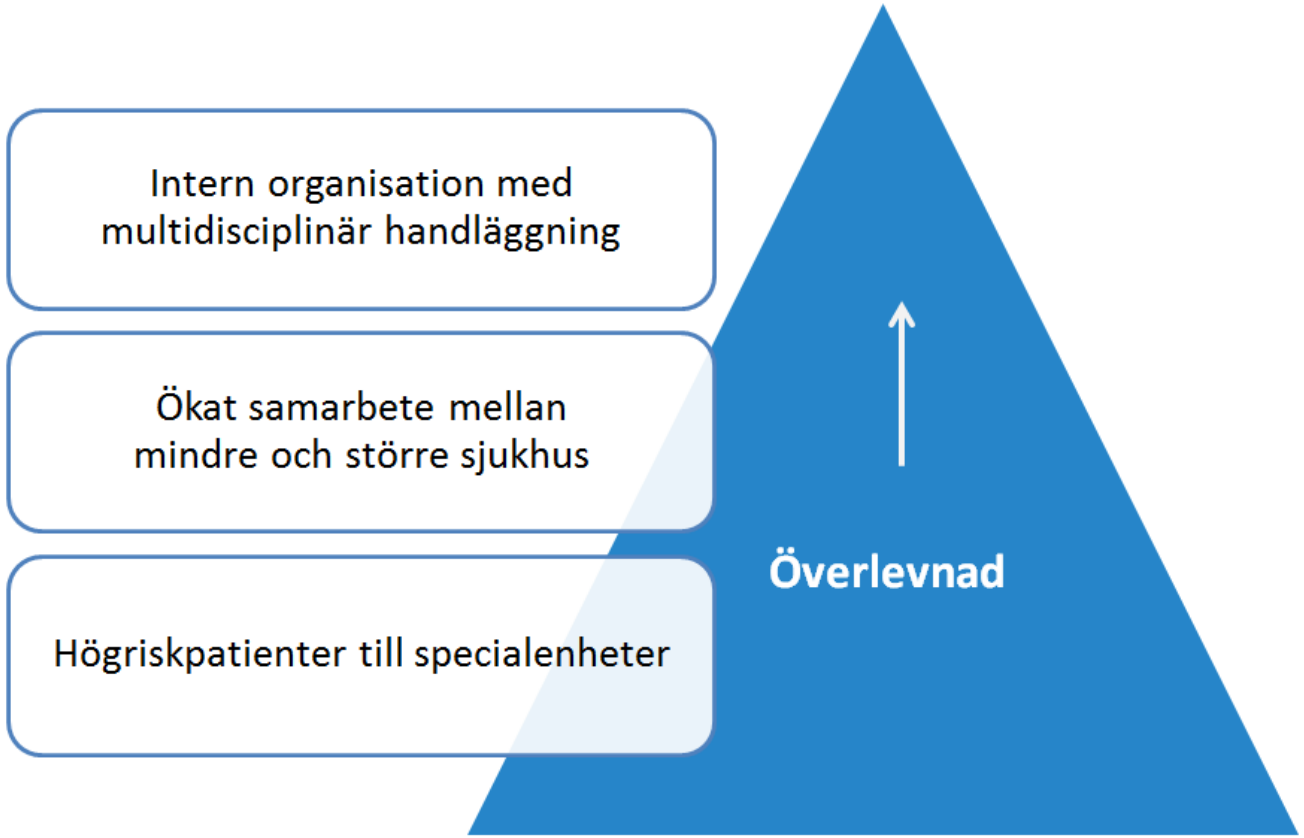
Recommendations for implantation of mechanical circulatory support in patients with refractory heart failure

Recommendations	Class [a]	Level [b]	Ref [c]
An LVAD should be considered in patients who have end- stage HFrEF despite optimal medical and device therapy and who are eligible for heart transplantation in order to improve symptoms, reduce the risk of HF hospitalization and the risk of premature death (Bridge to transplant indication).	IIa	C	
An LVAD should be considered in patients who have end-stage HFrEF despite optimal medical and device therapy and who are not eligible for heart transplantation to, reduce the risk of premature death.	IIa	B	605, 612, 613

Table 13.2 INTERMACS (Interagency Registry for Mechanically Assisted Circulatory Support) stages for classifying patients with advanced heart failure

INTERMACS level	NYHA Class	Description	Device	1y survival with LVAD therapy
1. Cardiogenic shock "Crash and burn"	IV	Haemodynamic instability in spite of increasing doses of catecholamines and/or mechanical circulatory support with critical hypoperfusion of target organs (severe cardiogenic shock).	ECLS, ECMO, percutaneous support devices	52.6±5.6%
2. Progressive decline despite inotropic support "Sliding on inotropes"	IV	Intravenous inotropic support with acceptable blood pressure but rapid deterioration of renal function, nutritional state, or signs of congestion.	ECLS, ECMO, LVAD	63.1±3.1%
3. Stable but inotrope dependent "Dependent stability"	IV	Haemodynamic stability with low or intermediate doses of inotropics, but necessary due to hypotension, worsening of symptoms, or progressive renal failure.	LVAD	78.4±2.5%
4. Resting symptoms "Frequent flyer"	IV ambulatory	Temporary cessation of inotropic treatment is possible, but patient presents with frequent symptom recurrences and typically with fluid overload.	LVAD	78.7±3.0%
5. Exertion intolerant "Housebound"	IV ambulatory	Complete cessation of physical activity, stable at rest, but frequently with moderate fluid retention and some level of renal dysfunction.	LVAD	93.0±3.9%[a]
6. Exertion limited "Walking wounded"	III	Minor limitation on physical activity and absence of congestion while at rest. Easily fatigued by light activity.	LVAD / Discuss LVAD as option	-
7. "Placeholder"	III	Patient in NYHA Class III with no current or recent unstable fluid balance.	Discuss LVAD as option	-

Organisation – logistik



Recommendations	Class [a]	Level [b]	Ref [c]
It is recommended that regular aerobic exercise is encouraged in patients with HF to improve functional capacity and symptoms.	I	A	321, 618–621
It is recommended that regular aerobic exercise is encouraged in stable patients with HFrEF to reduce the risk of HF hospitalization	I	A	618, 619
It is recommended that patients with HF are enrolled in a multidisciplinary care management programme to reduce the risk of HF hospitalization and mortality.	I	A	622–625
Referral to primary care for long-term follow-up may be considered for stable HF patients who are on optimal therapy to monitor for effectiveness of treatment, disease progression and patient adherence.	IIb	B	626, 627
Monitoring of pulmonary artery pressures using a wireless implantable haemodynamic monitoring system (CardioMems) may be considered in symptomatic patients with HF with previous HF hospitalization in order to reduce the risk of recurrent HF hospitalization.	IIb	B	628, 629
Multiparameter monitoring based on ICD (IN-TIME approach) may be considered in symptomatic patients with HFrEF (LVEF ≤35%) in order to improve clinical outcomes.	IIb	B	630

Samuels LS, et al. Ann Thorac Surg 2001;71:S67-72. Smedira NG, et al. Ann Thorac Surg 2001;71:S60-6. Dang NC, et al. JTCVS 2005;130:693-8. Leshnower BG, et al. Ann Thorac Surg 2006;81:1365-71.

