

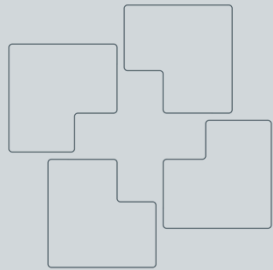
Ultrasonografické vyšetření pacienta v šoku

Lubomír Večeřa

Oddělení urgentního příjmu KNTB Zlín

Oddělení anesteziologie, resuscitace a intenzivní medicíny KNTB Zlín

Zdravotnická záchranná služba Zlínského kraje



No conflict of interest

Krajská nemocnice T. Bati, a. s.

- Vnímat jako RULE-IN než definitivní vyloučení diagnózy (RULE-OUT)

- Pokud RULE-OUT, tak největší přesnost u obstrukčního šoku

Stickles SP et al. The diagnostic accuracy of a point-of-care ultrasound protocol for shock etiology: A systematic review and meta-analysis. CJEM 2019 Jan 30;1-12. doi: 10.1017/cem.2018.498.

- Snížení celkové nejistoty v diagnostice o 27,7 %

- 24,6 % pacientů mělo signifikantní změnu v terapii (tekutiny, vasoaktivní látky, krevní deriváty)

Shokoohi H et al. Bedside Ultrasound Reduces Diagnostic Uncertainty and Guides Resuscitation in Patients With Undifferentiated Hypotension. Crit Care Med. 2015 Dec;43(12):2562-9.

- Korelace pracovní a definitivní diagnózy, bez POCUS – 60,6 %, s POCUS – 85 %

Ikbal Sasman M et al. Effect of Focused Bedside Ultrasonography in Hypotensive Patients on the Clinical Decision of Emergency Physicians. Emergency Medicine International . Volume 2017, Article ID 6248687, 8 pages <https://doi.org/10.1155/2017/6248687>.

- Nebyl nalezen žádný benefit stran přežití, délky hospitalizace, počtu CT vyšetření, inotropní podpory nebo tekutinové terapie.

Atkinson, PR, Milne, J, Diegelmann, L, et al. Does point-of-care ultrasonography improve clinical outcomes in emergency department patients with undifferentiated hypotension? An international randomized controlled trial from the SHoC-ED investigators. *Ann Emerg Med* 2018;72(4):478-89

- **Obstrukční šok**

 - **Tenzní pneumotorax**

 - **Tamponáda srdeční**

 - **Akutní plicní hypertenze (plicní embolie)**

 - Tenzní fluidotorax

 - Břišní hypertenze

 - Hypertrofická obstrukční kardiomyopatie

- **Kardiogenní šok**

 - **Globální**

 - Regionální

 - Chlopňové vady (ruptura papilárního svalu)

