Úvodní tekutinová resuscitace

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Recognize decreased mental status and perfusion.
Begin high flow O_2. Establish IV/IO access.

Initial resuscitation: Push boluses of 20 cc/kg isotonic saline or colloid up to & over 60 cc/kg until perfusion improves or unless rales or hepatomegaly develop.
Correct hypoglycemia & hypocalcemia. Begin antibiotics.

If 2nd PIV start inotrope.

shock not reversed?

Fluid refractory shock: Begin inotrope IV/IO.
use atropine/ketamine IV/IO/IM
to obtain central access & airway if needed.
Reverse cold shock by titrating central dopamine
or, if resistant, titrate central epinephrine
Reverse warm shock by titrating central norepinephrine.

dose range: dopamine up to 10 mcg/kg/min, epinephrine 0.05 to 0.3 mcg/kg/min.

shock not reversed?

Catecholamine resistant shock: Begin hydrocortisone if at risk for absolute adrenal insufficiency

Monitor CVP in PICU, attain normal MAP-CVP & $ScvO_2 > 70\%$

Cold shock with normal blood pressure:
1. Titrate fluid & epinephrine, $ScvO_2 > 70\%$, Hgb> 10g/dL
2. If $ScvO_2$ still< 70%
Add vasodilator with volume loading (nitrosovasodilators, milrininone, imrinone, & others)
Consider levosimendan

Cold shock with low blood pressure:
1. Titrate fluid & epinephrine, $ScvO_2 > 70\%$, Hgb > 10 g/dL
2. If still hypotensive consider norepinephrine
3. If $ScvO_2$ still < 70% consider dobutamine, milrinone, enoximone or levosimendan

Warm shock with low blood pressure:
1. Titrate fluid & norepinephrine, $ScvO_2 > 70\%$,
2. If still hypotensive consider vasopressin, terlipressin or angiotensin
3. If $ScvO_2$ still < 70% consider low dose epinephrine

shock not reversed?

Persistent catecholamine resistant shock: Rule out and correct pericardial effusion, pneumothorax, & intra-abdominal pressure >12 mm/Hg.
Consider pulmonary artery, PICCO, or FATD catheter, &/or doppler ultrasound to guide fluid, inotrope, vasopressor, vasodilator and hormonal therapies.
Goal C.I. > 3.3& < 6.0 L/min/m^2

shock not reversed?

Refractory shock: ECMO

Tekutinová resuscitace – první hodina

- **začátek rychlý bolus 20ml/kg [1]:**

  - izotonický krystaloid nebo 5% albumin
  - přetlakovou infuzí nebo „z ruky“
  - adekvátní BP a HR
  - kvalitní periferní pulsace, capillary refill
  - úroveň vědomí, diuréza
  - zvýšení dechové práce, šelest, cvalový rytmus (gallop) nebo hepatomegalii – oběhové přetížení!!!
  - korekce hypoglykémie a hypokalcémie

[1] Brierley et al. Clinical practice parameters for hemodynamic support of pediatric and neonatal septic shock: 2007 update from the American College of Critical Care Medicine. Crit Car. Med. 2009 Feb;37(2):666-88

Tekutinová resuscitace – první hodina

- **iniciální resuscitace většinou vyžaduje 40 - 60ml/kg…..200ml/kg**[1,2]
  - non-responders – invazivní hemodynamický monitoring
  - malé změny v CVP – lze podat další tekutiny
  - velký objem tekutin není spojen s ↑ ARDS, nebo edem mozku [1]

- **capillary leak**
  - → ↑ zvýšená potřeba tekutin; několik dnů [3]

[1] Carcillo JA et al. Role of early fluid resuscitation in pediatric septic shock. *JAMA* 1991; 266:1242–1245

[2] Brierley et al. Clinical practice parameters for hemodynamic support of pediatric and neonatal septic shock: 2007 update from the American College of Critical Care Medicine. Crit Car. Med. 2009 Feb;37(2):666-88

[3] Feltes TF et al. Quantitated left ventricular systolic mechanics in children with septic shock utilizing noninvasive wall stress analysis. *Crit Care Med* 1994; 22:1647–1659

Jaké tekutiny?

