KARIM
1.LF UK A VFN V PRAZE

Hrudní sonografie – update 2022

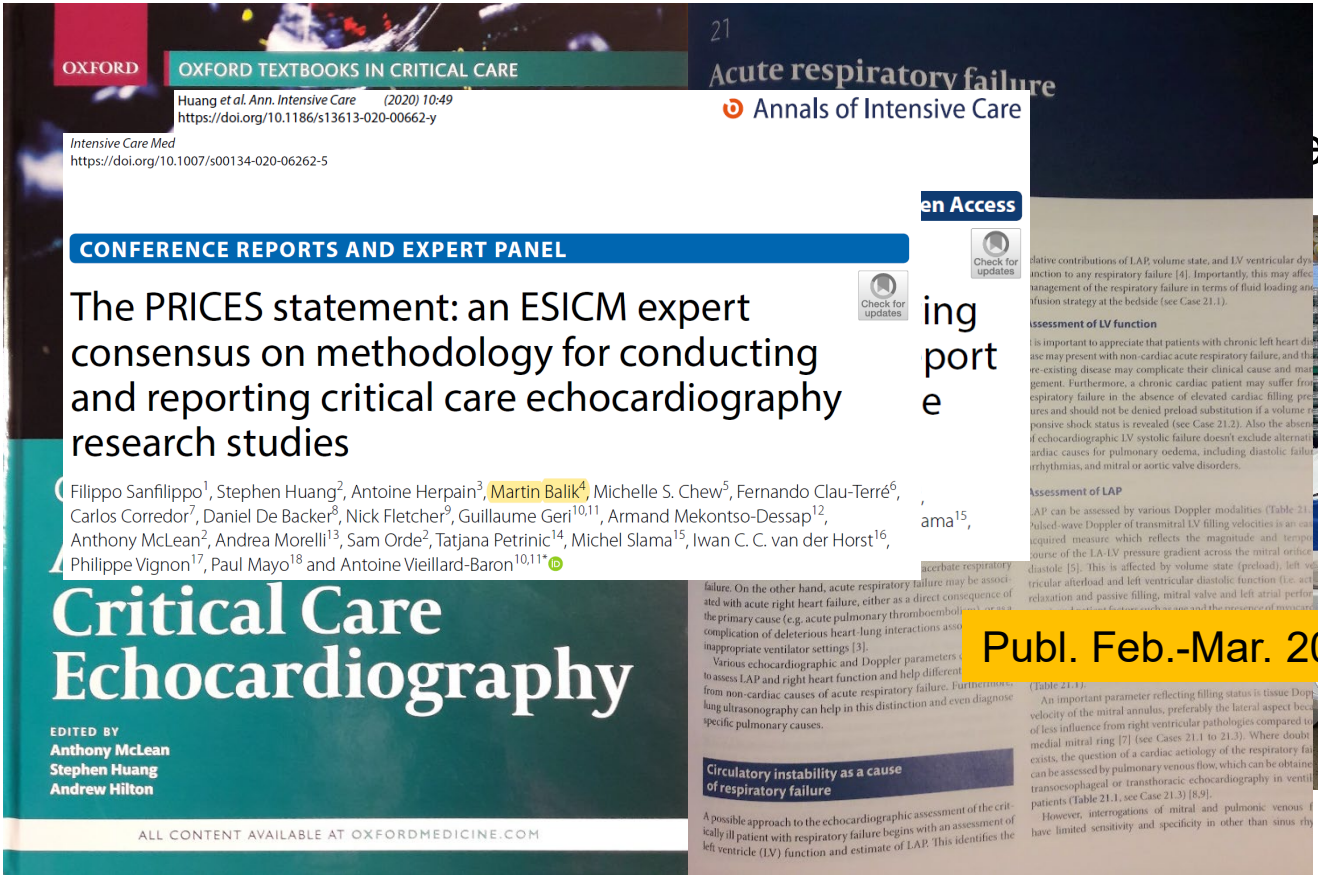
Martin Balik
Dept. of Anaesthesia and Intensive Care
1st Medical Faculty, Charles University, General University Hospital Prague, European Union

Klinika anesteziologie, resuscitace a intenzivní medicíny
1. lékařské fakulty UK a Všeobecné fakultní nemocnice v Praze

Adresa: U nemocnice 2; 128 08 Praha 2
www.karim-vfn.cz

Koncept bedside CUS a echokardiografie

- LV function and determination of LVEDP/LAP, mitral valve



ertension

Publ. Feb.-Mar. 2020

- Indication to ECMO (TTE+LUS….)

Echo a CUS in a respiratory failure

What is LVEDP and LAP ?
- Improvement in preload, contractility, afterload and heart rate/rhythm ?