 - Ruptura septa

- **Hypovolemický šok**

 - **Hemoragický**

 - **Traumatický**

 - **Netraumatický**

 - Nehemoragický

- **Distribuční šok**

 - **Septický**

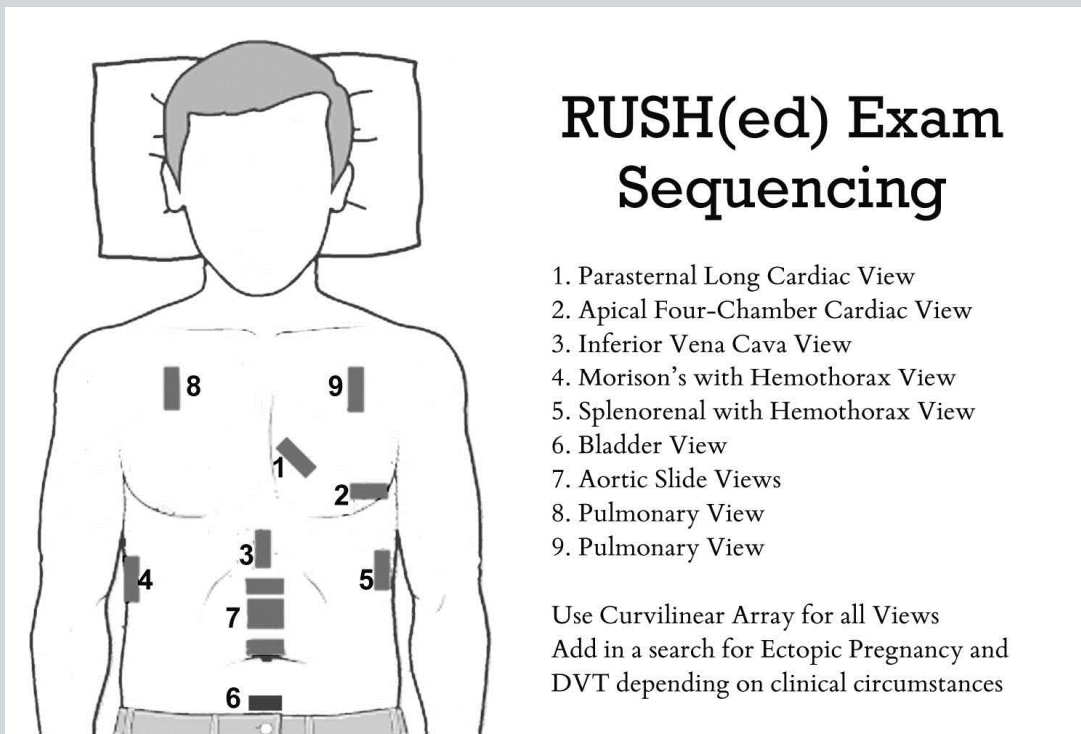
 - **Pankreatitida (kombinovaný)**

 - Neurogenní

 - Anafylaktický

 - Adrenální insuficience

Protokoly POCUS u pacienta v šoku - RUSH



Perera P, Mailhot T, Riley D, Mandavia D. The RUSH exam: Rapid Ultrasound in SHock in the evaluation of the critically ill. Emerg Med Clin North Am. 2010 Feb;28(1):29-56, vii. doi: 10.1016/j.emc.2009.09.010.

Protokoly POCUS u pacienta v šoku - RUSH

RUSH exam	Hypovolemic shock	Distributive shock	Obstructive shock	Cardiogenic shock
Pump	Hyperdynamic heart	Hyperdynamic heart (early sepsis) Poor contractility (late sepsis)	Pericardial tamponade RV strain Poor contractility	Poor contractility
Tank	Small, collapsing IVC Peritoneal or pleural fluid	Normal/small IVC Pleural or peritoneal fluid	Large, non-collapsing IVC Absent lung sliding	Large, non- collapsing IVC Lung rockets Pleural effusion
Pipes	AAA or dissection	Normal	DVT	Normal

Perera P, Mailhot T, Riley D, Mandavia D. The RUSH exam: Rapid Ultrasound in SHock in the evaluation of the critically ill. Emerg Med Clin North Am. 2010 Feb;28(1):29-56, vii. doi: 10.1016/j.emc.2009.09.010.

Senzitivita a specifita

■ RUSH senzitivita 88 % specifita 96 %

Bagheri-Hariri S et al. The impact of using RUSH protocol for diagnosing the type of unknown shock in the emergency department. Emergency radiology. 2015 Oct;22(5):517-520

Table 2

Reliability indices^a of RUSH^b criteria in diagnosis of each shock type

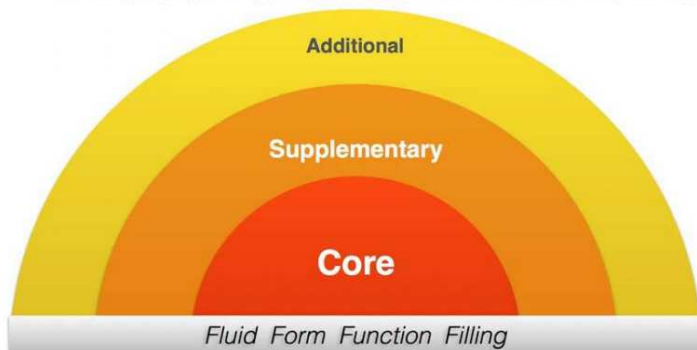
Shock type based on final diagnosis (number of cases)					
Reliability Index	Hypovolemic (n = 8) (%)	Cardiogenic (n = 12) (%)	Obstructive (n = 7) (%)	Distributive (n = 8) (%)	Mixed (n = 10) (%)
Sensitivity	100	91.7	100	75	70
Specificity	94.6	97.0	97.	100	100
PPV ^c	80	91.7	87.5	100	100
NPV ^d	100	97.0	100	94.9	92.1
Kappa ^e (P value)	0.86 (0.000)	0.89 (0.000)	0.92 (0.000)	0.83 (0.000)	0.74 (0.000)

