Non Pharmacological Treatment of the Acute Heart Failure

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DISCLOSURES

• Consultancies & lectures within last 2 y:

Boehringer, MerckPfizer, MSD, Sanofi, Pliva, Krka, Genzyme, Sandoz,
Belupo, JGL, Astra Zeneca, Berlin Chemie Menarini, PharmaS, Medtronic,
Thoratec
Acute Heart Failure (AHF)

- AHF is defined as the rapid onset of symptoms and signs of HF secondary to abnormal cardiac function.
- AHF can present itself as acute de novo or as an acutisation of a chronic HF
- Always life threatening and needs immediate therapy
- Mechanisms: AHF-REF, -PEF, arrhythmia, afeterload-preload missmatch
AHF treatment

• STRATEGIES
  Initial stabilization
    Transport to “MIC” i.e. tertiary hospital
    Defining etiology: targeted and complex Tx

• OPTIONS
  Drugs
  Non pharmacological Tx
Non pharmacological Rx for AHFS

“General” and ICU Tx

PCI and surgical Tx

Mechanical Circulatory Support (MCS)
“General” procedures

- Oxygen supplementation
- Electrical cardioversion and defibrillation
- Cardiac pacing
- Fluid management beyond diuretics
Oxygen supplementation stages

1. Non-rebreather face mask delivering high-flow percent oxygen

2. If respiratory distress, respiratory acidosis, and/or hypoxia persist, noninvasive positive pressure ventilation (NPPV) is indicated, as long as the patient does not have a contraindication

3. Patients with respiratory failure who fail NPPV, or do not tolerate or have contraindications to NPPV should be intubated for conventional mechanical ventilation.
Noninvasive positive pressure ventilation (NPPV)
Mechanical ventilation

To intubate or not to intubate?
Memento!

- Breathing increases oxygen consumption, decreases pO$_2$ and increases pCO$_2$
- Mechanical ventilation should not be performed without strict indication, just to bring more comfort to a doctor working with sedated patient
Electrical Cardioversion and Defibrilation

• Cardioversion - delivery of energy that is synchronized to the QRS complex
• Defibrillation - nonsynchronized delivery of a shock randomly during the cardiac cycle.
Indications

- Atrial fibrillation
- Atrial flutter and SVTs
- Ventricular tachycardia

Haemodynamically compromised patient in whom urgent restoration of sinus rhythm is required to improve the patient’s clinical condition rapidly.

- Pulseless ventricular tachycardia
- Ventricular fibrillation

CARDIOVERSION

DEFIBRILLATION
Cardiac pacing

• Indicated in patients haemodynamically compromised by severe bradycardia or heart block in order to improve the patient’s clinical condition
Symptomatic bradycardia and atrioventricular block

- Temporary transvenous (and external) pacing
- Before implanting conventional PM in a pt with HF-REF, consider whether there is an indication for an ICD, CRT-P or CRT-D
- Because RV pacing may induce dyssynchrony and worsen symptoms of HF, CRT should be considered instead of conventional pacing in pts with HF-REF

ESC HF Guidelines 2012
FLUID MANAGEMENT BEYOND DIURETICS

Ultrafiltration

Hemodyalasis
Ultrafiltration

• Effective method of fluid removal with some advantages:
  – adjustable fluid removal volumes and rates,
  – no effect on serum electrolytes, and
  – decreases neurohormonal activity

• Indication: AHF accompanied by renal insufficiency or diuretic resistance
Relief for Acutely Fluid Overloaded Patients With Decompensated Congestive Heart Failure:

RAPID-CHF trial

Bart et. al. JACC 2005;46:2043-2046
Early application of UF resulted in significant fluid removal

Bart et. al. JACC 2005;46:2043-2046 (n=40)
Ultrafiltration versus IV Diuretics for Patients Hospitalized for Acute Decompensated Congestive HF: A Prospective Randomized Clinical Trial

UNLOAD Trial

200 patients hospitalized for ADHF were randomly assigned to ultrafiltration or to standard care including intravenous diuretics during the admission.
Primary End Point: Weight Loss at 48 H

Weight Loss (kg)

Ultrafiltration Arm

M = 5.0, CI±0.68 kg (N=83)

Standard Care Arm

M = 3.1, CI±0.75 kg (N=84)