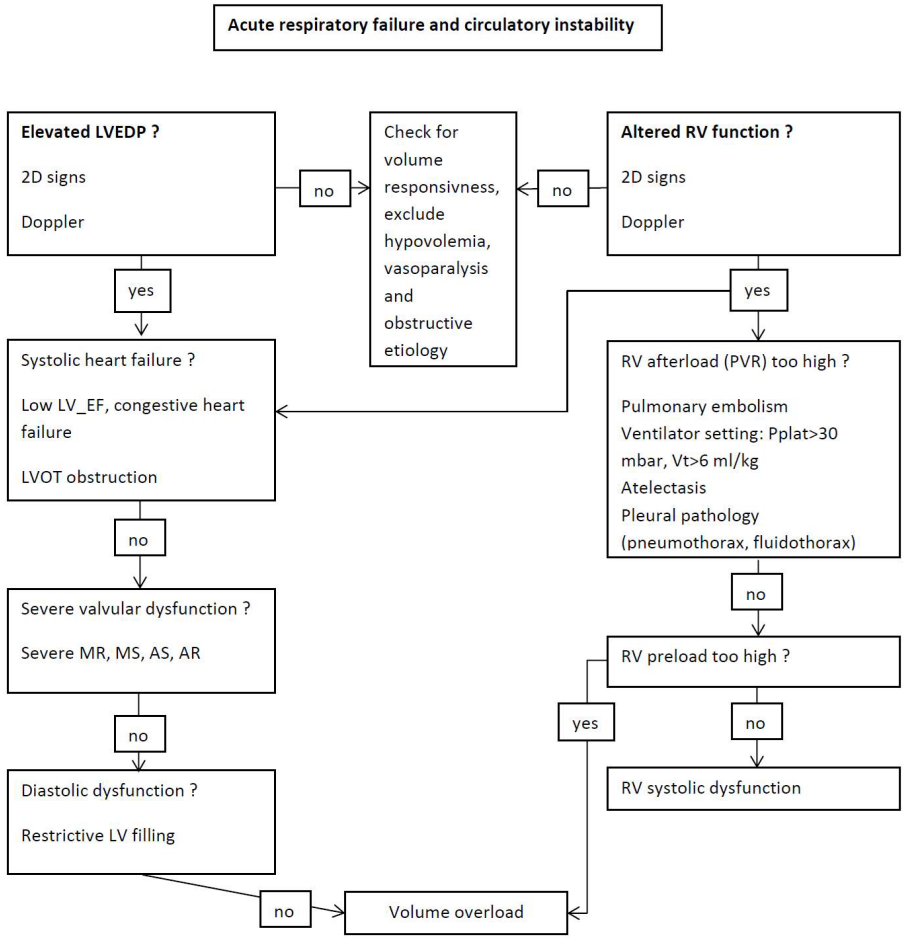
Cardiac failure, could the symptoms be relieved by mechanical ventilation ?

RV/RA function to tolerate IPPV ?

Is the lung recruitable ? How to set a ventilator ?

Patient´s position ? Is the pleural drainage feasible ? Is a fibreoptic bronchoscopy indicated ?

Is there an indication to ECLS ? What type of ECLS and what cannulation ? An optimal IPPV during ECLS ?

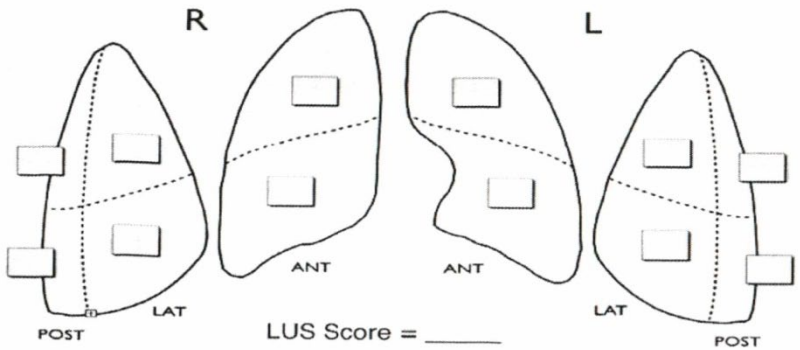


Systematic approach to chest US: 12 zones

LUNG ULTRASOUND
Report Form

PATIENT NAME: ..... GENDER: ☐ M ☐ F DATE OF BIRTH: .....
OPERATOR: ..... EXAM DATE: ..... HOUR ..... STORAGE CODE .....
HISTORY: .....
.....
SPONT VENTILATION: RR = ... Resp Distress: ☐ Yes ☐ No DECUBITUS: ☐ Sup ☐ Lat ☐ Pron ☐ Semirec
MECH VENTILATION: a) Modality: ☐ PCV ☐ DuoPAP ☐ ASV ☐ PSV ☐ SIMV ☐ NIV ☐ CPAP
b) Settings/Pattern: PEEP/Ps = ... /..... Ppeak ..... Pplat ..... RR ..... I:E ..... VT .....
EGA/EAB: pH ..... pCO2 ..... HCO3- ..... BE ..... PO2 ..... P/F ..... SpO2% ..... Hb .....