^aPATIENTS WITH FINAL DIAGNOSIS OF "NOT DEFINED" ETIOLOGY WERE EXCLUDED FOR CALCULATION OF RELIABILITY INDICES (SENSITIVITY, SPECIFICITY, PPV, AND NPV); ^bRUSH: RAPID ULTRASOUND IN SHOCK; ^cPPV: POSITIVE PREDICTIVE VALUE OF RUSH CRITERIA TO DETERMINE EACH SHOCK TYPE; ^dNPV: NEGATIVE PREDICTIVE VALUE OF RUSH CRITERIA TO DETERMINE EACH SHOCK TYPE; ^eKAPPA: INDEX OF AGREEMENT BETWEEN DIAGNOSIS OF SHOCK TYPE BASED ON RUSH CRITERIA AND FINAL DIAGNOSIS

Mohammad RG et al. Accuracy of early rapid ultrasound in shock (RUSH) examination performed by emergency physician for diagnosis of shock etiology in critically ill patients. J Emerg Trauma Shock. 2015 Jan-Mar; 8(1): 5–10.

Protokoly POCUS u pacienta v šoku - SHoC

Sonography in Hypotension and Cardiac Arrest (SHoC)



SHoC – Cardiac Arrest

- Core - Subxiphoid and parasternal cardiac views**
Performed during the rhythm check pause in chest compressions.
Look for pericardial *fluid*, ventricular *form* (e.g. right heart strain) and *function* (e.g. asystole versus organized cardiac activity).
- Supplementary - Lung views; IVC views**
Look for absent lung sliding in pneumothorax; for pleural *fluid*; and IVC size for *filling*.
- Additional** ultrasound applications include endotracheal tube confirmation, proximal leg veins for DVT, or for sources of blood loss (AAA, peritoneal/pelvic *fluid*).

SHoC – Hypotension

- Core - Subxiphoid and parasternal cardiac views; Lung views; IVC views**
Look for pericardial *fluid*, ventricular *form* (size and shape) and *function* (hyper/hypo-dynamic); for pleural *fluid*; and for B-lines and *filling* status.
- Supplementary - Additional cardiac views**
- Additional** ultrasound applications (when clinically indicated) are proximal leg veins for DVT; pelvis for IUP; and for sources of blood loss (AAA, peritoneal/pelvic *fluid*).

Atkinson P et al. International Federation for Emergency Medicine Consensus Statement: Sonography in hypotension and cardiac arrest (SHoC): An international consensus on the use of point of care ultrasound for undifferentiated hypotension and during cardiac arrest. CJEM 2017 Nov;19(6):459-470. doi: 10.1017/cem.2016.394. Epub 2016 Dec 21.

Protokoly POCUS u pacienta v šoku - SHoC

Table 3

Proposed Approach to Purpose of Scans for the Proposed SHoC Protocol.

(LV: left ventricle; RV: right ventricle; IVC: inferior vena cava)

Cardiac Views

1. Fluid Is there a significant pericardial effusion?
2. Form Is the heart small, normal or large? Is the LV larger than the RV?
3. Is there vigorous contractility? Are the valves opening?

Function

IVC and Lung Views

4. Is the IVC dilated and non-collapsing? Is the IVC small and collapsing? Are there multiple B-lines in the lungs bilaterally? Is there pleural fluid?

