Optimal blood pressure target
in septic shock

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Questions

1- **Why** do we **use** a vasopressor in septic shock?

2- **When** to **initiate** a vasopressor in septic shock?

3- **Which** MAP **target** in septic shock?
Why do we use a vasopressor in septic shock?

1- Septic shock is characterized by a **decreased vascular tone**
   (inducible NO synthase activation, etc)

↓

Hypotension

↓

Worsening of hypoperfusion
Autoregulation of organ blood flow

Mean Arterial Pressure

organ blood flow
**Why** do we **use** a vasopressor in septic shock?

1- Septic shock is characterized by a decreased vascular tone
   (inducible NO synthase activation, etc)

2- Profound **hypotension** worsens **organ hypoperfusion**
   ...... and represents an **independent risk of death**
Hemodynamic variables related to outcome in septic shock

Area under MAP 65 mmHg

Time under MAP 65 mmHg

Area under MAP 65 mmHg

Best predictor of 30-day mortality
Why do we use a vasopressor in septic shock?

1- Septic shock is characterized by a decreased vascular tone (inducible NO synthase activation, etc)

2- Profound hypotension worsens organ hypoperfusion ...... and represents an independent risk of death

3- Correction of hypotension with a vasopressor allows improving organ perfusion
Creatinine clearance

0-2 hrs  4-6 hrs

60
30
54 mmHg 72 mmHg

Blood lactate (meq/l)

7
14
3
54 mmHg 73 mmHg 72 mmHg

baseline 4 hrs 8 hrs

Urine flow (ml/h)

150
100
50
0

54 mmHg 73 mmHg 72 mmHg

baseline 4 hrs 8 hrs

while cardiac output did not change
Autoregulation of renal blood flow

renal blood flow

mean arterial pressure

54 72
**Why do we use a vasopressor in septic shock?**

1- Septic shock is characterized by a decreased vascular tone (inducible NO synthase activation, etc)

2- Profound hypotension worsens organ hypoperfusion ...... and represents an independent risk of death

3- **Correction** of *hypotension* with a vasopressor allows improving *organ perfusion* and *microcirculation*
Restoring arterial pressure with norepinephrine improves muscle tissue oxygenation assessed by near-infrared spectroscopy in severely hypotensive septic patients

<table>
<thead>
<tr>
<th></th>
<th>Before norepinephrine (introduction/increase)</th>
<th>After norepinephrine (introduction/increase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAP (mmHg)</td>
<td>86 ± 19</td>
<td>126 ± 18*</td>
</tr>
<tr>
<td>DAP (mmHg)</td>
<td>38 ± 7</td>
<td>52 ± 8*</td>
</tr>
<tr>
<td>MAP (mmHg)</td>
<td>54 ± 8</td>
<td>77 ± 9*</td>
</tr>
<tr>
<td>Heart rate (min⁻¹)</td>
<td>98 ± 25</td>
<td>101 ± 28</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>37.5 ± 1.4</td>
<td>37.5 ± 1.3</td>
</tr>
<tr>
<td>CI (L/min/m²)</td>
<td>3.1 ± 1.0</td>
<td>3.6 ± 1.3*</td>
</tr>
<tr>
<td>GEDVI (mL/m²)</td>
<td>687 ± 117</td>
<td>730 ± 156*</td>
</tr>
<tr>
<td>ScvO₂ (%)</td>
<td>68 ± 9</td>
<td>72 ± 7*</td>
</tr>
</tbody>
</table>
Restoring arterial pressure with norepinephrine improves muscle tissue oxygenation assessed by near-infrared spectroscopy in severely hypotensive septic patients.

StO\textsubscript{2}: 75 ± 9%

healthy volunteers

82 ± 4 *
StO₂ (%)

Vascular Occlusion Test

Start point: 0.98 x baseline StO₂

End point: 0.85 x baseline StO₂

Start point: 1.05 x minimal StO₂

Deflation of the pneumatic cuff

Inflation of the pneumatic cuff

Occlusion time

AUC

Desaturation slope

Index of recruitment of microvessels

Recovery slope
Restoration of a “good” MAP with NE resulted in recruitment of microvessels and better tissue oxygenation.
1- Why do we use a vasopressor in septic shock?

2- When to initiate a vasopressor in septic shock?

