SEPSI: COSA, COME MONITORIAMO?

Paolo Onorato, S.O.C. Pronto Soccorso e Medicina d’Urgenza
ASUIUD S. Maria della Misericordia di Udine
Monitoraggio: osservazione, a scopo di controllo, di una grandezza variabile, eseguita mediante appositi strumenti (monitor).

- Intermittente/continuo
- Non invasivo/invasivo
- Macro-parametri/micro-parametri
- Statici/dinamici
A LETTO DEL PAZIENTE...

- PA
- polso/SpO₂
- Tc, estremità
- Basi polmonari FR
- addome
- sensorio
- giugulari
- toni cardiaci
- CRT
- urine
- alluce
PARAMETRI VITALI

• PAM [PAD + 0.412 X (PAS – PAD)]
• FC
• FR (ispezione e palpazione)
• COSCIENZA (GCS, ACVPU)
• PERFUSIONE CUTANEA (grado di marezzatura, RCT, gradiente di temperatura)
• DIURESI (CV)
PRESSIONE ARTERIOSA MEDIA

- PAM [PAD + 0.412 x (PAS-PAD)]

\[
\begin{align*}
\text{PAS/PAD} & \rightarrow \text{PAM} \\
120/70 & \rightarrow 90,6 \\
101/40 & \rightarrow 65,1 \\
90/35 & \rightarrow 57,6
\end{align*}
\]
Consensus on circulatory shock and hemodynamic monitoring. Task force of the European Society of Intensive Care Medicine

Shock is typically associated with evidence of inadequate tissue perfusion on physical examination. The three organs readily accessible to clinical assessment of tissue perfusion are the:

- skin (degree of cutaneous perfusion);
- kidneys (urine output); and
- brain (mental status)
## Valutazione della Perfunzione Cutanea

<table>
<thead>
<tr>
<th>Metodo</th>
<th>Variabile</th>
<th>Vantaggio</th>
<th>Limiti</th>
<th>Significato</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marezzatura cutanea</td>
<td>Presente/assente</td>
<td>Facile da esaminare</td>
<td>Poco specifico</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Punteggio</td>
<td>Facile e riproducibile</td>
<td>Non utile se cute scura</td>
<td>Pz grave se score 4-5</td>
</tr>
<tr>
<td>Refill capillare</td>
<td>Refill indice</td>
<td>Facile e riproducibile</td>
<td>Risultati variabili</td>
<td>Shock &gt; 2.5 sec</td>
</tr>
<tr>
<td></td>
<td>Refill ginocchio</td>
<td>Riproducibile</td>
<td>Non utile se cute scura</td>
<td>Shock &gt; 5 sec</td>
</tr>
<tr>
<td>Gradiente di temperatura</td>
<td>Avambraccio-dito</td>
<td>Metodo validato</td>
<td>Tecnologia complessa</td>
<td>Significativo se &gt; 4°C</td>
</tr>
<tr>
<td></td>
<td>Centrale-alluce</td>
<td>Metodo validato</td>
<td>Tecnologia complessa</td>
<td>Significativo se &gt; 7°C</td>
</tr>
</tbody>
</table>

Hafid Ait- Oufella, and Jan Bakker.  
**Understanding clinical signs of poor tissue perfusion during septic shock.**  
*Intensive Care Med 2016.*
Mottling score predicts survival in septic shock.

H. Ait-Oufella et al.
Mottling score predicts survival in septic shock.
Capillary refill time exploration during septic shock

Capillary refill time:

firm pressure to the distal phalanx of the index finger for 15 s.

Time for return of the normal color.
sensibilità 82 %
specificità 73 %
FLUID RESPONSIVENESS

“... fluid responsiveness is a measure of preload dependence or preload reserve of the two ventricles...”


“Whose SV increases by 10-15% after a fluid challenge (250-500 ml) is considered to be a fluid responder.”

Marik PE, Monnet X, Teboul JL. “Hemodynamic parameters to guide fluid therapy“. Ann Crit Care 2011; 1: 1
“To predict fluid responsiveness, two methods must be combined to generate the changes in preload on one hand and to measure the subsequent changes in stroke volume on the other hand.”

"It is likely that less than 40% of hypotensive patients with severe sepsis or septic shock are fluid responders...
...in patients with sepsis, less than 5% of a crystalloid bolus remains intravascular an hour after the end of the infusion..."


"The concept of fluid responsiveness is based on pathophysiologic consideration and has not been rigorously evaluated in randomized controlled trials ..."

Conclusions: This review has highlighted the plethora of goals and methods for monitoring fluid therapy. Strikingly, there is scant high quality evidence, in particular for non-invasive G/M combinations in non-operative and non-intensive care settings. There is an urgent need to address this research gap, which will be helped by methodologies to compare utility of G/M combinations.
Will This Hemodynamically Unstable Patient Respond to a Bolus of Intravenous Fluids?