Take home message

→ AHF / CS --- makro- och mikrocirkulation

→ Handlingsplan A, B ev C innan MCS

→ Tidig intervention förbättrar överlevnad

→ Organisation

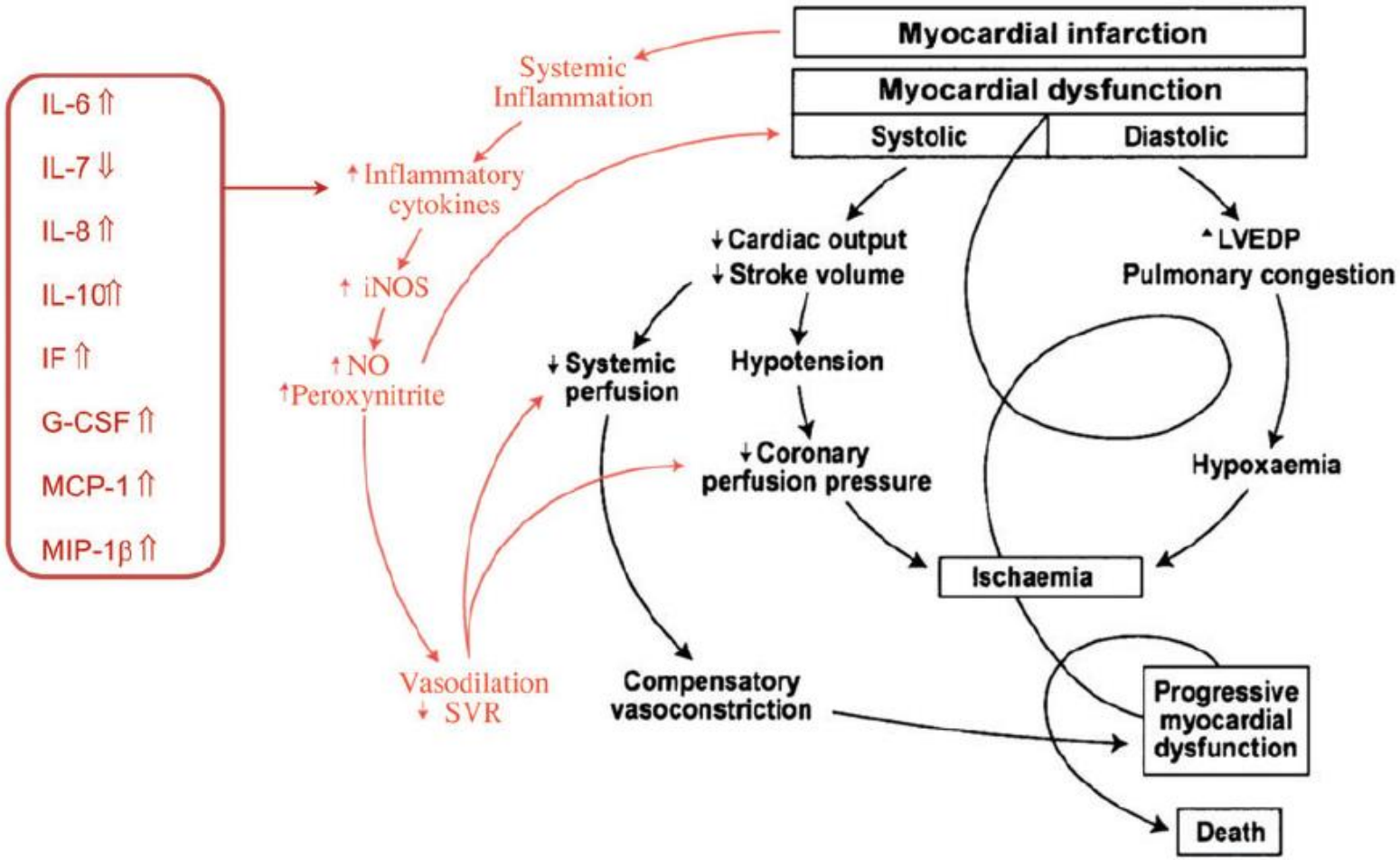
Lärandemål AHF;

1. Komplex patofysiologi

2. Lite evidens för någon intervention → individualiserad behandling

3. Multidisciplinär handläggning

AHF - CS



Werdan K, et al. Eur Heart J;35:156-167.

Terapeutiska interventioner

→ Sedering

→ Artificiell ventilation

→ Hemodynamik
- Volym
- Vasodilatation
- Inotropi /inodilatation
- MCS

→ CRRT

→ Nutrition, antibiotika etc.

