Non Invasive Hemodynamic Monitoring in the ED

Roberta PETRINO
Director Emergency Medicine Unit
S. Andrea Hospital, Vercelli - Italy
EuSEM Vice-president

Is haemodinamic monitoring useful in the ED?

- Helps in diagnosis
- Gives information on disease progress
- Guides in adjusting therapy

Often, dyspnea poses a significant diagnostic challenge especially in patients with concurrent chronic lung disease and congestive heart failure.

It is necessary to find an easy and cheap method to evaluate and monitor the hemodynamic status of the patient with dyspnea, in particular when the etiology may be difficult and the therapy may be highly influenced by the result.

Cardiac Output (CO)

Cardiac Output measurement gives information on heart function

- Stroke Volume (SV) = EDV – ESV (vn 70-120 ml)
- Ejection Fraction (EF) = (SV / EDV) x 100%
- Cardiac Output (Q) = SV x HR

Measurement of CO may result extremely helpful in differentiating and monitoring outcome in undifferentiated dyspnea in the ED.

Bedside clinical evaluation of haemodynamic profile of the patient

<table>
<thead>
<tr>
<th>Hyponperfusion at rest</th>
<th>Congestion at rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>NORMAL Hot and Dry</td>
</tr>
<tr>
<td></td>
<td>CPE Hot and Wet</td>
</tr>
<tr>
<td></td>
<td>DISCHARGE</td>
</tr>
<tr>
<td>NO</td>
<td>OBS/ADMIT</td>
</tr>
<tr>
<td>YES</td>
<td>HYPOTHELEMIC SHOCK</td>
</tr>
<tr>
<td></td>
<td>Cool and Dry</td>
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<td>ADMIT/ICU</td>
</tr>
</tbody>
</table>

Classification by Stevenson et al. (J Am Coll Cardiol 1999)

Invasive Hemodynamic Monitoring

Swan Ganz®

- Pulmonary artery cannulation
- 25 years experience
- Internal jugular vein puncture
Invasive Hemodynamic Monitoring

**VIGILEO®**

- **PreSap aneurysm catheter (SVCO)**
- **Vigileo monitor**
- **FloTrac sensor** (peripheral artery)

**PiCCO®**

- **Catheter injection**
- **Right Heart**
- **Left Heart**

**LiDCO®**

Using echography, the diameter of the inferior vena cava (IVC) and its decrease on deep inspiration (collapse index) permits an indirect estimation of CVP.

<table>
<thead>
<tr>
<th>IVC Diameter</th>
<th>Collapse Index</th>
<th>CVP (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1.5</td>
<td>&gt;50%</td>
<td>0-5</td>
</tr>
<tr>
<td>1.5-2.0</td>
<td>30-50%</td>
<td>5-10</td>
</tr>
<tr>
<td>2.0-2.5</td>
<td>0-30%</td>
<td>15-20</td>
</tr>
<tr>
<td>&gt;2.5</td>
<td>No Collapse</td>
<td>&gt;20</td>
</tr>
</tbody>
</table>

Non Invasive Hemodynamic Monitoring

**Caval Vein Echography**

- **Lung comets artifacts**

**Non Invasive Hemodynamic Monitoring**

- **Caval Vein Echography**

- **Heart**
- **IVC (inferior vena cava)**

**Non Invasive Hemodynamic Monitoring**

- **Caval Vein Echography**

- **Heart**
- **IVC (inferior vena cava)**
Non Invasive Hemodynamic Monitoring
Passive Leg Raising (PLR)

How Bioreactance works?

Non Invasive Hemodynamic Monitoring
Bioimpedence and Bioreactance

Both technologies are based on passage of low voltage current through the thorax.
Bioimpedance measures the amplitude of the waves (AM ←)
Bioreactance measures the frequency of the waves (FM ↑)

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Bioreactance measures the frequency of the waves (F M ↑↑ ↑↑)

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NICOM®

NICOM®: what does it measures?

Direct measures
- HR
- CO, CI
- SV, SVI
- Systolic, Diastolic and Mean Blood Pressure
- Thoracic Fluid Content: TFC

Calculated data
- Total Peripheral Resistance TPRI
- DO2 (derived from Hct, SaO2)

Before and during Passive Leg Raising (PLR)

Practical applications of Non Invasive Hemodynamic Monitoring in the ED

Diagnosis
- AHF vs COPD

Therapeutic choice
- The patient is wet or dry?
- Fluid challenge evaluation (PLR)

Monitoring
- Treatment effect
- Dose adjustment
- Continuous hemodynamic evaluation

In patients with acute dyspnea, when a clear clinical doubt on the etiology, a useful tool for diagnosis and therapy monitoring is the evaluation of hemodynamic status of the patient.
The COMET Protocol: methods

All patients are normally treated according to common therapeutic protocols for their supposed clinical diagnosis

At T0, 3 and 6 hours from admission, along with classical clinical monitoring (diuresis, thoracic objective exam, vitals), we perform:

- NICOM monitoring
- thoracic US
- BGA
- inferior vena cava collapse index (CCI)

The COMET Protocol: preliminary results

6 patients so far enrolled:

- No sensible improving of CO or CI neither in patients with acute cardiac failure (ACF) nor in respiratory patients
- Sensible reduction of Total Peripheral Resistance (TPR) and Total Peripheral Resistance Index (TPRI), as well as Thoracic Fluid Content (TFC) and its variation over time (TFCd), reflecting intrathoracic water, in patients with ACF clinically responding to treatment.
- Such findings seem to correlate with reduction in Thoracic US comet score and P/F improvement.
To define and validate TFC and TPR normal values, which could be very useful, particularly when combined with thoracic US, in quick differential diagnosis between cardiac and respiratory acute dyspnoea.

To define and validate TPRI variations and TFCd to target in monitoring effectiveness of therapy in ACF patients.

The COMET Protocol: potential further investigations

grazie
ropetrino@gmail.com