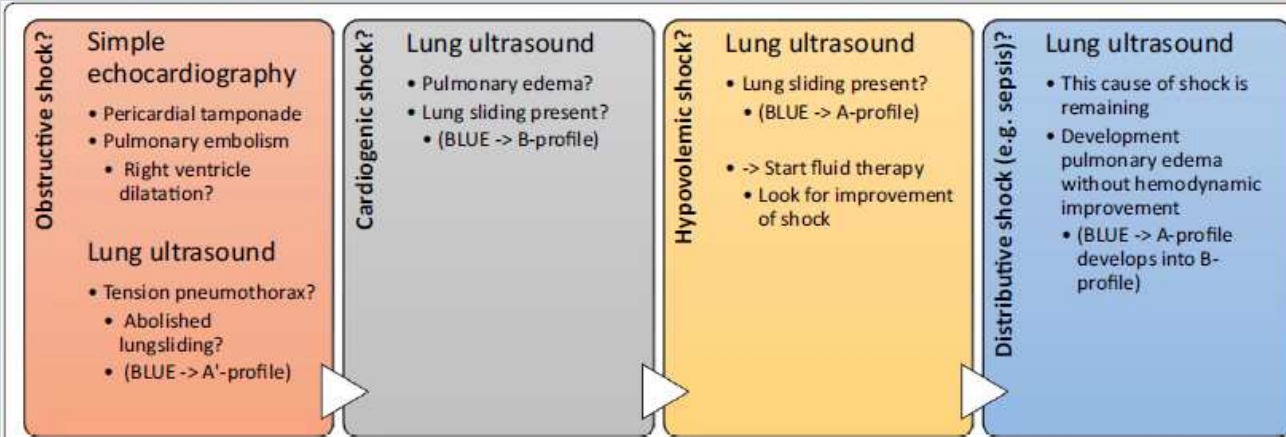
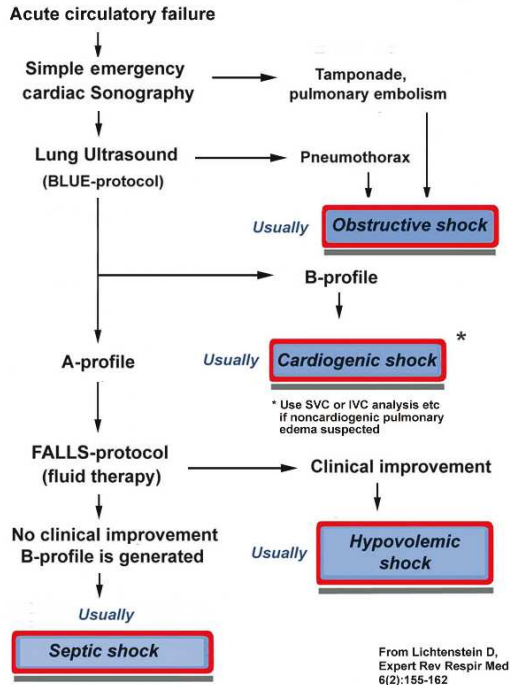
Sonography in Hypotension

Finding	Frequency
LV Dynamic Change	43%
IVC Abnormalities	27%
Pericardial Effusion	16%
Pleural Fluid	8%
Peritoneal Fluid	5%
AAA	2%

Atkinson P et al. International Federation for Emergency Medicine Consensus Statement: Sonography in hypotension and cardiac arrest (SHoC): An international consensus on the use of point of care ultrasound for undifferentiated hypotension and during cardiac arrest. CJEM 2017 Nov;19(6):459-470. doi: 10.1017/cem.2016.394. Epub 2016 Dec 21.

Protokoly POCUS u pacienta v šoku

The FALLS-protocol (Schematic decision tree)



Lichtenstein D. FALLS-protocol: lung ultrasound in hemodynamic assessment of shock. Heart Lung Vessel. 2013; 5(3): 142-147.

Ketelaars R et al. ABCDE of prehospital ultrasonography: a narrative review. Crit Ultrasound J. 2018;10:17

Protokoly POCUS u pacienta v šoku

- SESAME (Sequential Echographic Scanning Assessing Mechanism or Origin of Sever Shock of Indistinct Cause)
- ACES (Abdominal and Cardiac Evaluation with Sonography in Shock)

- **5 patologických obrazů**

Tamponáda srdeční

Plicní embolie (dilatovaná pravá komora)

Dilatovaná a hypokontraktilní levá komora

Prázdná LK, „kissing papilárních svalů, hyperkinetický pohyb komory

Hypertrofie LK (HOCM?)