Bridge begreppet - MCS

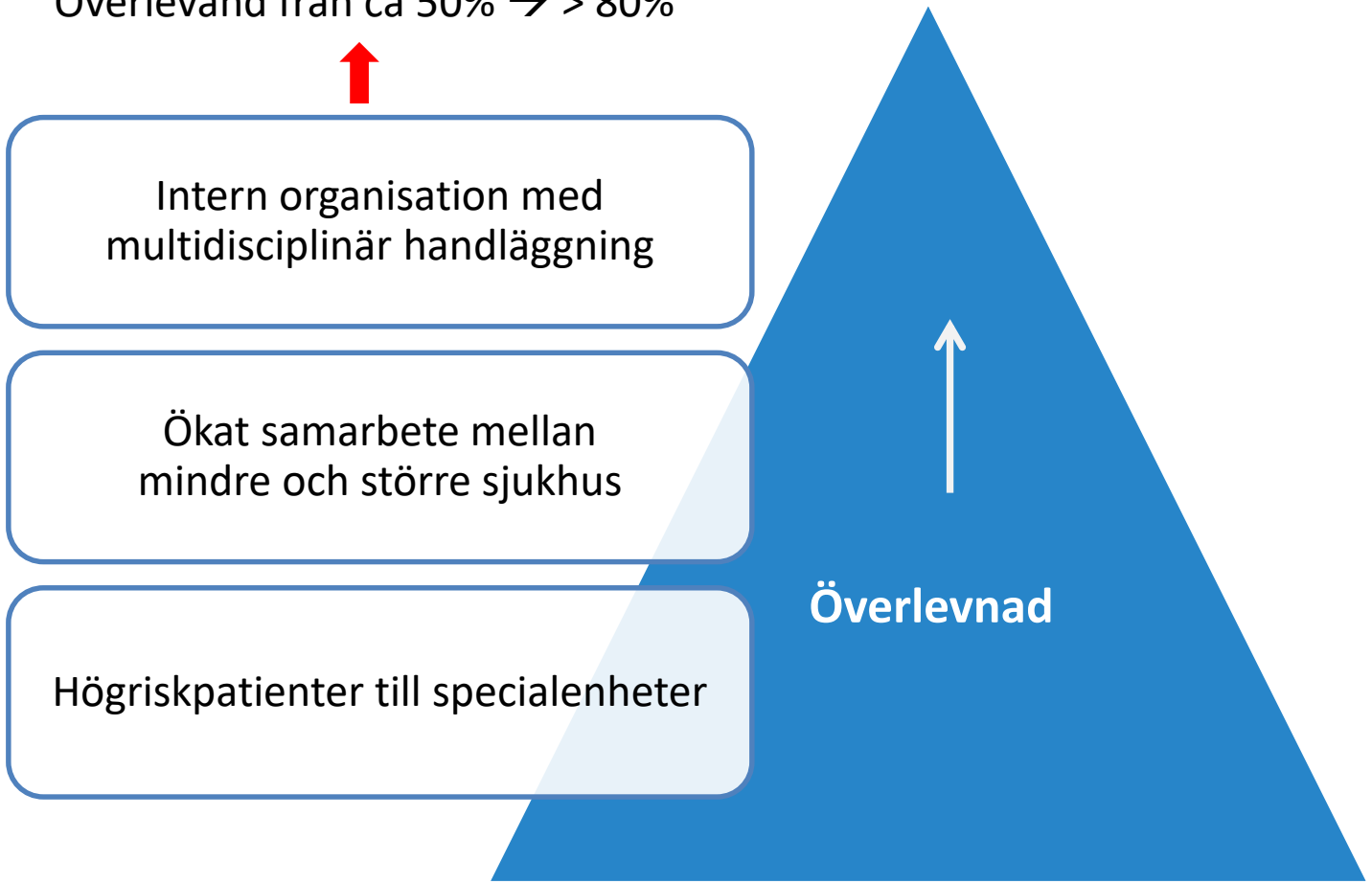
- Bridge to Decicion (BTD)
- Bridge to Recovery (BTR)
- Bridge to Bridge (BTB)

#

- Bridge to transplantation (BTT) - I,B
- Destination Therpapy (DT) - II,A

Organisation – logistik

Överlevand från ca 50% → > 80%



Samuels LS, et al. Ann Thorac Surg 2001;71:S67-72. Smedira NG, et al. Ann Thorac Surg 2001;71:S60-6. Dang NC, et al. JTCVS 2005;130:693-8. Leshnower BG, et al. Ann Thorac Surg 2006;81:1365-71.

Temporära assister

BTD = bridge to decision

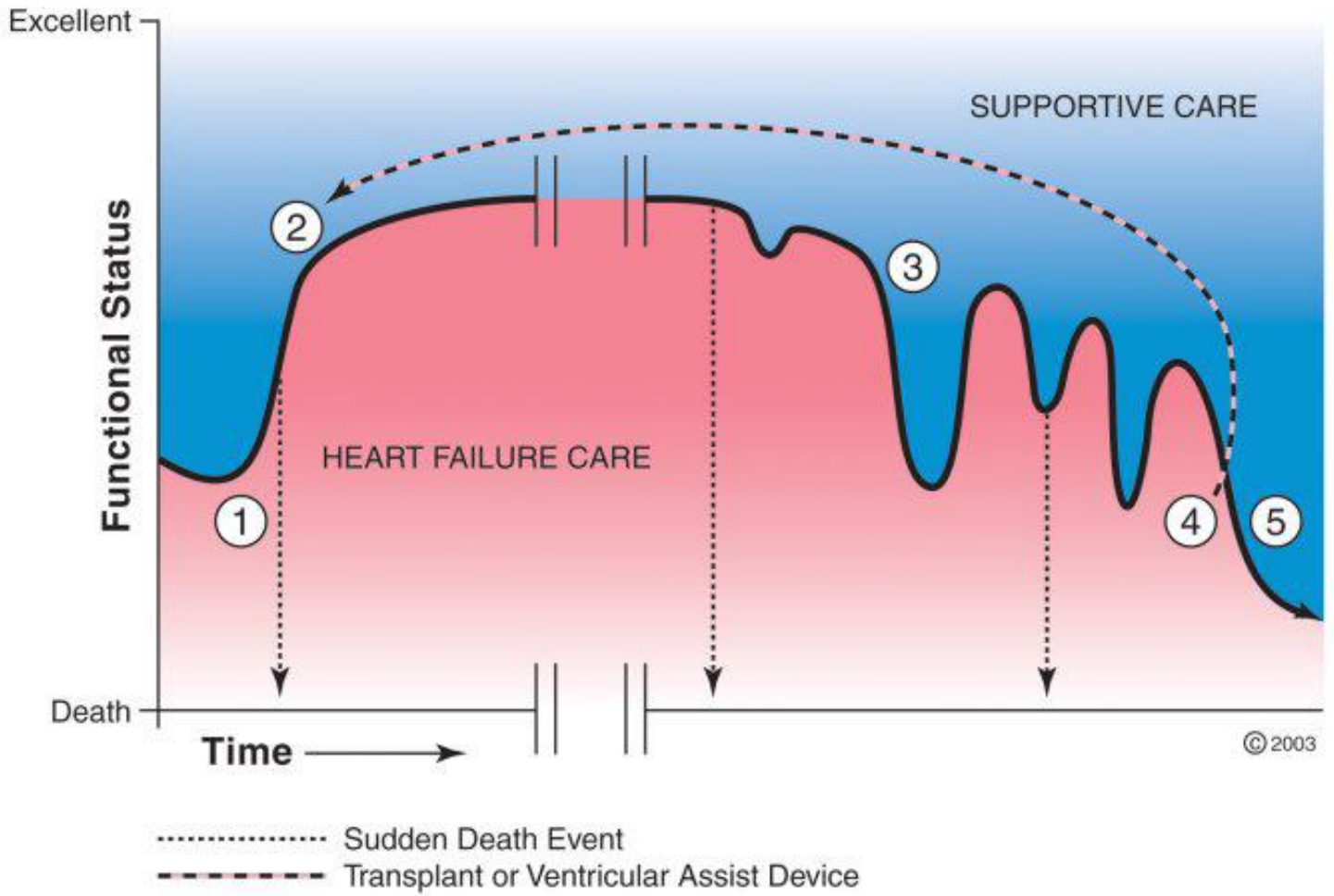
BTR = bridge to recovery

BTB = bridge to bridge

BTT = bridge to translpantation

DT = destiantion theraphy

Hjärtsvikt


Excellent
Functional Status
Death
Time
SUPPORTIVE CARE
HEART FAILURE CARE
1
2
3
4
5
© 2003
Sudden Death Event
Transplant or Ventricular Assist Device

AUTHORS' CONCLUSIONS

Implications for practice

At present there are no robust and convincing data to support a specific inotropic or vasodilator drug therapy as the best solution to reduce mortality in haemodynamically unstable patients with CS complicating AMI.