INDICATION: ☐ DIAGNOSTIC ☐ SCR.EENING ☐ MONITORING ☐ PROCEDURAL GUIDANCE
TYPE OF EXAM: ☐ simplified ☐ comprehensive ☐ focused (ANT / POST)



LUS Score = _____

Legenda: **0** = A-Pattern (or nearly normal); **1** = B-Pattern (B-lines >3/field, well spaced); **2** = B-Pattern (crowded, coalescent +/- subpleural consolidations) **3** = Consolidation* **E**= Effusion*; **Pn** = Pneumothorax**; **NS**= Sliding Abolition; **LP**=Lung Pulse *(3 and E: characterize below in description) **(indicate Lung Point(s))

DESCRIPTION .....
.....
.....

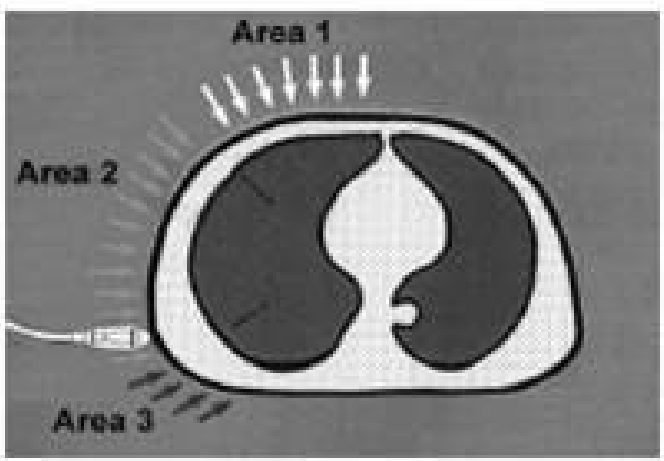
DIAGNOSIS .....

☐ Suspected ☐ Not made ☐ Second Opinion needed

Signature

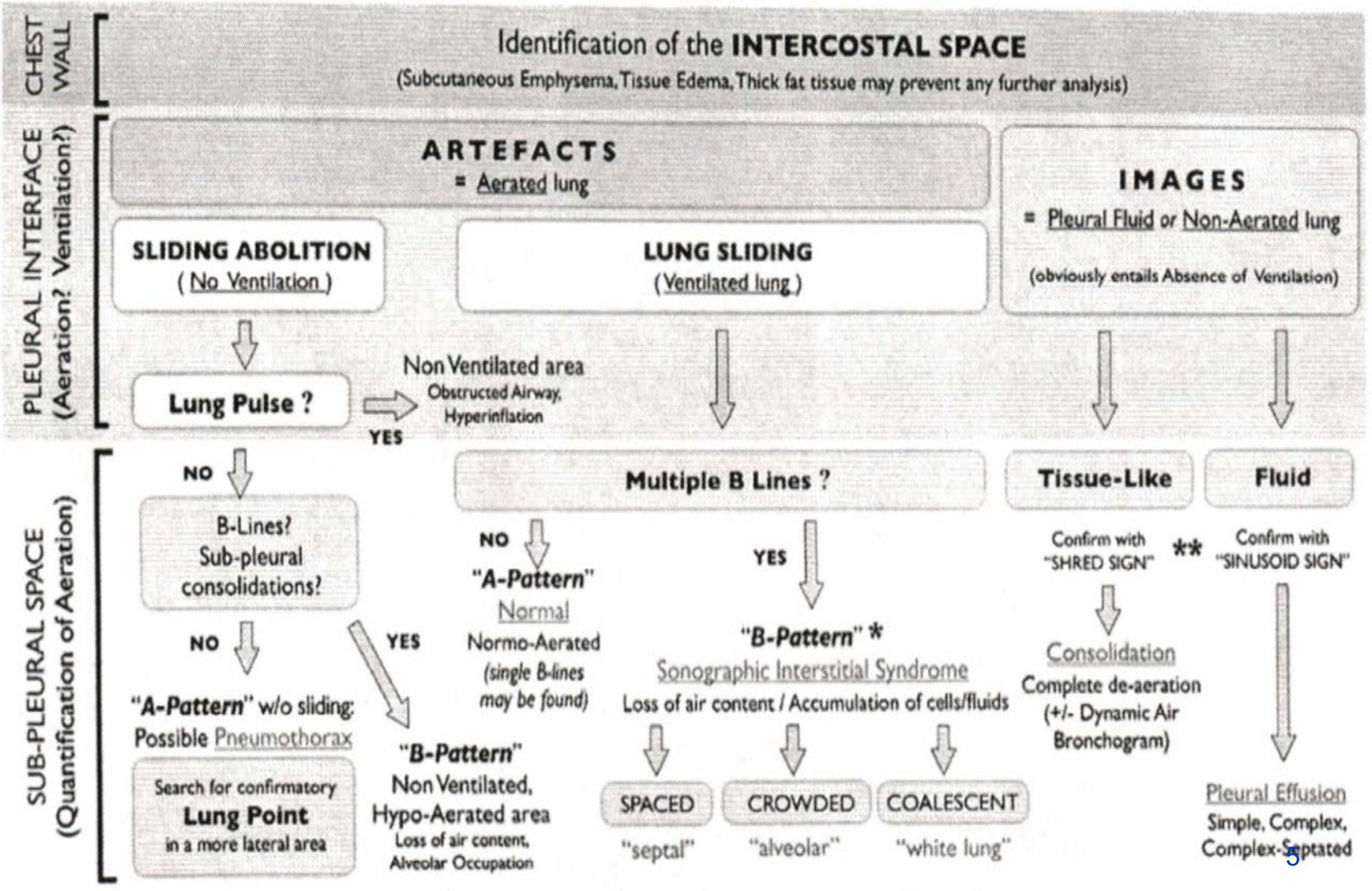
Right:
Upper: Ant – Lat – Post
Lower: Ant – Lat – Post
Left:
Upper: Ant – Lat – Post
Lower: Ant – Lat – Post