Vyšetření srdce (SX, PLAX, A4C)



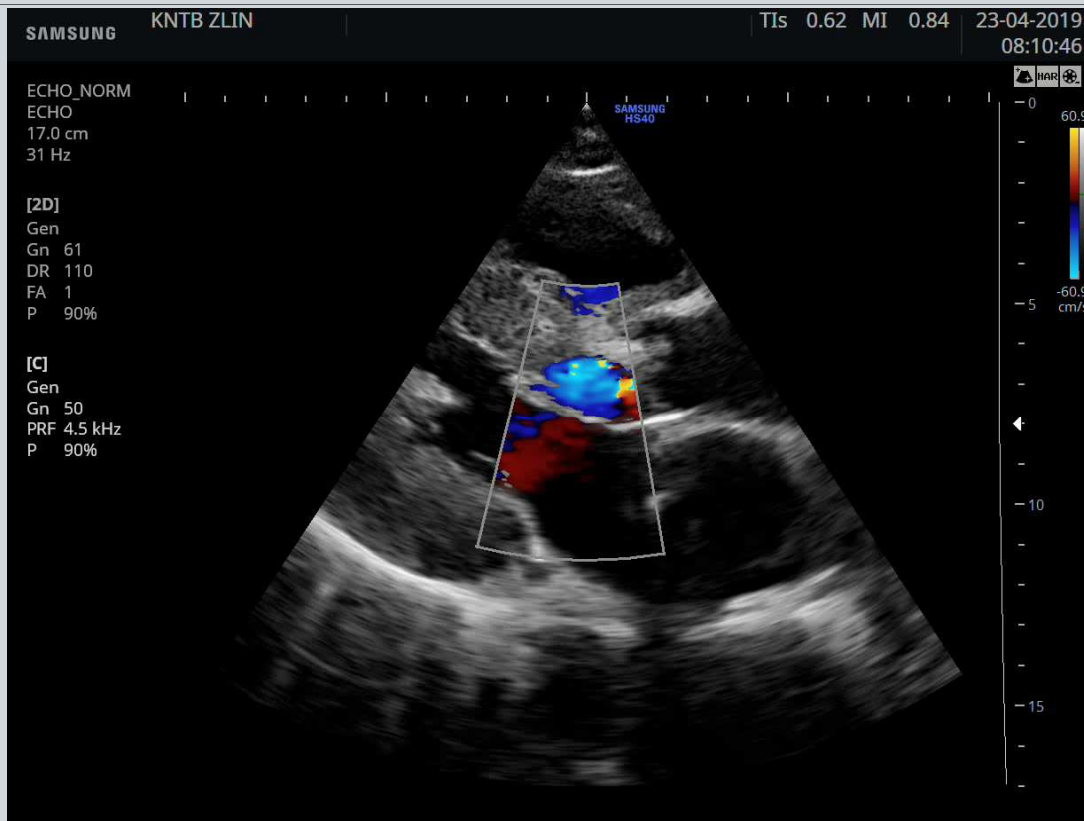
Vyšetření srdce (SX, PLAX, A4C)



Vyšetření srdce (SX, PLAX, A4C)



Vyšetření srdce (SX, PLAX, A4C)