In terms of haemodynamic improvements, levosimendan may be useful for haemodynamic stabilisation but there still remain major concerns as to whether these haemodynamic improvements can be translated into mortality benefits, especially in haemodynamic constellations in which inotropic support has to be combined with vasopressors.

If there is a need for inotropic support levosimendan may be considered for additional therapeutic escalation ('ultima ratio') because at present there are no relevant data describing increased risks with levosimendan in these patients, although there is not enough evidence to claim therapeutic superiority in providing inotropic support.

The interface or 'missing link' in critically ill patients that is necessary for an understanding of macrocirculatory haemodynamics as represented by CI and MAP, systemic inflammatory response and multiple organ failure could be the effects of CS on the microcirculation. Once multi-organ failure has become established haemodynamic improvements by inotropes and vasoactive drugs will be of reduced prognostic value.

Cochrane 2014, Issue 1

Vasopressors for hypotensive shock (Review) Cochrane 2016, Issue 2

Gamper G, Havel C, Arrich J, Losert H, Pace NL, Müllner M, Herkner H

We found no evidence of substantial differences in total mortality between several vasopressors. Dopamine increases the risk of arrhythmia compared with norepinephrine and might increase mortality. Otherwise, evidence of any other differences between any of the six vasopressors examined is insufficient. We identified low risk of bias and high-quality evidence for the comparison of norepinephrine versus dopamine and moderate to very low-quality evidence for all other comparisons, mainly because single comparisons occasionally were based on only a few participants. Increasing evidence indicates that the treatment goals most often employed are of limited clinical value. Our findings suggest that major changes in clinical practice are not needed, but that selection of vasopressors could be better individualised and could be based on clinical variables reflecting hypoperfusion.

Mirkocirkulation - inflammation

- NO-blockad --> nej

- Cytokin, interleukin --> nej

- Endotelinblockad – sen effekt

- Koagulation – ev.

- Neurohumoral blockad - ja vid kronisk svikt

- ”Reversed remodeling” - ev MCS

AUTHORS' CONCLUSIONS

Implications for practice

At present there are no robust and convincing data to support a specific inotropic or vasodilator drug therapy as the best solution to reduce mortality in haemodynamically unstable patients with CS complicating AMI.

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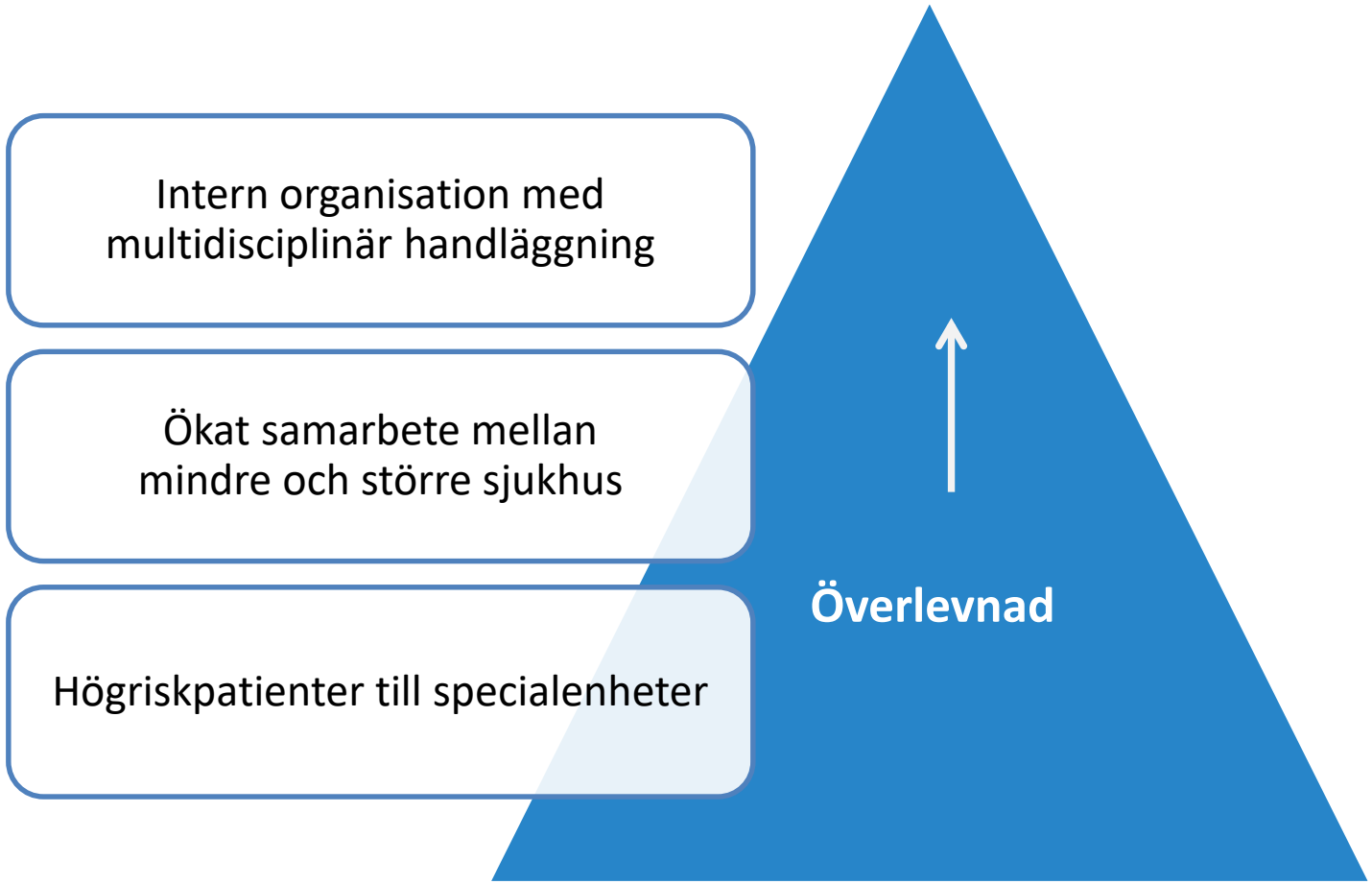
Cochrane 2014, Issue 1

Organisation – logistik



Samuels LS, et al. Ann Thorac Surg 2001;71:S67-72. Smedira NG, et al. Ann Thorac Surg 2001;71:S60-6. Dang NC, et al. JTCVS 2005;130:693-8. Leshnower BG, et al. Ann Thorac Surg 2006;81:1365-71.