(Via G, et al: Minerva Anestesiol 2012)



Sequential interpretation of chest US

(Via G, et al: Minerva Anestesiol 2012; 78: 1282-96)



Detection of pleura, pulse, sliding, A a B lines

A line: reverberation of pleural line

B line: interlobular septa, >3…. accumulate fluid, 25-28% above diaphragm on IPPV

- ALI, ARDS
- card. lung edema
- pneumonia
- chronic interst. process

Heralds X-ray edema (Badgett RG 1996, Lichtenstein 2005, 2007)

Intersticial syndrome - grading

4 degrees of lung consolidation

I **(N)** – A lines, aerated lung, a comet, Z lines acceptable

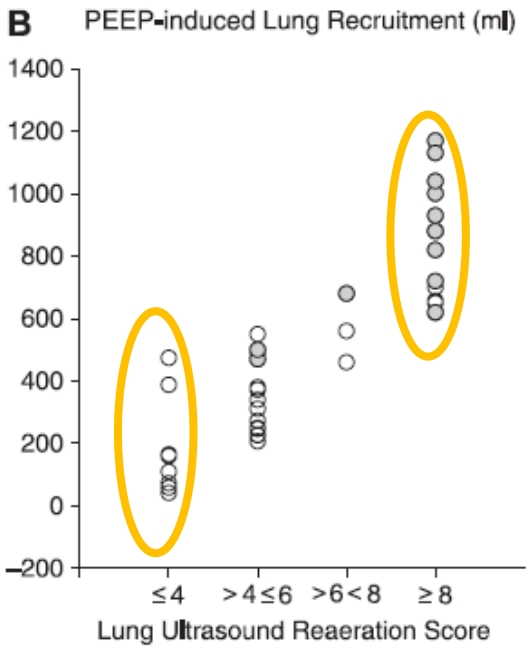
II **(B1)** - B lines, up to B4-7 mm, A line absent

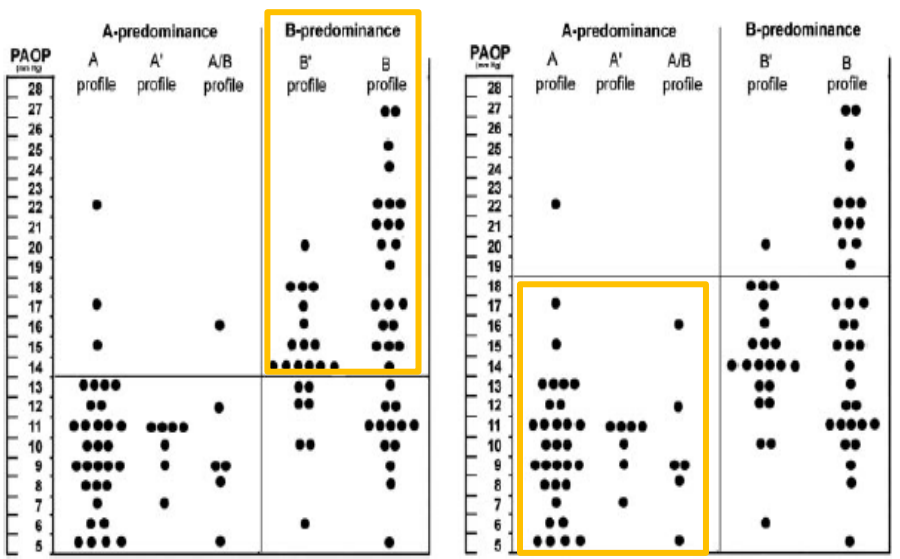
III **(B2)** – B lines 3 mm to coalescent