3- Which MAP target in septic shock?
Rationale. Vasopressor therapy is required to sustain life and maintain perfusion in the face of life-threatening hypotension, even when hypovolemia has not yet been resolved.

Adequate fluid resuscitation is a fundamental aspect of the hemodynamic management of patients with septic shock and should ideally be achieved before vasopressors and inotropes are used; however, using vasopressors early as an emergency measure in patients with severe shock is frequently necessary, as when diastolic blood pressure is too low.
1- Why do we use a vasopressor in septic shock?

2- When to initiate a vasopressor in septic shock?

3- Which MAP target in septic shock?
Autoregulation of organ blood flow

organ blood flow

Mean Arterial Pressure

65 mmHg?
Effects of perfusion pressure on tissue perfusion in septic shock

David LeDoux, MD; Mark E. Astiz, MD, FCCM; Charles M. Carpati, MD; Eric C. Rackow, MD, FCCM


MAP: 65 mmHg
MAP: 75 mmHg
MAP: 85 mmHg

%
Autoregulation of organ blood flow

Mean Arterial Pressure (mmHg)

organ blood flow

65 75 85
Increasing mean arterial pressure in patients with septic shock: Effects on oxygen variables and renal function*

Aurélie Bourgoin, MD; Marc Leone, MD; Anne Delmas, MD; Franck Garnier, MD; Jacques Albanèse, MD; Claude Martin, MD, FCCM

Crit Care Med 2005; 33:780 –786

increasing MAP above 65 mmHg results in little benefit
Vasopressors

• Vasopressor therapy initially to target a MAP of 65 mmHg (grade 1C)
Is it dangerous to target a MAP value up to "normal values" (around 85 mmHg) in septic shock?
The effect of increasing doses of norepinephrine on tissue oxygenation and microvascular flow in patients with septic shock

Shaman Jhanji, MRCP, FRCA; Sarah Stirling, MRCP, FRCA; Nakul Patel, MBBS; Charles J. Hinds, FRCP, FRCA; Rupert M. Pearse, FRCA, MD

Effects of changes in arterial pressure on organ perfusion during septic shock

Auréli Thosif, Raphaël Favory, Diamantino Ribeiro Salgado, Fabio S Taccone, Kasia Donadello, Daniel De Becker, Jacques Coteur and Jean-Louis Vincent

Critical Care 2011, 15:R222

13 pts with septic shock

Recovery slope \( \% / \text{min} \)

Level of MAP \( \text{mmHg} \)

- Level of MAP (mmHg)
  - 65
  - 75
  - 85

Recovery slope (\( \% / \text{min} \))

- Recovery slope at 65 mmHg
- Recovery slope at 75 mmHg with an asterisk (*)
- Recovery slope at 85 mmHg with an asterisk (*)

Graph showing the relationship between MAP levels and recovery slope.
Effects of changes in arterial pressure on organ perfusion during septic shock

Perfused Vessel Density

<table>
<thead>
<tr>
<th></th>
<th>65 mmHg</th>
<th>75 mmHg</th>
<th>85 mmHg</th>
<th>65 mmHg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small PPV (%)</td>
<td>83.6 (76.1-91.0)</td>
<td>87.9 (81.8-94.0)</td>
<td>91.1 (87.9-94.3)</td>
<td>86.4 (76.3-96.5)</td>
</tr>
<tr>
<td>MFI</td>
<td>2.4 (2.2-2.7)</td>
<td>2.7 (2.4-2.9)</td>
<td>2.9 (2.8-2.9)</td>
<td>2.5 (2.2-2.9)</td>
</tr>
</tbody>
</table>

No worsening but improvement of microcirculation for MAP target up to 85 mmHg with NE

Microvascular Flow Index

6 pts with septic shock
Highly variable response among patients

Critical Care 2009, 13:R92
Vasopressors

- Vasopressor therapy initially to target a MAP of **65** mmHg (grade 1C)

Probably higher target value if:

- **History of chronic hypertension**
Autoregulation of Brain Circulation in Severe Arterial Hypertension