Peter Bentzer, MD, PhD; Donald E. Griesdale, MD, MPH; John Boyd, MD; Kelly MacLean, MD; Demetrios Sirounis, MD; Najib T. Ayas, MD, MPH

“...diagnostic accuracy of dry mucous membranes, dry axilla, decreased tissue turgor, CRT > 2 seconds, tachycardia and low jugular venous pressure... LR and respective 95% CIs for all of these findings crossed 1.0...

...diagnostic accuracy of a systematic clinical assessment of skin turgor, CRT, jugular vein distension, appearance of mucous membranes, pulmonary ascultation and presence of leg edema, ascites and pleural effusions... this approach was poor predictor of fluid responsiveness with 95% Cis of the LRs crossing 1.0 (LR + 0.93, LR – 1.2).”
MONITORAGGIO “AVANZATO”

Eco VCI

acute circulatory failure

- evident fluid loss?
- early phase of sepsis?

Termodiluizione

- spontaneous breathing?
- cardiac arrhythmias?
- low tidal volume/low lung compliance?

PVI

LUS

yes

fluid administration

no

SDF

TTE

yes

- passive leg raising test
- end-expiratory occlusion test
- «mini» fluid challenge

no

TEE

- pulse pressure/stroke volume respiratory variation
- passive leg raising test
- end-expiratory occlusion test
- «mini» fluid challenge

COSA MISURARE?

Consensus on circulatory shock and hemodynamic monitoring. Task force of the European Society of Intensive Care Medicine

- We raccomend that fluid resuscitation should be guided by more than one single hemodynamic variable

- We raccomend using dynamic over static variables, when applicable, to predict fluid responsiveness, when applicable

- When raccomend for fluid administration is made we raccomend to perform a fluid challenge unless in cases of obvious hypovolemia
Focused ultrasonography is a diagnostic technique to consider as part of multimodal hemodynamic assessment during the care of select patients with septic shock.

Classe C di evidenza: opinioni di esperti
Collapsibility index of IVC = \[
\frac{(\text{max IVC diameter} - \text{min IVC diameter})}{\text{max IVC diameter}} \times 100
\]

“Will This Hemodynamically Unstable Patient Respond to a Bolus of Intravenous Fluids?” Peter Bentzer, MD, PhD; Donald E. Griesdale, MD, MPH; John Boyd, MD, JAMA September 27, 2016 Volume 316, Number 12.
ECO VCI

VUOTA

PIENA DIPENDE...
ECO VCI

Le escursioni respiratorie della VCI possono risultare falsamente ridotte in varie condizioni cliniche e pertanto, se non interpretate, precludere un‘adeguata terapia infusiva in pazienti ancora fluid-responder:

- PNX
- Tamponamento cardiaco
- TEP, IMA vdx, insufficienza tricuspidalica severa, CPC
- Contusione cardiaca
- ARDS
- PEEP
- Sindrome compartimentale addominale
- Compressione ab estrinseco
Conclusion: responders vs non-responders.
Respiratory changes in inferior vena cava diameter are helpful in predicting fluid responsiveness in ventilated septic patients.

Conclusion: Using a threshold dIVC of 18%, responders and non-responders were discriminated with 90% sensitivity and 90% specificity. A strong relation (r=0.9) was observed between dIVC at baseline and the CI increase following blood volume expansion. Baseline central venous pressure did not accurately predict fluid responsiveness.
Does inferior vena cava respiratory variability predict fluid responsiveness in spontaneously breathing patients?

Table 5 Accuracy of cIVC at baseline, IVCmax and ΔCO after PLR for predicting fluid responsiveness

<table>
<thead>
<tr>
<th></th>
<th>Se</th>
<th>Sp</th>
<th>LR+</th>
<th>LR-</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>cIVC &gt; 42 %</td>
<td>31%</td>
<td>97%</td>
<td>9</td>
<td>0.7</td>
<td>90%</td>
<td>59%</td>
</tr>
<tr>
<td>IVCmax at baseline &lt; 2.1 cm</td>
<td>93%</td>
<td>33%</td>
<td>1.4</td>
<td>0.2</td>
<td>57%</td>
<td>83%</td>
</tr>
<tr>
<td>ΔCO &gt; 10 %</td>
<td>52%</td>
<td>87%</td>
<td>4</td>
<td>0.6</td>
<td>79%</td>
<td>65%</td>
</tr>
</tbody>
</table>

ΔCO change in CO between baseline and after PLR, cIVC collapsibility index at baseline, IVCmax maximum diameter of the IVC, PLR passive leg raising, Se sensitivity, Sp specificity, LR likelihood ratio, PPV positive predictive value, NPV negative predictive value.
Respiratory variations of inferior vena cava diameter to predict fluid responsiveness in spontaneously breathing patients with acute circulatory failure: need for a cautious use.