- **Krystaloidy**
  - 0,9% NaCl, Ringer laktát [1][2]……..balancované roztoky?
- **Koloidy**
  - dextran, želatina, 5% albumin [1][2]……HES?
- **FFP**
  - korekce PT, APTT
  - hypotenze – vazoaktivní kininy, ↑ koncentrace citrátu

[1]Nhan NT et al. Acute management of dengue shock syndrome: A randomized double-blind comparison of 4 intravenous fluid regimens in the first hour.ClinInfectDis 2001; 32:204–212

[2]Brierley et al. Clinical practice parameters for hemodynamic support of pediatric and neonatal septic shock: 2007 update from the American College of Critical Care Medicine. Crit Car. Med. 2009 Feb;37(2):666-88

Tekutinová resuscitace – po první hodině

- **perzistentní hypovolemie** [1]
  - capillary leak; několik dní

- **další dodávka tekutin – dosažení optimálních hodnot** [1]
  - perfuzní tlak
  - CVP
  - end-diastolický tlak – ECHO
  - optimalizace tlaku v zaklínění v plicnici (PAWP)
  - CO

[1] Brierley et al. Clinical practice parameters for hemodynamic support of pediatric and neonatal septic shock: 2007 update from the American College of Critical Care Medicine. Crit Car. Med. 2009 Feb;37(2):666-88

Hemoglobin

- Obsah kyslíku v arteriální krvi: $CaO_2 = Hb \times SaO_2 \times 1{,}39 + 0{,}03 \times PaO_2$
- Dodávka (transport) kyslíku: $DO_2 = CO \times CaO_2$

- Koncentrace hemoglobinu

minimum 100g/l [1,2]

Hemoglobin > 100g/l – krystaloidy

Hemoglobin < 100 g/l - transfuze erytrocytů

[1]de Oliveira CF et al: ACCM/PALS haemodynamic support guidelines for paediatric septic shock: An outcomes comparison with and without monitoring central venous oxygen saturation. *Intensive Care Med* 2008; 34: 1065–1075

[2]Rivers E et al. Early goal-directed therapy in the treatment of severe sepsis and septic shock. *N Engl J Med* 2001; 346:1368–1377

Tekutinová resuscitace – po první hodině

- **při prodlouženém INR**

  - podání čerstvě zmražené plazmy

- **po EGDT → přetížení tekutinami přibližně o 10% → ledviny nejsou schopny tuto tekutinu eliminovat!**

  - použití diuretik event. peritoneální dialýzy nebo kontinuálních eliminačních metod

- **↑ hladina laktátu a vzestup AG**

  - zajistit dostatečnou dodávku kyslíku (ScvO2 > 70%)… Hb > 100 g/l

  - hodnota CI > 3,3 l/min/m2…dostatečnou dodávkou tekutin

    … použitím vasoaktivních látek

- **hodnota glykémie v rozmezí 4,4 – 8,3 mmol/l**

  - izotonický roztok 10% glukózy

  - hyperglykemie …inzulin

Roztoky glukózy < 10% nejsou schopny zajistit dostatečnou dodávku glukózy

Table 2. Death and Other Adverse Event End Points at 48 Hours and 4 Weeks.

End Point	Albumin Bolus (N=1050)	Saline Bolus (N=1047)	No Bolus (N=1044)	Saline Bolus vs. No Bolus		Albumin Bolus vs. No Bolus		Albumin Bolus vs. Saline Bolus		Albumin and Saline Boluses vs. No Bolus	
				Relative Risk (95% CI)	P Value	Relative Risk (95% CI)	P Value	Relative Risk (95% CI)	P Value	Relative Risk (95% CI)	P Value
		no. (%)									
48 Hours											
Death — no. (%)	111 (10.6)	110 (10.5)	76 (7.3)	1.44 (1.09–1.90)	0.01	1.45 (1.10–1.92)	0.008	1.00 (0.78–1.29)	0.96	1.45 (1.13–1.86)	0.003
Pulmonary edema — no. (%)	14 (1.3)	6 (0.6)	6 (0.6)								
Increased intracranial pressure — no. (%)	16 (1.5)	18 (1.7)	11 (1.1)								
Severe hypotension — no. (%)*	1 (0.1)	2 (0.2)	3 (0.3)								
Allergic reaction — no. (%)	3 (0.3)	4 (0.4)	2 (0.2)								
Pulmonary edema, increased intracranial pressure, or both — no. (%)†	27 (2.6)	23 (2.2)	17 (1.6)	1.34 (0.72–2.51)	0.34	1.57 (0.87–2.88)	0.10	1.17 (0.68–2.03)	0.49	1.46 (0.85–2.53)	0.17
4 Weeks											
Death — no. (%)	128 (12.2)	126 (12.0)	91 (8.7)	1.38 (1.07–1.78)	0.01	1.40 (1.08–1.80)	0.01	1.01 (0.80–1.28)	0.91	1.39 (1.11–1.74)	0.004
Neurologic sequelae — no./total no. (%)‡	22/990 (2.2)	19/996 (1.9)	20/997 (2.0)	0.95 (0.51–1.77)	0.87	1.10 (0.61–2.01)	0.74	1.16 (0.63–2.14)	0.62	1.03 (0.61–1.75)	0.92
Neurologic sequelae or death — no./total no. (%)‡	150/990 (15.2)	145/996 (14.6)	111/997 (11.1)	1.31 (1.04–1.65)	0.02	1.36 (1.08–1.71)	0.008	1.04 (0.84–1.28)	0.71	1.33 (1.09–1.64)	0.005