S. STRANDGAARD, J. OLESEN, E. SKINHØJ, N. A. LASSEN


Organ
Blood flow

no prior hypertension

with prior hypertension

Mean arterial pressure

65

mmHg
High versus Low Blood-Pressure Target in Patients with Septic Shock

Pierre Asfar, M.D., Ph.D., Ferhat Meziani, M.D., Ph.D., Jean-François Hamel, M.D., Fabien Grelon, M.D., Bruno Megarbane, M.D., Ph.D., Nadia Anguel, M.D., Jean-Paul Mira, M.D., Ph.D., Pierre-François Dequin, M.D., Ph.D., Soizic Gergaud, M.D., Nicolas Weiss, M.D., Ph.D., François Legay, M.D., Yves Le Tulzo, M.D., Ph.D., Marie Conrad, M.D., René Robert, M.D., Ph.D., Frédéric Gonzalez, M.D., Christophe Guitton, M.D., Ph.D., Fabienne Tamion, M.D., Ph.D., Jean-Marie Tonnelier, M.D., Pierre Guezennec, M.D., Thierry Van Der Linden, M.D., Antoine Vieillard-Baron, M.D., Ph.D., Eric Mariotte, M.D., Gaël Pradel, M.D., Olivier Lesieur, M.D., Jean-Damien Ricard, M.D., Ph.D., Fabien Hervé, M.D., Damien du Cheyron, M.D., Ph.D., Claude Guerin, M.D., Ph.D., Alain Mercat, M.D., Ph.D., Jean-Louis Teboul, M.D., Ph.D., and Peter Radermacher, M.D., Ph.D.
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Low MAP (n=388)</th>
<th>High MAP (n=388)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age — years</td>
<td>65 ± 15</td>
<td>65 ± 13</td>
</tr>
<tr>
<td>Male gender — no (%)</td>
<td>250 (64.4)</td>
<td>277 (68.8)</td>
</tr>
<tr>
<td>SAPSII#</td>
<td>57.2 ± 16.2</td>
<td>56.1 ± 15.5</td>
</tr>
<tr>
<td>SOFA score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serum lactate level — mmol/L</td>
<td>3.7 ± 3.7</td>
<td>3.3 ± 3.2</td>
</tr>
<tr>
<td>Hemoglobin concentration — g/L</td>
<td>103 ± 21</td>
<td>106 ± 21</td>
</tr>
<tr>
<td>Fluid therapy before Inclusion — mL</td>
<td>2946±1360</td>
<td>2973±1331</td>
</tr>
</tbody>
</table>

Benefits in terms of kidney function with a high MAP target in patients with chronic hypertension
A high mean arterial pressure target is associated with improved microcirculation in septic shock patients with previous hypertension: a prospective open label study

Critical Care (2015) 19:130

Microvascular Flow Index

![Graph showing microvascular flow index with small perfused vessel density (vessels/mm²) on the y-axis and mean arterial pressure (MAP) on the x-axis. The graph indicates a decrease in vessel density as MAP increases.]
Vasopressors

- Vasopressor therapy initially to target a **MAP of 65 mmHg** (grade 1C)

Probably **higher target value** if:

- History of chronic hypertension
- Elevated CVP
Association between elevated CVP and AKI suggests a role of venous congestion in the development of AKI
Elevated central venous pressure is associated with impairment of microcirculatory blood flow in sepsis: a hypothesis generating post hoc analysis

Narmkje AR Vellinga\textsuperscript{1,2}, Can Ince\textsuperscript{1} and E Christiaan Boerma\textsuperscript{2,3}

*BMC Anesthesiology 2013, \textbf{13}:17*
Vasopressors

• Vasopressor therapy initially to target a MAP of 65 mmHg (grade 1C)

Probably higher target value if:

• History of chronic hypertension
• Elevated CVP
• Elevated abdominal pressure
**Target blood pressure in circulatory shock**

- We recommend **individualizing** the target blood pressure during shock resuscitation.  
  *Recommendation Level 1: QoE moderate (B)*

- We recommend to **initially target a MAP of ≥ 65 mmHg.**  
  *Recommendation: Level 1; QoE low (C)*

- We suggest a **higher MAP** in septic patients with a **history of hypertension.**  
  *Recommendation: Level 2; QoE low (B)*
Which MAP target in septic shock?

Conclusion

• Individualized assessment is recommended

• 65-85 mmHg seems to be a safe range
  - at least 65 mmHg
  - probably more if:
    • History of chronic hypertension
    • Elevated CVP
    • Increased abdominal pressure
Thank you