Vyšetření dolní duté žíly

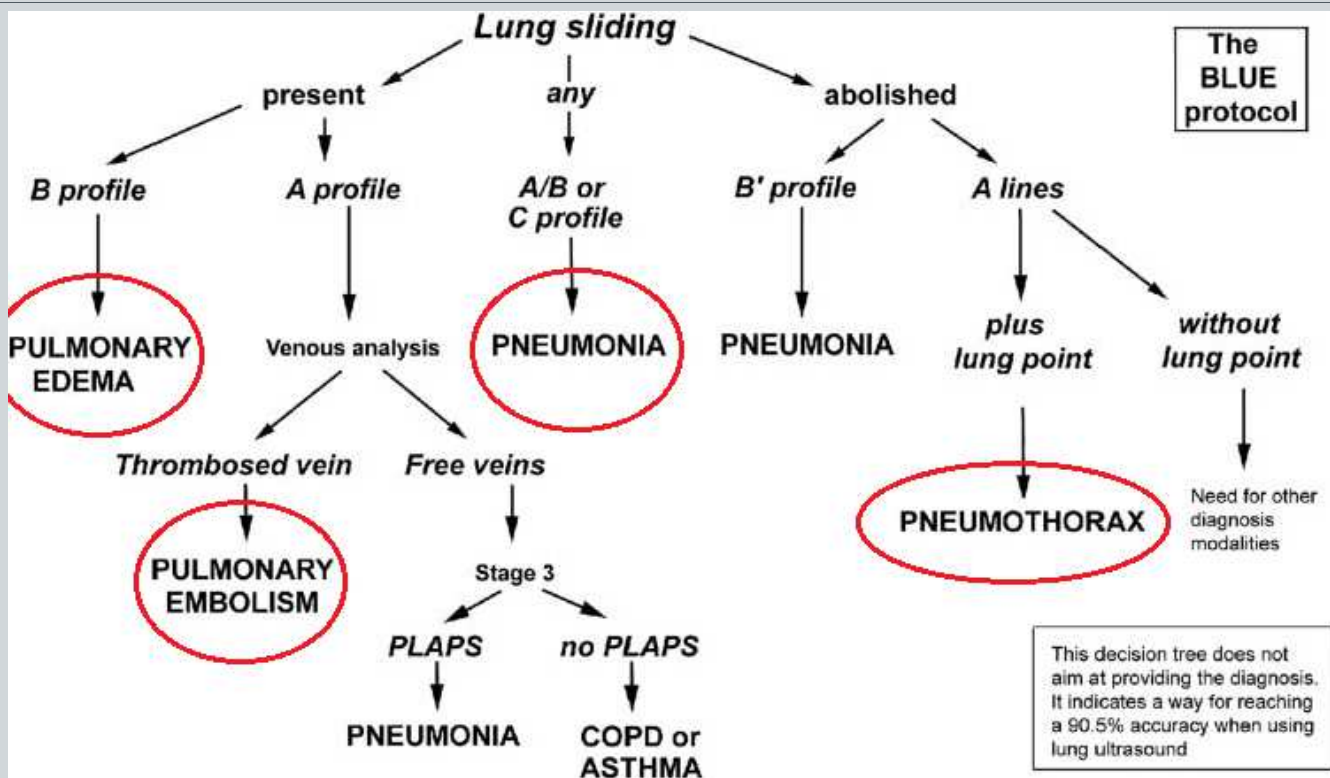
- Velikost (norma 1,5-2,5 cm)
- Kolapsibilita = fluid responsiveness
 - Spontánně ventilující > 50 %
 - UPV > 15 – 20 %

Senzitivita 0,63, specifita 0,73, AUC 0,79 (Long E et al. Shock 2017 May; 47 (5): 550-559)

IVC diameter	CI-IVC	CVP (cm H₂O)
< 1.5cm	100% (total collapse)	0 – 5
1.5 - 2.5cm	>50% (partial collapse)	6 – 10
1.5 - 2.5cm	<50% (partial collapse)	11 – 15
> 2.5cm	<50% (partial collapse)	16 – 20
> 2.5cm	0% (no change)	> 20

Brennan J, Blair J, Goonewardena S. Reappraisal of the Use of Inferior Vena Cava for Estimating Right Atrial Pressure, Journal of the American Society of Echocardiography, Vol. 20, Issue 7, pp.: 857-861 (July 2, 2007)

Vyšetření hrudníku - BLUE



Daniel A. Lichtenstein and Gilbert A. Mezière. Relevance of Lung Ultrasound in the Diagnosis of Acute Respiratory Failure : The BLUE Protocol. Chest 2008;134:117-125

POCUS vs. RTG hrudníku a plic

- Větší senzitivita i specifita pro pneumothorax i pneumonii
- Bed-side metoda, není nutný transport nebo manipulace s pacientem
- Časově nenáročný
- Není radiační zátěž

Ebrahim A et al. Diagnostic Accuracy of Chest Ultrasonography versus Chest Radiography for Identification of Pneumothorax: A Systematic Review and Meta-Analysis. Tanaffos 2014;13(4):29-40

Miguel A Chavez et al. Lung ultrasound for the diagnosis of pneumonia in adults: a systematic review and meta-analysis. Respiratory research 2014.
(http://respiratory_research.biomedcentral.com/articles/10.1186/1465-9921-15-50)