Kontraindikationer

- Intrakraniell blödning
- Okontrollerad koagulopati
- Okontrollerad sepsis
- Långvarig och progredierande MOF
- Aorta- och mitralisinsufficiens

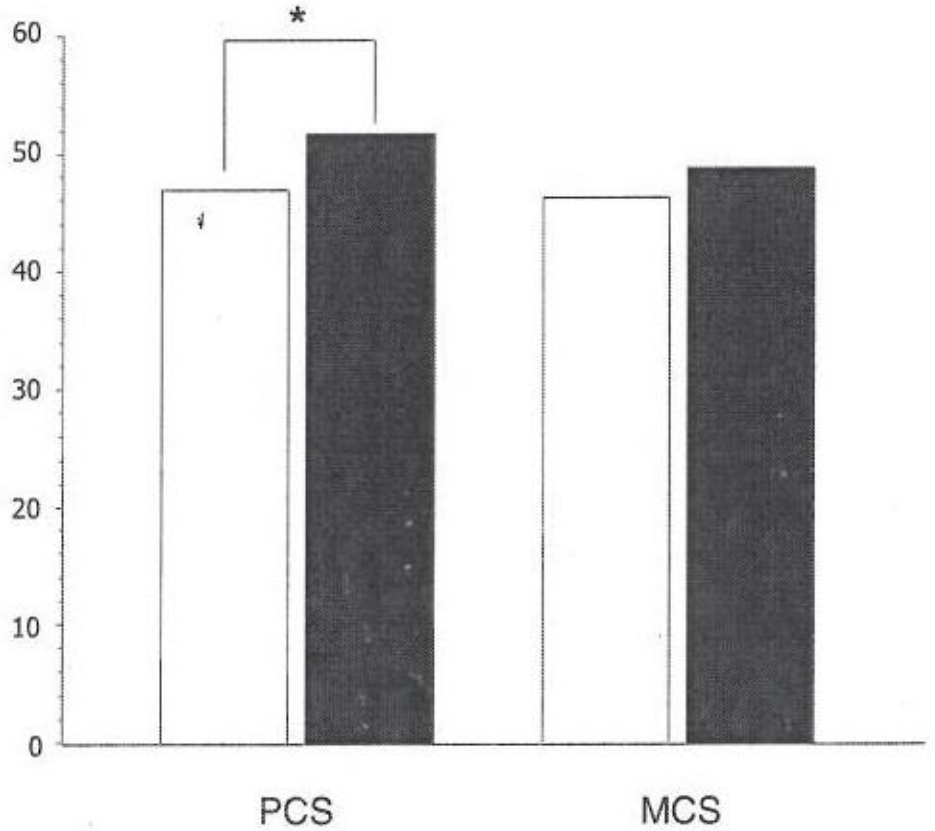


Figure 3. Short-Form 36 mean physical (*PCS*) and mental component scores (*MCS*) for extracorporeal membrane oxygenation patients (*white bars*) and their French age- and sex-matched controls (*black bars*). *$p < .05$.

Combes A, et al. Crit Care 2008;1404-1411.