$P = .001$

Non pharmacological Rx for AHFS

“General” and ICU Tx

PCI and surgical Tx

Mechanical Circulatory Support (MCS)
Revascularization procedures

• The most common cause of HF is Coronary Artery Disease
• CAD is present in 60– 70% of patients with HF and impaired LVEF $^{1,2}$
• Coronary artery bypass grafting (CABG) and percutaneous coronary intervention (PCI) should be considered in selected HF patients with CAD


Aortic valve surgery

- Aortic stenosis
  - in eligible patients with **HF symptoms and severe AS**
  - in asymptomatic patients with severe AS and impaired LVEF (<50%)

- Aortic regurgitation
  - in all eligible patients with **severe AR who have symptoms of HF**
  - in asymptomatic patients with severe AR and moderately impaired LVEF (LVEF<50%)
Mitral valve surgery

- **Organic** mitral regurgitation
  - for patients with LVEF > 30% (valve repair if possible).
  - for patients with severe MR and LVEF < 30% *(medical therapy should be a first choice)*

- **Functional** mitral regurgitation
  - in patients with **severe functional MR and severely depressed LV function**, who remain symptomatic despite OMT

- **Ischaemic** mitral regurgitation
  - in patients with severe MR and LVEF > 30% when CABG is planned.
Non pharmacological Tx for AHFS

“General” and ICU Tx

PCI and surgical Tx

Mechanical Circulatory Support (MCS)
Mechanical Circulatory Support (MCS)

- IABP
- ECMO/ECLS
- VAD
- TAH
INTRA-AORTIC BALLOON PUMP

A = One complete cardiac cycle
B = Unassisted aortic end-diastolic pressure
C = Unassisted systolic pressure
D = Diastolic augmentation
E = Reduced aortic end-diastolic pressure
F = Reduced systolic pressure

Inflation
- At the onset of diastole, IAB inflation occurs, giving rise to sharp ‘V’ on arterial waveform.
- Effect:
  - Increased coronary perfusion

Deflation
- Occurs at end of diastole before systole resulting in reduction of aortic end-diastolic and systolic pressures.
- Effects:
  - Decreased afterload
  - Decreased cardiac work
  - Decreased myocardial oxygen consumption
  - Increased cardiac output

Please Note:
- R-wave deflation may provide more effective support for patients experiencing arrhythmias

Source: Cont Edu Anaesth Crit Care & Pain © 2009 Oxford University Press
Effects of IABP

- Blood moves during diastole (when the pump inflates) to the proximal part of the aorta
- Pump deflation during systole reduces afterload by creating a vacuum effect

- Systolic pressure decrease by 20%
- Aortic diastolic pressure increase by 30%
- Mean arterial pressure increase
- Heart rate reduction by 20%
- Pulmonary capillary wedge pressure decrease by 20%
- Cardiac output increase by 20 percent

IABP

• **INDICATIONS:**
  – Acute Myocardial Infarction
  – Ventricular arrhythmias
  – Cardiogenic Shock
  – Unstable Angina
  – Cardiac Surgery

• **CONTRAINDICATIONS:**
  • (Absolute Contraindications):
    – Aortic regurgitation
    – Aortic dissection
    – Severe peripheral vascular disease
    – Complete cardiac arrest
  • (Relative Contraindications):
    – Uncotrolled sepsis and bleeding diathesis
Extracorporeal Membrane Oxygenation

FIGURE 3.4 The first successful extracorporeal life support patient, treated by J. Donald Hill using the Bramson oxygenator (foreground), Santa Barbara, 1971.
Both provide respiratory support, but only VA ECMO provides hemodynamic support.
PORTABLE ECMO
Maquet CardioHelp - ECMO, transportable
ECMO Outcomes

• VA ECMO provides acute support in patients in cardiogenic shock
• ECMO is initiated until the patient recovers or being switched to VAD
• Several studies and case series reported survival rates of 20-43% among patients who received VA ECMO\(^1\)\(^-\)\(^4\)

\(^2\) Kelly RB et al. Duration of cardiopulmonary resuscitation before extracorporeal rescue: how long is not long enough? ASAIO J. 2005;51(5):665.
Complications

- Bleeding (30-40% of patients)
- Thromboembolism
- Cannulation-related (vessel perforation, dissection, distal ischemia)
- Infections
- Heparin-induced thrombocytopenia
VAD - Options

LVAD  RVAD  BIVAD

Ao  RA  PA  LV apex  Ao  Apex  LVAD  RVAD  LVAD
VAD: classification

- Short term
- Medium term
- Long term
- Pulsatile
- Nonpulsatile
Criteria for VAD selection

• Failure of one or two ventricles?