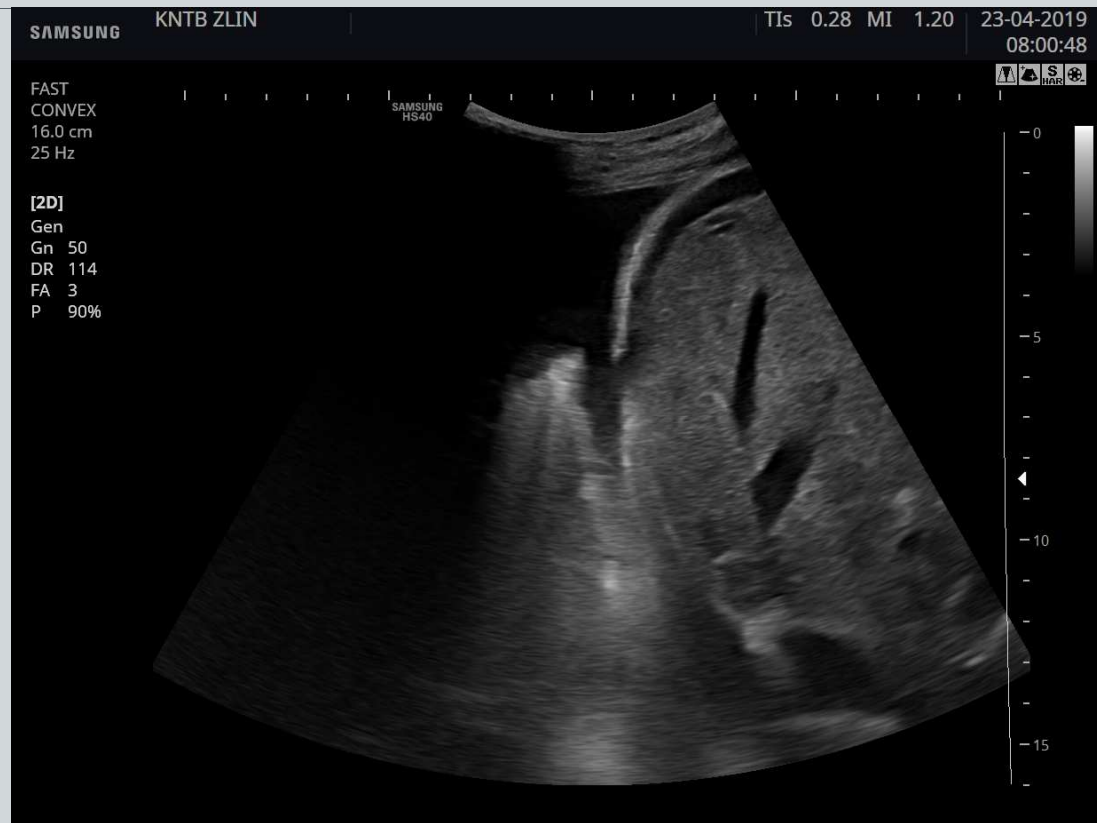
Daniel J Pallin. Lung Ultrasound May Be Superior to Chest X-Ray for Diagnosing Pneumonia. reviewing Nazerian P et al. Am J Emerg Med 2015 May.
Ali Taghizadieh. Diagnostic Accuracy of Chest x-Ray and Ultrasonography in Detection of Community Acquired Pneumonia; a Brief Repor. Emergency 2015.

Vyšetření břicha

- Hepatorenální prostor
- Pravý hemitorax
- Splenorenální prostor
- Levý hemitorax
- Douglasův prostor