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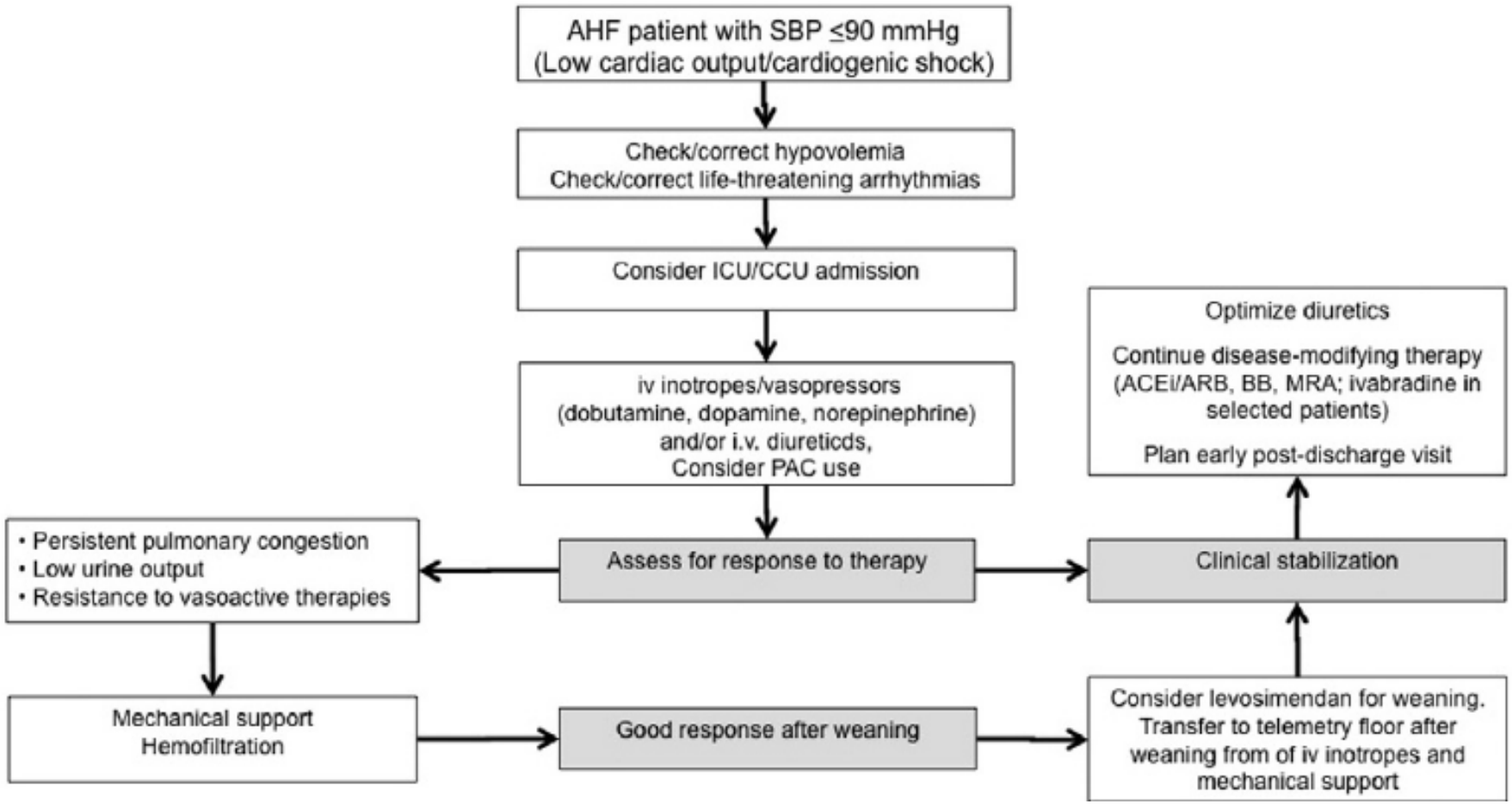
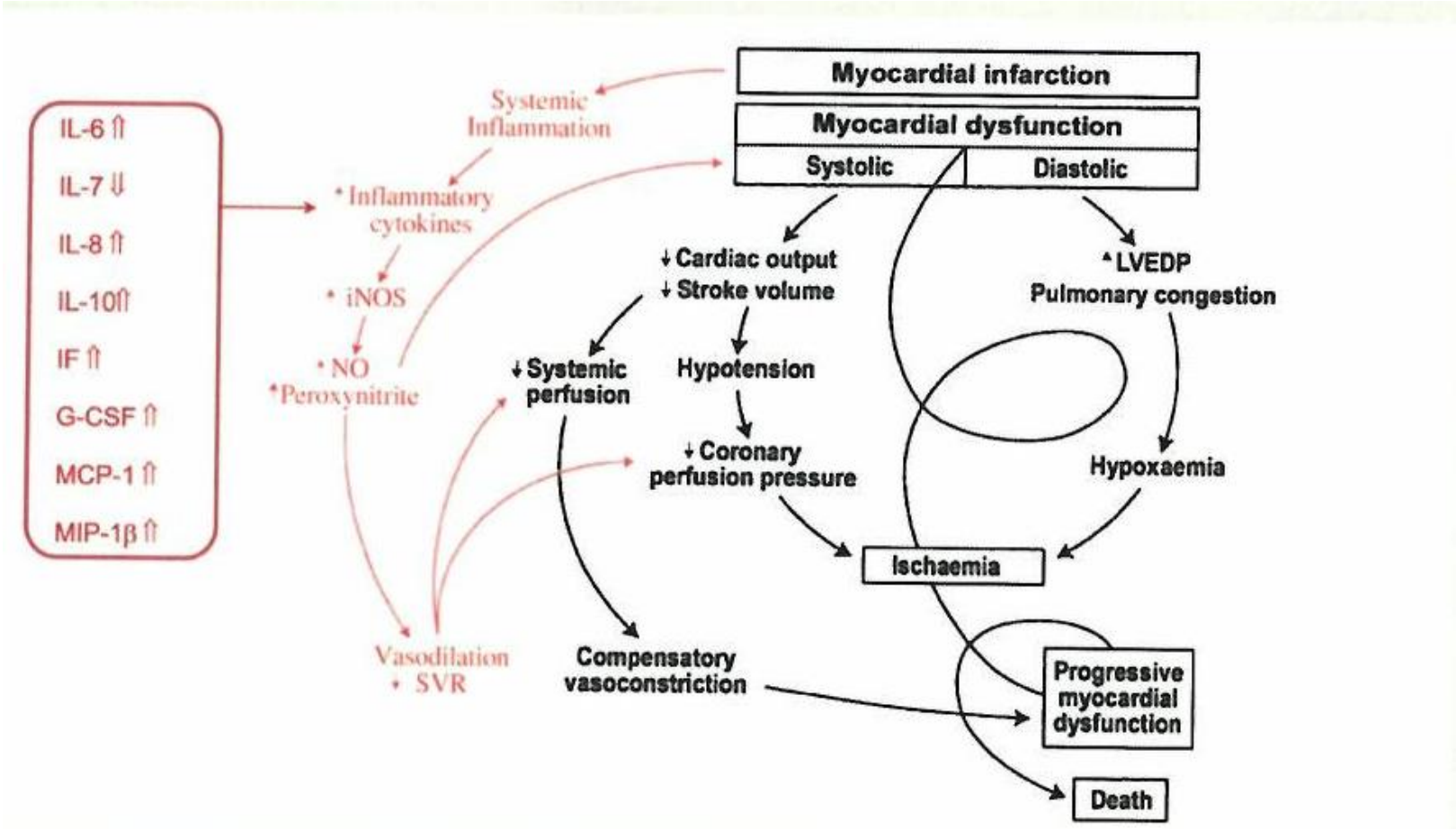
Review

In-hospital management of acute heart failure: Practical recommendations and future perspectives

Dimitrios Farmakis [a,*], John Parissis [a], Apostolos Karavidas [b], Charalambos Karvounis [c], Filippos Triposkiadis [d], Gerasimos Filippatos [a], John Lekakis [a], Collaborators





