Refrakterní septický šok

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Step-wise algorithm for evaluation of a circulatory collapse

1.) Obstructive shock – YES/NO
2.) Cardiogenic shock – YES/ NO
3.) Hypovolaemic shock – YES/NO
4.) Distributive shock: sepsis ?, anaphylaxis ?, neurogenic ? – YES/ NO
5.) Endocrine (hypoadrenal, hypothyroid, DKA), intoxication

...otherwise......risk of unnecessary/contraindicated fluid loading (SSC: 30 ml/kg within 3h....800-1000 ml/h !) ......risk of missed cardiac interventions or therapy of obstructive causes
Step 4 = If cause of shock still unclear...

- At this stage, basic clinical exam and echo should rule out or confirm
  - Obstructive shock
  - Cardiogenic shock
  - Hypovolaemia: preload now optimised
- Syndrome of vasoplegia is therefore likely, but it can have a myriad of causes
- Vasoplegia can be taken by basic echocardiography
Vasodilatation and low endsystolic pressure

Low SVR, ESA → High FS, $S_{tdi}$, EFLV

Higher transmitral E

IVC 24-21 mm

SVV < 15%

FS = 65%
Physiology of severe („refractory“) vasoparalysis

- $\text{MAP} = \text{CO} \times \text{SVR}$

• **Septic shock:**
  - $\downarrow \text{MAP} = \downarrow \text{SVR} \times \text{HR} \times \downarrow \text{SV}$

Noradrenalin $>$ 0.5 ug/kg.min

- increases PAP
- occurrence of arrhythmiases
- accumulation of fluid
- rates of renal failure


Vasopressin

- Non-catecholamine V1, V2, V3 receptors
  - Helps in down regulated alpha-receptors
- Abates catecholamine side effects
  - Arrhythmias (*Reardon JP, J Crit Care 2014*)
  - Increase of PVR - does not elevate PAP (*xNAD....*)
  - Decrease of splanchnic blood flow - renal and splanchnic protection (*Russel JA, VASST, NEJM 2008*)

- **Vasopressin levels** decrease in septic shock
- **Dose**: 0.01 to 0.04 IU/kg.h
- **Recommended if NAD > 0.5 ug/kg.min**
  - **Polito A**: *Intensive Care Med 2012*
  - **Price L**: *Crit Care 2010*
Angiotensin II

- range 1.25-40 ng/kg.min
- MAP +10 mmHg or 75 mmHg at 3h, 69.9% vs 23.4%, OR 7.95
- AT II (Giapreza) approved by FDA 21.12.2017 as a rescue therapy for refractory septic or distributive shock
Non-selective NOS inhibitors: Methylene blue

- NOS inhibitors in septic shock: Not significant or deleterious impact on the outcome (*Bakker J, Crit Care Med 2004; Lopez A, Crit Care Med 2004*)
- X (!) potential rescue drug in profound vasoparalysis of non-septic origin

**Succesful use of methylen blue in a patient in refractory shock on a veno-arterial extracorporeal membrane oxygenation**

**Pořízka M.¹, Kunstýř J.¹, Kopecký P.¹, Balík M.¹: Anaesth Intensive Med 2017**
Critical illness related corticosteroid insufficiency (CIRCI)
- dysregulation of the hypothalamic–pituitary–adrenal (HPA) axis
- altered cortisol metabolism
- tissue resistance to glucocorticoids

- Basal cortisol <100 ug/l
- ACTH test (250 ug) not obligatory
- Stress dose hydrocortisone (2mg/kg) if prolonged hypotension on high dosage catecholamine and not improving lactate clearance
Low afterload (sepsis) + predisposing factors + low preload: Dynamic LVOT obstruction causing heart failure

Incidence 22% with EGDT protocol!

Th: volume, betablocker, VVI pacing
Vasodilatation and ventriculo-arterial coupling - uncoupling in septic shock

- Vasoparalysis increases SV and CO vs decrease in a hypertensive crisis
- Ees – systolic function, heart energetics
- Ea/Ees +/- 1, septic shock > 1.3-1.8

*Guarracino F: Crit Care 2014*
Impact of vasoparalysis on cardiac function (.....plus direct effect of sepsis on heart....)

- Low SVR maintains lower LVESV and higher LV_EF
- Critical decrease of SVR and afterload = possible relation to circulatory failure in non-dilated LV with preserved LV_EF
- Dilated LV better maintain SV and CO (Parker M, Ann Intern Med, 1984)
- LV size more important (Huang SJ, et al: Critical Care 2013)
Septic heart

- Septic cardiomyopathy 15-60% (Vieillard-Baron A: Crit Care 2013)
- VA or VAV-ECMO according to „inadequate cardiac output“ (GUH Prague)

Venoarterial Extracorporeal Membrane Oxygenation Support for Refractory Cardiovascular Dysfunction During Severe Bacterial Septic Shock

Nicolas Bréchet, MD, PhD1; Charles-Edouard Luyt, MD, PhD1; Matthieu Schmidt, MD1; Pascal Leprince, MD, PhD1; Jean-Louis Trouillet, MD1; Philippe Léger, MD1; Alain Pavie, MD2; Jean Chastre, MD1; Alain Combes, MD, PhD1

Successful Use of Extra-corporeal Membrane Oxygena Sepsis: A Case Report and Review of Literature
VA-ECMO for septic cardiomyopathy (hypodynamic septic shock)
VA-ECMO for profound vasoparalysis? (hyperdynamic septic shock)

- From hypodynamic to hyperdynamic septic shock (+72-96h from drop of SV/CI)
- MAP = CO * SVR
- Chasing MAP with high CO!
- Evidence in children (low BMI)
- Adults require high ECMO blood flows and cannulas up to 51F (central ECMO with sternotomy)
- Adding another peripheral ECMO......?

Refractory septic shock in children: a European Society of Paediatric and Neonatal Intensive Care definition

Take home messages

- EGDT causes problems in at least 43% of patients
- Use functional haemodynamics and echo
- Decatecholaminize, correct preload, use AVP
- Hypodynamic septic shock (inadequate CI) may be bridged by the VA-ECMO
- Syndrom of refractory vasoplegia is challenging in terms of
  - Titration of preload and vasopressors incl. novel drugs
  - Management may include VA ECMO in the refractory cases
- In patients in extremis, guidelines may not work and some creativity is desired!

Thank you for your attention!