• Prediction of mechanical support duration

• Anticipation of final outcome

• Logistic circumstances
Short term Device options

- IABP
- ECMO
- Tandem Heart
- AbioMed 5000
- Centrimag
- Impella

Bridge to recovery
Bridge to decision
Axial flow pump - Impella

- Microaxial flow device
- In one study\(^1\) (24 patients) received Impella device for postcardiotomy failure:
  - mortality was 54% (comparable to that seen in high-risk patients supported with an IABP)

Abiomed 5000

- Extracorporeal
- Pneumatic pulsatile pumps
- Uni- or biventricular support
- Bridge to transplant
- Easy to insert and operate so used in community hospitals
- Flows 6L/min

TANDEM HEART
Percutaneous left atrial-to-femoral-arterial VAD

• Can be positioned within 30 minutes

• Short-term stabilization until recovery of jeopardized myocardium or as a bridge to definite surgical treatment

• One case serie\(^1\) of 18 patients:
  • Cardiac Index improved from 1.7 to 2.4 L/min/

• Observational study\(^2\) of 117 patients:
  • Mortality was 40.2% at 30 days and 45.3% at six months

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Short-term VADs

Medtronic Biomedicus (centrifugal-type extracorporal blood pump)
Availability: 7 days

Levitronix Centrimag (continuous-flow, centrifugal-type rotary extracorporal blood pump)
Availability: 30 days
Medium- and Long-term VADs

Pulsatile flow, external (paracorpoeral) VAD
Availability – 6 to 12 months

Continuous flow, intracorporeal VADs
Availability – still not determined
Survival to transplantation of patients supported by LVAD versus control (device unavailability or family refusal)

Log-rank analysis: p = 0.0001

LONG-TERM USE OF A LEFT VENTRICULAR ASSIST DEVICE FOR END-STAGE HEART FAILURE

ERIC A. ROSE, M.D., ANNETINE C. GELIJNS, PH.D., ALAN J. MOSKOWITZ, M.D., DANIEL F. HEITJAN, PH.D., LYNN W. STEVENSON, M.D., WALTER DEMBITSKY, M.D., JAMES W. LONG, M.D., PH.D., DEBORAH D. ASCHEIM, M.D., ANITA R. TIERNEY, M.P.H., RONALD G. LEVITAN, M.SC., JOHN T. WATSON, PH.D., AND PAUL MEIER, PH.D., FOR THE RANDOMIZED EVALUATION OF MECHANICAL ASSISTANCE FOR THE TREATMENT OF CONGESTIVE HEART FAILURE (REMATCH) STUDY GROUP*
<table>
<thead>
<tr>
<th>Study (Therapy)</th>
<th>Control vs therapy 1 year survival (%)</th>
<th>Relative Benefit, %</th>
<th>Absolute benefit No, Patients/100</th>
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<tbody>
<tr>
<td>SOLVD (ACEI)</td>
<td>86 vs 89</td>
<td>3.5</td>
<td>3</td>
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<tr>
<td><em>N Engl J Med 1991;325:293-302</em></td>
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<tr>
<td>CONSENSUS (ACEI)</td>
<td>38 vs 55</td>
<td>45</td>
<td>17</td>
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<td><em>N Engl J Med 1987;316:1429-35</em></td>
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<tr>
<td>COPERNICUS (β-blocker)</td>
<td>81.5 vs 89</td>
<td>9</td>
<td>7.5</td>
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<td><em>N Engl J Med 2001;344:1651-8</em></td>
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<tr>
<td>RALES (spironolactone)</td>
<td>75 vs 83</td>
<td>11</td>
<td>8</td>
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<tr>
<td><em>N Engl J Med 2002;346:1845-53</em></td>
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<tr>
<td>REMATCH – (LVAD)</td>
<td>25 vs 52</td>
<td>108</td>
<td>27</td>
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<tr>
<td><em>Circulation 2003;108:3059-63</em></td>
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</tbody>
</table>
HeartMate II BTT – Hemodynamic and Functional Status Response

**Cardiac Index**

- Baseline: 2.0 L/min/m²
- Day 1: 3.0 L/min/m²
- P < 0.001

**PCWP (Pulmonary Capillary Wedge Pressure)**

- Baseline: 25 mmHg
- Day 1: 15 mmHg
- P < 0.001

**Improvement in Heart Failure Symptoms**

- 83% Improved to NYHA Class I or II from Class IV
- 14% Improved to NYHA Class III from Class IV
- 3% No change

*Based on improvement in New York Heart Association Heart Failure Classification 3 months after implantation.