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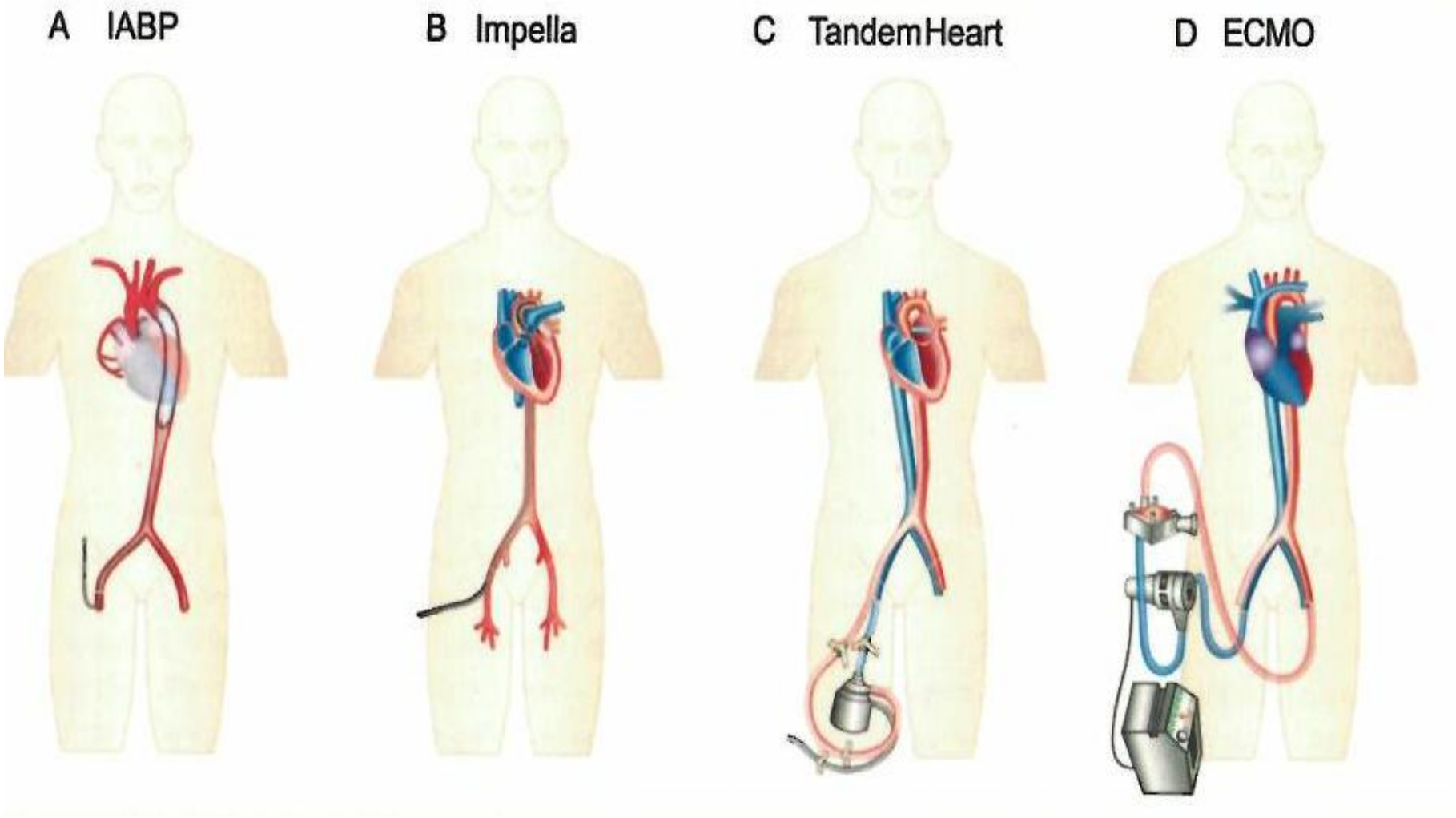
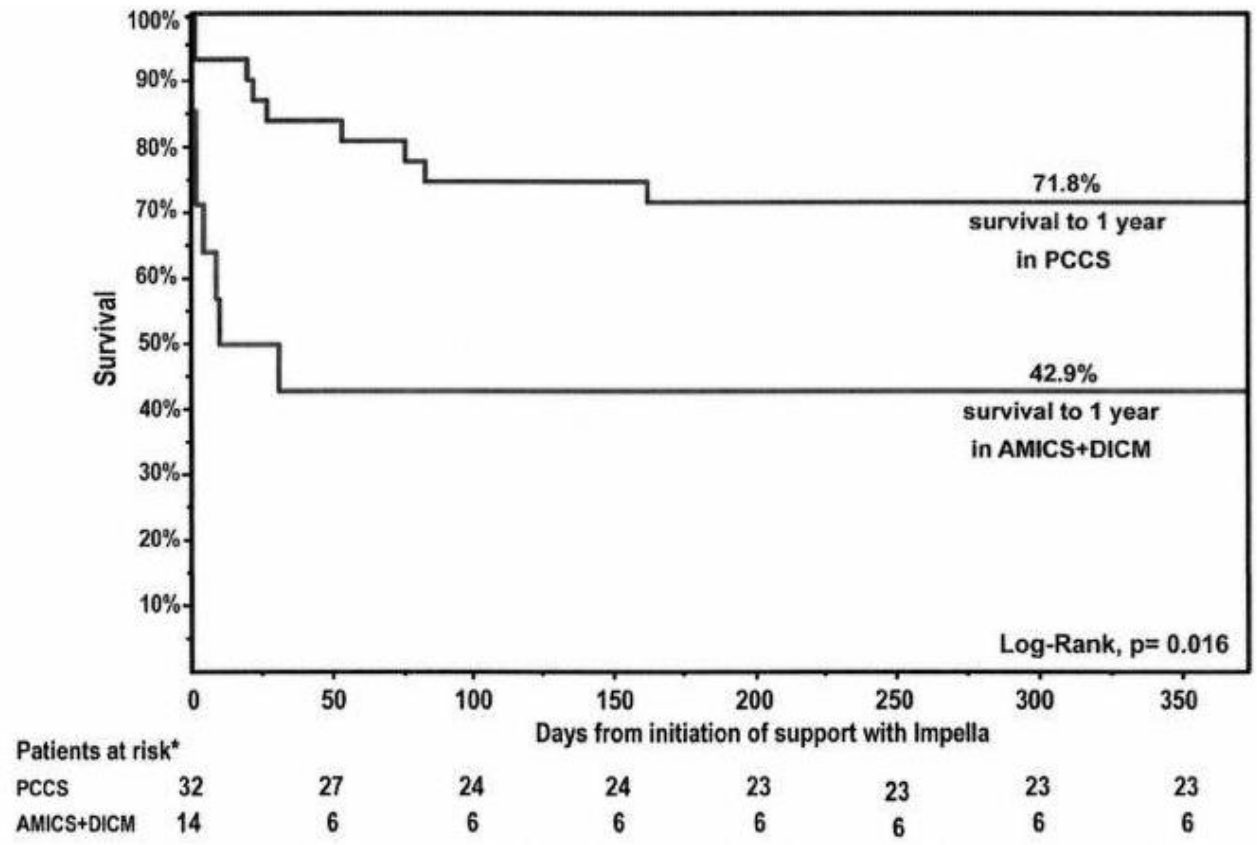
Temporära cirkulationsstöd