Recruitability II and III, seldom IV anterior, lateral
Never IV basal and caudal ! (Bouhemad B: AJRCCM 2011)

Kumulace tekutiny, recruitabilita a preload

- **ARDS: correlate (weak) with EVLW** (Baldi G: Intens Care Med 2013)
  - **No correlation to oxygenation** (Haddam M, Intensive Care Med 2016)
- **Monitoring of proning and positioning** (Tsubo T: Crit Care Med 2004)
- **Monitoring of ATB and th of VAP** (Bouhemad B, Crit Care Med 2010)
- **Prediction of SBT failure** (T-piece in intubated)
  - Derecruitment anterior, lateral, posterior (Soummer A: Crit Care Med 2012)





Daniel Lichtenstein: Chest 2009

Multi-organ Point of Care Ultrasound for COVID-19 (PoCUS4COVID): Evidence and International Recommendations for the Front-line Clinician

Arif Hussain*#1 and Gabriele Via*2, Lawrence Melniker3, Alberto Goffi4, Guido Tavazzi5, Luca Neri6, Tomas Villen7, Richard Hoppmann8, Francesco Mojoli9, Vicki Noble10, Laurent Zieleskiewicz11, Pablo Blanco12, Irene W.Y. Ma13, Mahathar Abd. Wahab14, Abdulmohsen Alsaawi15, Majid Al Salamah16, Martin Balik17, Diego Barca18, Karim Bendjelid19, , Belaid Bouhemad20, Pablo Bravo-Figueroa21, Raoul Breitkreutz22, Juan Calderon23, Jim Connolly24, Roberto Copetti25, Francesco Corradi26, Anthony J. Dean27, André Denault28, Deepak Govil29, Carmela Graci30, Young-Rock Ha31, Laura Hurtado32, Toru Kameda33, Michael Lanspa34, Christian torfano39, Peiman di Osman44, José elaert49, Susanna ale Tung Chen55,

Crit Care 2020

2 round Delphi, voting on PICO in 9 domains

DOMAIN	PoCUS APPLICATION
1	DIAGNOSIS OF SARS-COV2 INFECTION
2	TRIAGE/DISPOSITION
3	DIAGNOSIS OF COVID-19 PNEUMONIA
4	CARDIOVASCULAR DIAGNOSIS
5	SCREENING AND DIAGNOSIS OF THROMBOEMBOLIC DISEASE
6	PoCUS AND RESPIRATORY SUPPORT STRATEGIES
7	MANAGEMENT OF FLUID ADMINISTRATION
8	MONITORING OF COVID-19 PATIENTS
9	INFECTION CONTROL, TECHNIQUES, TECHNOLOGY AND PROTOCOLS

- **CUS je přesnější než RTG pro dg. respir. insufficience**
- **B linie, ztluštění pleury, subpleur konsolidace**
- **Konsolidace s bronchogramem hlavně u superinfekcí**
- **Bilat. A pattern vylučuje Covid19 pneumonii**
- **Integrace s klinikou a lab. dg. je kruciální pro správnou interpretaci**

Porovnání LUS a CT u Covid-19

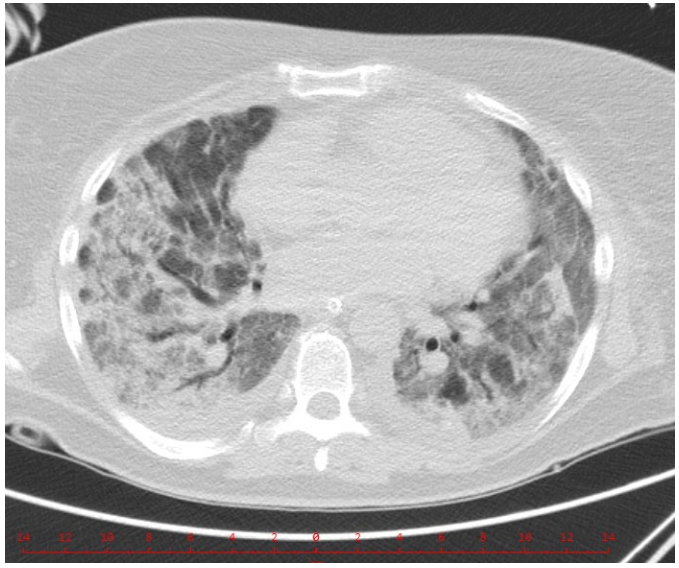
Intensive Care Med (2020) 46:1908–1910
https://doi.org/10.1007/s00134-020-06221-0

EDITORIAL

Lung ultrasonography as an alternative to chest computed tomography in COVID-19 pneumonia?

Antoine Vieillard-Baron[1,2], Alberto Goffi[3,4] and Paul Mayo[5*]

- Problém v definici: Kolik B linií a jakou hustotu potřebujete ke korelátu s ground glass opacities ? …..coalescent B linies, gr.3 !