Figure 1 Individual values of inferior vena cava collapsibility (cIVC) (%) after infusion of 500 mL of HES. The best cutoff value is 40%.
Will This Hemodynamically Unstable Patient Respond to a Bolus of Intravenous Fluids?

Peter Bentzer, MD, PhD; Donald E. Griesdale, MD, MPH; John Boyd, MD; Kelly MacLean, MD; Demetrios Sirounis, MD; Najib T. Ayas, MD, MPH

“Despite the fact that the pooled LRs indicate relatively good accuracy (LR + 5.3, LR – 0.27 in ventilated patient, VCD index threshold of 15%, LR + 3.5, LR – 0.38 in spontaneously breathing patientes, VCC index of 41%), the test should be interpreted with some caution. Respiratory variation in the VC is less useful and requires further confirmatory studies.”
Volume responsive, but does the patient need volume?

Giving volume to fluid responders as long as they respond should not become the iatrogenic syndrome of the decade.
1. Intrathoracic thermal volume (ITTV)
2. Global end-diastolic volume (GEDV) = ITTV - TPV
3. Intrathoracic blood volume (ITBV) = 1.25 x GEDV
4. Extravascular lung water (EVLW) = ITTV - ITBV
"Clinical update Ultrasound of extravascular lung water: a new standard for pulmonary congestion"  
LUS, fluid responsiveness e EVLW

“Whole body Ultrasonography in the critical ill”. Daniel A. Lichtenstein 2010
International evidence-based recommendations for point-of-care lung ultrasound
### Table 2  Scoring of B-lines

<table>
<thead>
<tr>
<th>Score</th>
<th>Number of B-lines</th>
<th>EVLW</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(&lt;5)</td>
<td>Absent</td>
</tr>
<tr>
<td>1</td>
<td>6–15</td>
<td>Mild degree</td>
</tr>
<tr>
<td>2</td>
<td>16–30</td>
<td>Moderate degree</td>
</tr>
<tr>
<td>3</td>
<td>(\geq 30)</td>
<td>Severe degree</td>
</tr>
</tbody>
</table>

**Figure 1**  The recommended protocol for evaluating B-lines is performed by scanning 28-region protocol on the anterior chest with the patient in the supine position.\(^3,4,23\)
**Point of Care Ultrasound Fluid Resuscitation Guide**

- using IVC and lung ultrasound -

**Underfilled**

- < 1.5 cm

  - Intubated
    - Passive
      - Fluid Resuscitate
        - Give Crystalloid
          - Septic patients, consider dynamic fluid responsiveness test

  - Triggering
    - (Dias-Dias) / [(Dias+Dias)/2] > 12%
      - **A-line predominance**
      - Fluid Test
        - Consider Crystalloid
          - Crystalloid may help and unlikely to harm
          - Dynamic fluid responsiveness test indicated if available
      - **B-line predominance**
      - Fluid Restrict
        - Hold Crystalloid
          - Vasoactive agents indicated to support shock

**Normal**

- 1.5 - 2.5 cm

  - Intubated
  - Not Intubated

**Distended**

- > 2.5 cm, non-varying IVC

"Exceptions: Elevated RA pressure e.g. tamponade, pHTN, etc. or B-line etiologies other than pulmonary edema. May still be fluid responsive."
Relying on a single measurement to make clinical decisions could lead to poor outcome... the decision to administer fluid at bedside not be based solely on a test result but also on risks and benefits of fluid administration in the clinical context.
GRAZIE PER L'ATTENZIONE!
Figure 3 Correlation of the extravascular lung water index with the ultrasound score. (A) We found a close correlation of the ultrasound (US) score with the extravascular lung water index (EVLWI) (Spearman’s $r = 0.91$, $P < 0.0001$). (B) Correlation of the blinded US score as a mean of two independent examiners is shown (Spearman’s $r = 0.72$, $P < 0.0001$). (C) Bland-Altman plot comparing the difference (EVLWI – US score) with the average (of EVLWI and US score). Additionally, a linear regression (difference = 7.62 – 0.46 × average) and the 95% confidence intervals (linear regression ± 1.96 × 3.6) are plotted. (D) Receiver operating characteristic curves of the US score obtained to identify patients with EVLWIs >7 and >15 show excellent diagnostic performance, as indicated by the areas under the curve of 0.9419 and 0.9636.
FALLS-protocol: lung ultrasound in hemodynamic assessment of shock

D. Lichtenstein
Service de Réanimation Médicale, Hôpital Ambroise-Paré, Université Paris-Ouest, France