Acute Management of Dengue Shock Syndrome: A Randomized Double-Blind Comparison of 4 Intravenous Fluid Regimens in the First Hour

Ngo Thi Nhan,[1] Cao Xuan Thanh Phuong,[1,a] Rachel Kneen,[2,3] Bridget Wills,[2,3] Nguyen Van My,[1] Nguyen Thi Que Phuong,[1] Chu Van Thien,[1] Nguyen Thi Thuy Nga,[1] Julie A. Simpson,[2,3] Tom Solomon,[2,3] Nicholas J. White,[2,3] and Jeremy Farrar[2,3]

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Table 1. WHO guidelines for the diagnosis of dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS).

DHF grade	Duration of fever, d	Hemorrhage	Thrombocytopenia: platelets/mm^3	Increased vascular permeability
I	>2, ≤7	Positive tourniquet test only	≤100,000	Plasma leakage[a]
II	>2, ≤7	Spontaneous bleeding[b]	≤100,000	Plasma leakage[a]
III (DSS)	>2, ≤7	Positive tourniquet test and/or spontaneous bleeding[b]	≤100,000	Plasma leakage[a] and circulatory failure with pulse pressure ≤20 mm Hg or hypotension for age
IV (DSS)	>2, ≤7	Positive tourniquet test and/or spontaneous bleeding[b]	≤100,000	Plasma leakage[a] and profound shock with undetectable pulse and blood pressure

Nhan NT et al, *CID* 2001; 32: 204 – 213

Table 3. Effect of treatment group on selected clinical and laboratory parameters.

Outcome variable	Solution administered: All patients (n = 222)	Dextran 70 (n = 55)	Gelatin (n = 56)	Lactate Ringer's (n = 55)	"Normal" saline (n = 56)	P
Primary						
PPRT, h median (range)	0.75 (0.25–7)	0.50 (0.25–3)	0.50 (0.25–2)	0.75 (0.25–7)	0.75 (0.25–3)	.030[a]
PPRT >1 h, no. (%) of patients	21 (9.5)	3 (5.5)	3 (5.4)	11 (20)	4 (7.1)	.022[a]
Mean h ± SD	11.7 ± 5.5	15 ± 6.8	11.4 ± 4	10 ± 4.1	10.3 ± 5.6	.068
Range	1.5–23	2.5–23	3–17	3–16	1.5–23	
Secondary						
Decrease in hematocrit at 1 h, %						
Mean ± SD	8.4 ± 3.8	11.5 ± 3.3	9.7 ± 3.0	5.7 ± 2.8	6.5 ± 2.9	<.001[a]
Range	−2 to 19	2 to 19	0 to 16	−2 to 13	0 to 17	
Decrease in pulse at 1 h, beats/min						
Total volume of iv fluid infused, mL/kg						
Mean ± SD	134.1 ± 20.6	134.3 ± 22.1	135 ± 23.5	134.2 ± 19.9	132.9 ± 16.6	.954
Range	89–212	89–189	93–212	103–182	106–172	
Requirement for dextran after first hour, no. (%) of patients	69 (31.1)	17 (30.9)	15 (26.8)	20 (36.4)	17 (30.4)	.749
Volume of dextran after first hour, mL/kg (n = 69)[b]						
Mean ± SD	28.3 ± 12.7	22.1 ± 6.1	30.7 ± 11.6	33.5 ± 14.3	26.3 ± 14.3	.035[a]
Range	10–69	12–27.5	14.5–67	15–64	15–69	
Required frusemide, no. (%) of patients	55 (25)	9 (16)	9 (17)	8 (14.5)	12 (21.4)	.328

NOTE. PPRT, pulse pressure recovery time.

[a] Significant P value.

[b] In 6 patients the pulse at presentation with shock was too rapid and weak to count accurately; thus n = 216 for the whole study group (A, 55; B, 56; C, 50; D, 55).