Intensive Care Med
https://doi.org/10.1007/s00134-020-06186-0

Důležitost illness severity pro dg. přesnost LUS

ORIGINAL

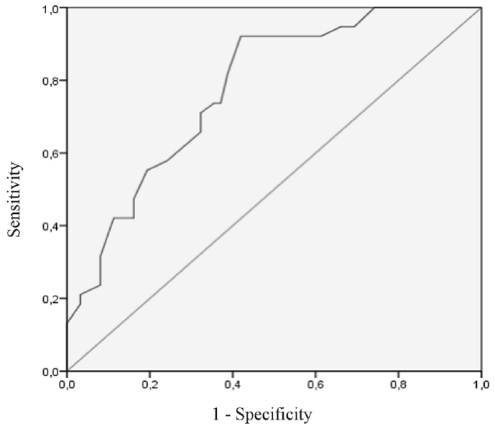
Check for updates

Comparative study of lung ultrasound and chest computed tomography scan in the assessment of severity of confirmed COVID-19 pneumonia

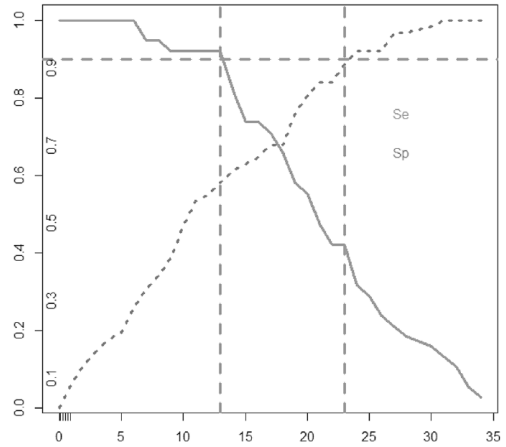
Laurent Zieleskiewicz[1,2*], Thibaut Markarian[3], Alexandre Lopez[1], Chloé Taguet[3], Neyla Mohammedi[1],

- **4 centra, 100 pts, LUS score ve 12 regionech: 0-36 (12x 0-1-2-3)**
- **AUC 0.78 (CI 95%, 0.68-0.87, p<0.0001), AUC 0.92 pro pac na UPV**
- **LUS>23 predikce CT pneumonie se spec >90%, PPV 70%**
- **LUS<13 vylučuje CT pneumonii se spec >90%, NPV 92%**
- **38% inkonkluzivní, skore 13-23…možná indikace k CT**

a ROC curve of LUS score versus chest CT scan

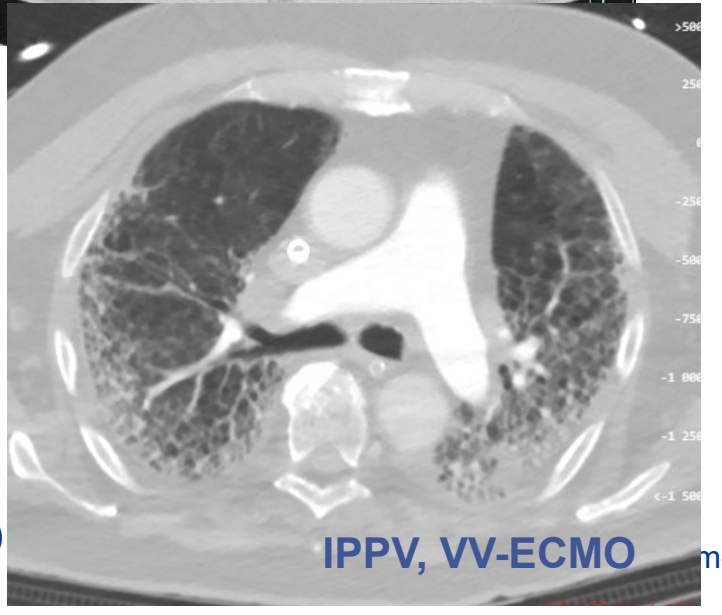


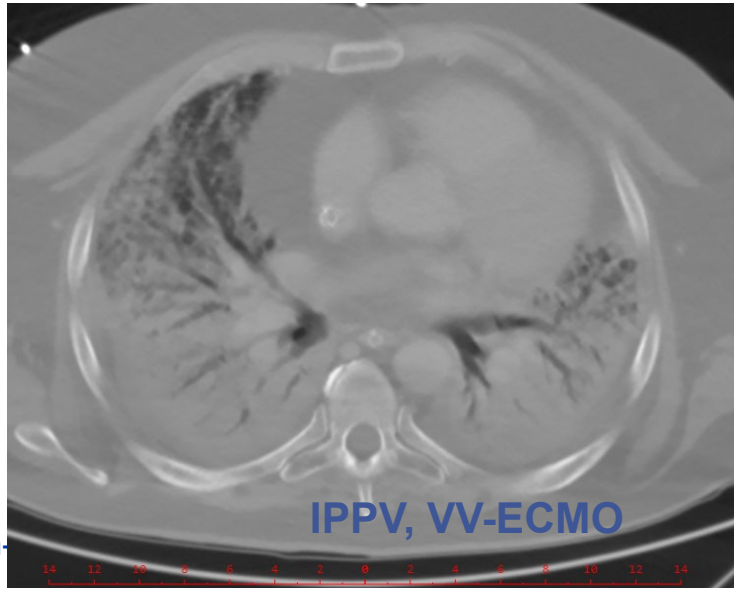
b Grey zone of LUS score versus chest CT scan