Complications in patients assisted by VAD

<table>
<thead>
<tr>
<th>Complication</th>
<th>% of all patients assisted by VAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renal dysfunction</td>
<td>56</td>
</tr>
<tr>
<td>Bleeding</td>
<td>48</td>
</tr>
<tr>
<td>Infection</td>
<td>45</td>
</tr>
<tr>
<td>Neurologic dysfunction</td>
<td>27</td>
</tr>
<tr>
<td>Thromboembolic events</td>
<td>12</td>
</tr>
<tr>
<td>Mechanical Failure</td>
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</table>

J Thorac Cardiovasc Surg 2001;122:1186-1195
ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012

The Task Force for the Diagnosis and Treatment of Acute and Chronic Heart Failure 2012 of the European Society of Cardiology. Developed in collaboration with the Heart Failure Association (HFA) of the ESC

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<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
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<tbody>
<tr>
<td>Bridge to decision (BTD):</td>
<td>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.</td>
</tr>
<tr>
<td>Bridge to candidacy (BTC):</td>
<td>Use of MCS to improve end-organ function in order to make an ineligible patient eligible for transplantation.</td>
</tr>
<tr>
<td>Bridge to transplantation (BTT):</td>
<td>Use of MCS to keep a patient at high risk of death before transplantation alive until a donor organ becomes available.</td>
</tr>
<tr>
<td>Bridge to recovery (BTR):</td>
<td>Use of MCS to keep patient alive until intrinsic cardiac function recovers sufficiently to remove MCS.</td>
</tr>
<tr>
<td>Destination therapy (DT):</td>
<td>Long-term use of MCS as an alternative to transplantation in patients with end-stage heart failure ineligible for transplantation.</td>
</tr>
</tbody>
</table>

MCS = mechanical circulatory support.
HEART TRANSPLANTATION
HTx as a golden standard

• The ideal therapy for the management of heart failure refractory to usual medical care continues to be cardiac transplantation

• Shortage of organs...

• Reversibility of HF?

• Eligibility for a heart transplant?

• The alternative therapy for end stage heart failure should be integrated with HTx programme
However, despite technological improvements, bleeding, thromboembolism (both of which can cause stroke), infection, and device failure remain significant problems; these issues, plus the high cost of devices and implantation, have limited their wider use. It is recommended that such devices are only implanted and managed at tertiary heart failure centres with appropriately trained, specialist HF physicians and surgeons. Ideally these centres should also undertake transplantation.

ESC HF Guidelines, 2012
University Hospital Centre Zagreb,

HTX since 1987

MCS since 2008.
MCS: device selection algorithm at University Hospital Centre Zagreb

ACUTE & ADVANCED
REFRACTORY HF

POSTCARDIOTOMY

VAD (Biomedicus) or ECLS

VAD (Levitronix)

PVAD / HeartMate

NON-SURGERY RELATED

CARDIOGENIC SHOCK

ECLS, IABP

HTx or “Destination”

REFRACTORY HEART FAILURE

Levitronix

PVAD or HeartMate

VAD (Biomedicus) or ECLS

VAD (Levitronix)

PVAD / HeartMate

ECLS, IABP

HTx or “Destination”

Levitronix

PVAD or HeartMate
Conclusions

• No strict guidelines for AHF Tx due to poor EBM
• Non-pharmacological Tx: when drugs are not enough (but still needed)
• General ICU methods: $O_2$; Ultrafiltration, Pacing, D/C
• Targeted Tx: PCI, CABG, valve surg.
Conclusions (MCS)

- IABP – limited efficacy
- ECMO: BTC, BTD (survival 20-40%)
- Short term VAD: BTD including BTT
- Long term LVAD: BTT or Destination Tx
- Last but not least:
  TO DISTINGUISH
  
  terminal HF vs terminal patient
Levitronix centrifugal, paracorporeal, short term support

in a 32 yo pt with DCM, Cardiogenic + septical shock, and MOF + HIT

1st successful bridge to heart transplant (BTT) at University Hospital Center Zagreb 2008.
Thank you!