Mortalita 0 %

Nhan NT et al, *CID* 2001; 32: 204 – 213

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ACCM/PALS haemodynamic support guidelines for paediatric septic shock: an outcomes comparison with and without monitoring central venous oxygen saturation

ScvO2 goal-directed therapy >70%

- nižší mortalita (28-day mortality 11.8% vs. 39.2%, $p = 0.002$)
- méně nově vzniklých orgánových dysfunkcí ($p = 0.03$)

ScvO2 goal-directed therapy >70% vyžaduje během prvních 6h

- více krystaloidů 28 (20–40) vs. 5 (0–20) ml/kg; $p < 0.0001$
- více krevních transfuzí 45.1% vs. 15.7%; $p = 0.002$)
- větší inotropní podporu 29.4% vs. 7.8%; $p = 0.01$)

Fluid overload before continuous hemofiltration and survival in critically ill children: A retrospective analysis*

Jason A. Foland, MD; James D. Fortenberry, MD, FAAP, FCCM; Barry L. Warshaw, MD, FAAP; Robert Pettignano, MD, FAAP, FCCM; Robert K. Merritt, MA; Micheal L. Heard, RN; Kris Rogers, RN; Chris Reid, RRT; April J. Tanner, RN; Kirk A. Easley, MS

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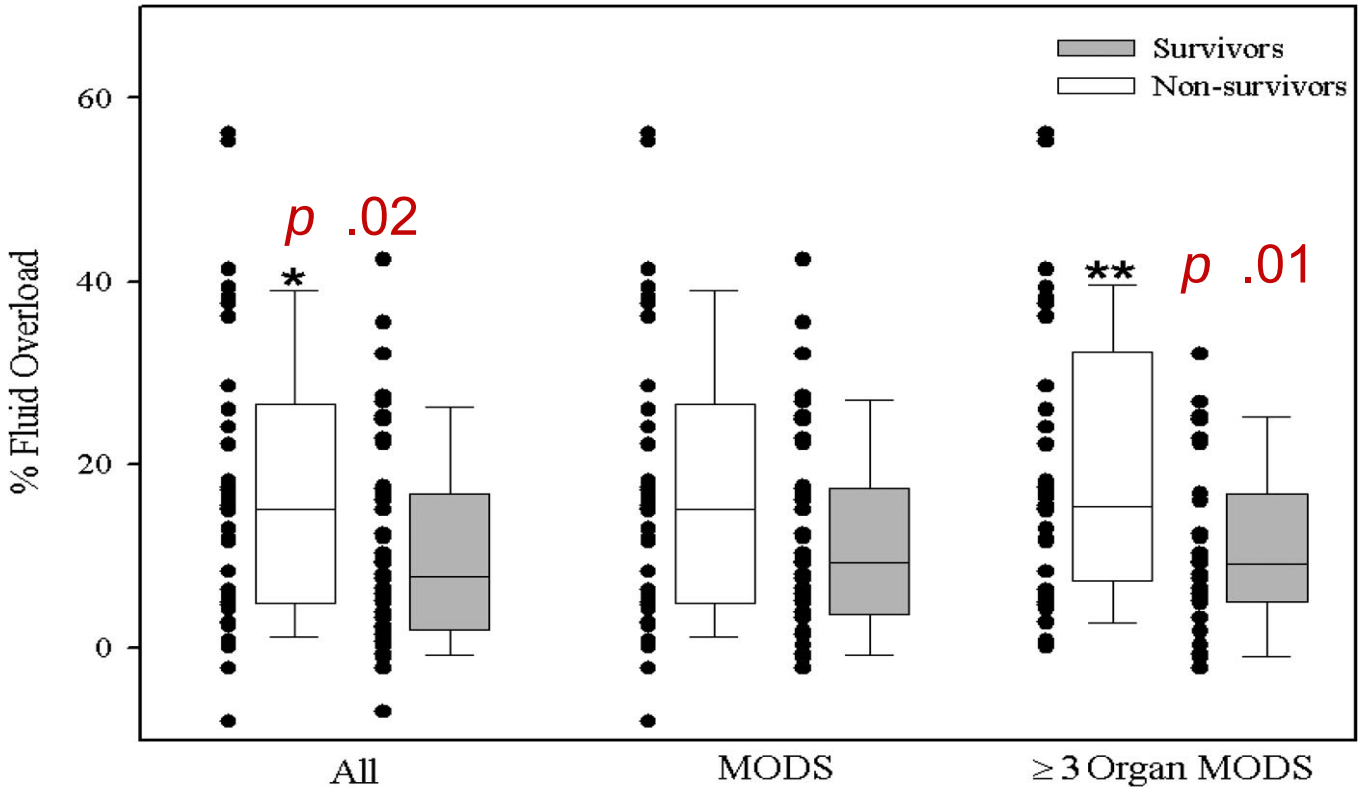

Úvodní tekutinová resuscitace

- **začátek rychlý bolus 20ml/kg….. 40 - 60ml/kg…..200ml/kg**
- **izotonický krystaloid, 5% albumin**
- **Hb > 100g/l**
- **FFP**

Děkuji za pozornost