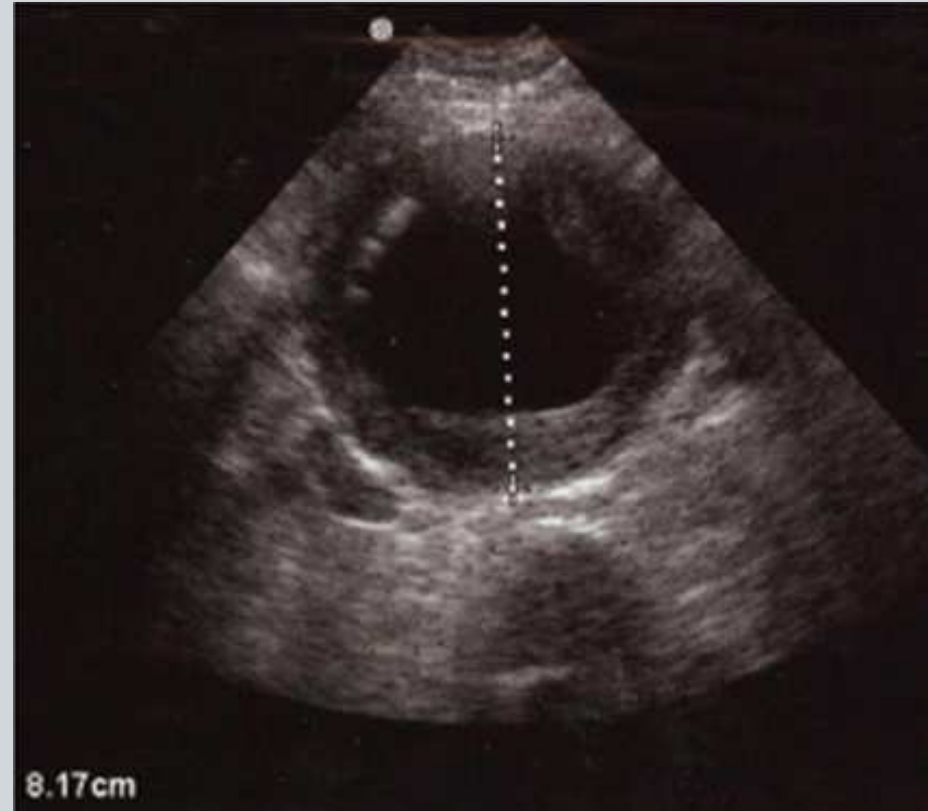
Odhad objemu fluidotoraxu:
 $V \text{ (ml)} = 20 \times \text{Sep} \text{ (mm)}$

Balik M et al., Ultrasound estimation of volume of pleural fluid in mechanically ventilated patients. Intensive Care Med. 2006 Feb; 32(2):318-21



Vyšetření aorty

- Normální velikost do 3 cm
- 3-5 cm – aneurysma
- Nad 5 cm hrozící ruptura

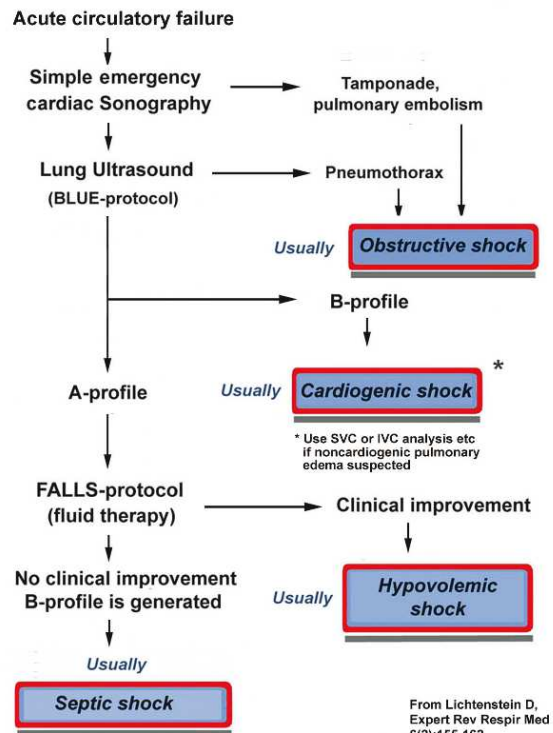


Vyšetření hlubokých žil DKK



Take home message

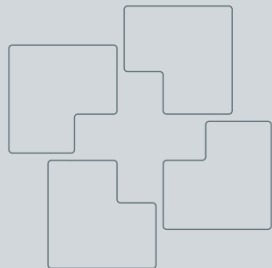
The FALLS-protocol (Schematic decision tree)



**WHO IS THE
COOLEST PERSON IN
THE HOSPITAL**



**THE ULTRASOUND
GUY**



Děkuji za pozornost

Krajská nemocnice T. Bati, a. s.