KARIM
1.LF UK A VFN V PRAZE

4 různí Covid-19 pacienti: Závažnost CT nálezu a korelace mezi LUS a CT





CT není automatickou součástí diagnostiky těžkých intersticiálních plicních procesů

- CT jako možný indikátor ICU při příjmu (nebo standard ?) – ne prvních 48h
- neexistuje korelát mezi CT/RTG plicního parenchymu a funkčním stavem
- Tzv. procentuální výpočet zasažení plicního parenchymu nekoreluje s virovou náloží = neurčuje virostatickou léčbu
- Rutinní CT zatěžuje pacienta, RDG a ICU personál, pojišťovací systém (indukovaná léčba pro ICU…), spotřeby ochranných pomůcek….

(ACR Recommendations for the use of Chest Radiography and Computed Tomography (CT) for Suspected COVID-19 Infection, www.acr.org)

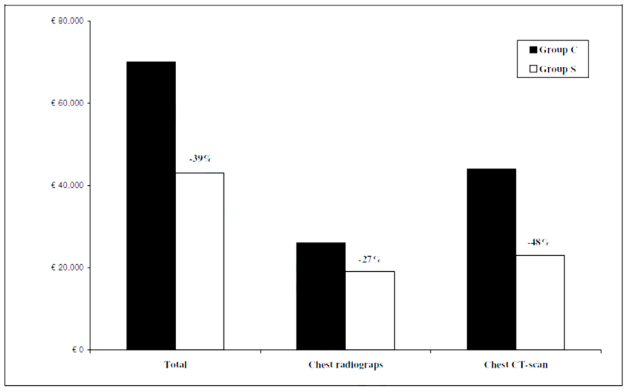
Intensive Care Med
https://doi.org/10.1007/s00134-021-06373-7

ORIGINAL

Lung ultrasound for the early diagnosis of COVID-19 pneumonia: an international multicenter study

Giovanni Volpicelli[1*], Luna Gargani[2*], Stefano Perlini[3], Stefano Spinelli[4], Greta Barbieri[4], Antonella Lanotte[5],

(Anesth Analg 2010;111:687–92)



KARIM
1.LF UK A VFN V PRAZE

www.karim-vfn.cz

Intensive Care Med (2016) 42:1546–1556
DOI 10.1007/s00134-016-4411-7

ORIGINAL

Lung ultrasonography for assessment of oxygenation response to prone position ventilation in ARDS

Malik Haddam[1], Laurent Zieleskiewicz[1], Sebastien Perbet[2], Alice Baldovini[1], Christophe Guervilly[3],

CUS: lokalizace konsolidované plíce pro dosažení maximálního benefitu polohování a pronace

Conclusions: In ARDS patients with a PaO_2/FiO_2 ratio ≤150 mmHg, bedside LUS cannot predict oxygenation response after the first PP session. At the bedside, LUS enables monitoring of aeration changes during PP.

Indication to bronchoscopy

- FOB 24/7 managed by intensivists
- Indication supported by imaging including ultrasonography
- Absence of dynamic bronchogram has 94% specificity for atelectasis (Lichtenstein D: Chest 2009)
- Positioning, proning, physiotherapy