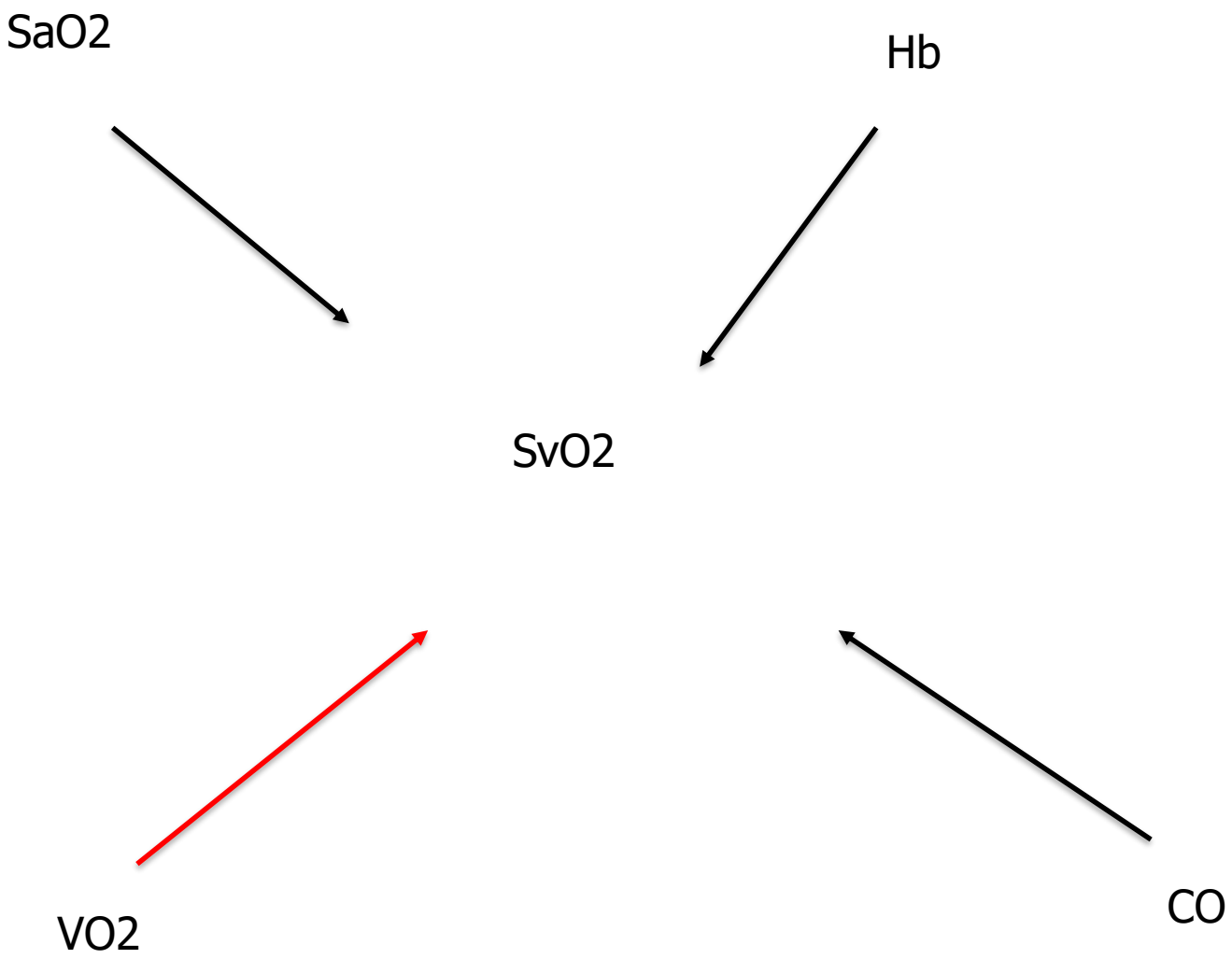
Lemaire A, et al. Ann Thorac Surg 2014;97:133-8.

Akut svår hjärtsvikt

- Behandla bakomliggande orsak
- Begränsa myokardskadan
- Adekvat organperfusion

#

- Tidig mortalitet → MOF
- Sen mortalitet → hjärtsvikt


SaO2
Hb
SvO2
VO2
CO

Inotropic agents and vasodilator strategies for acute myocardial infarction complicated by cardiogenic shock or low cardiac output syndrome (Review)

Unverzagt S, Wachsmuth L, Hirsch K, Thiele H, Buerke M, Haerting J, Werdan K, Prondzinsky R

2014, Issue 1.

AUTHORS' CONCLUSIONS

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Recommendations for the management of patients with acute heart failure: pharmacotherapy

Recommendations	Class[a]	Level[b]	Ref[c]
Diuretics			
Intravenous loop diuretics are recommended for all patients with AHF admitted with signs/symptoms of fluid overload to improve symptoms. It is recommended to regularly monitor symptoms, urine output, renal function and electrolytes during use of i.v. diuretics.	I	C	
In patients with new-onset AHF or those with chronic, decompensated HF not receiving oral diuretics the initial recommended dose should be 20–40 mg i.v. furosemide (or equivalent); for those on chronic diuretic therapy, initial i.v. dose should be at least equivalent to oral dose.	I	B	540, 548
It is recommended to give diuretics either as intermittent boluses or as a continuous infusion, and the dose and duration should be adjusted according to patients' symptoms and clinical status.	I	B	548
Combination of loop diuretic with either thiazide-type diuretic or spironolactone may be considered in patients with resistant oedema or insufficient symptomatic response.	IIb	C	549
Vasodilators			
i.v. vasodilators should be considered for symptomatic relief in AHF with SBP >90 mmHg (and without symptomatic hypotension). Symptoms and blood pressure should be monitored frequently during administration of i.v. vasodilators.	IIa	B	537, 550–555
In patients with hypertensive AHF, i.v. vasodilators should be considered as initial therapy to improve symptoms and reduce congestion.	IIa	B	537, 551–554
Inotropic agents – dobutamine, dopamine, levosimendan, phosphodiesterase III (PDE III) inhibitors			
Short-term, i.v. infusion of inotropic agents may be considered in patients with hypotension (SBP <90 mmHg) and/or signs/symptoms of hypoperfusion despite adequate filling status, to increase cardiac output, increase blood pressure, improve peripheral perfusion and maintain end-organ function.	IIb	C	
An intravenous infusion of levosimendan or a PDE III inhibitor may be considered to reverse the effect of beta-blockade if beta-blockade is thought to be contributing to hypotension with subsequent hypoperfusion.	IIb	C	
Inotropic agents are not recommended unless the patient is symptomatically hypotensive or hypoperfused because of safety concern.	III	A	556, 557
Vasopressors			
A vasopressor (norepinephrine preferably) may be considered in patients who have cardiogenic shock, despite treatment with another inotrope, to increase blood pressure and vital organ perfusion.	IIb	B	558
It is recommended to monitor ECG and blood pressure when using inotropic agents and vasopressors, as they can cause arrhythmia, myocardial ischaemia, and in the case of levosimendan and PDE III inhibitors also hypotension. In such cases intra-arterial blood pressure measurement may be considered.	I IIb	C C	540, 559–563
Thrombo-embolism prophylaxis			
Thrombo-embolism prophylaxis (e.g. with LMWH) is recommended in patients not already anticoagulated and with no contra-indication to anticoagulation, to reduce the risk of deep venous thrombosis and pulmonary embolism.	I	B	564
Other drugs			
For acute control of the ventricular rate In patients with atrial fibrillation: a. digoxin and/or beta-blockers should be considered as the first-line therapy.[d] b. amiodarone may be considered.	IIa IIb	C B	565–567
Opiates may be considered for cautious use to relieve dyspnoea and anxiety in patients with severe dyspnoea but nausea and hypopnea may occur.	IIb	B	568, 569

ESC Guidelines
Eur Heart J 2016;37:2129-2200.