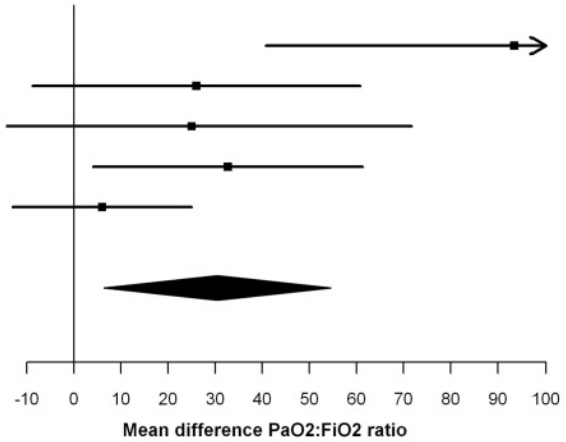
+36h

Immediately after FOB

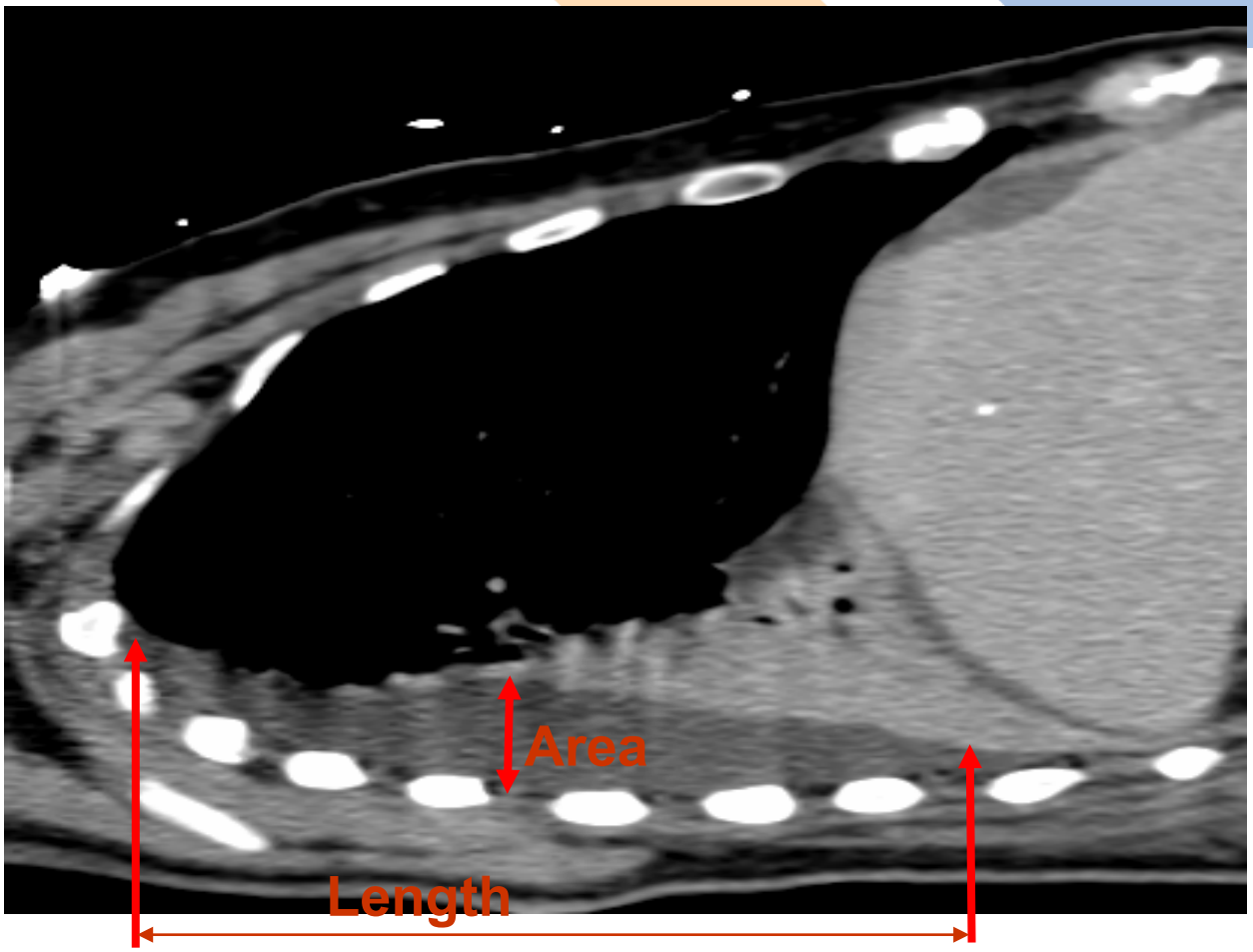
Fluidothorax: Kvalitativní zhodnocení

Fluidothorax and favourable impact of drainage on oxygenation and weaning of IPPV

- 19 studies in metaanalysis of Goligher et al (Crit Care 2011): paO_2/FiO_2 increase by 18% after drainage
- Impact on LOS IPPV and mortality
  - …positive, without stat sig. (Fartoukh et al: Chest 2002, Adenigbagbe A: Chest 2007)
  - …larger effusion with larger benefit (Talmor et al: Surgery 1998)
- Quantification, therapeutic tap: >350-400 ml
- Time factor (PH, cardiac failure..)



Distribution of pleural fluid: bi-conical shape, common base



Remerand, et al: Intensive Care Med 2010

V [ml] = Area [cm2] x Length [cm]

Balik et al. Critical Care (2022) 26:144
https://doi.org/10.1186/s13054-022-04018-9

Critical Care

CORRESPONDENCE Open Access

Pulmonary consolidation alters the ultrasound estimate of pleural fluid volume when considering chest drainage in patients on ECMO

- Volume = L sep[mm] * 17 + 540 (prediction error 129 ml)

Intensive Care Med (2006) 32:318–321
DOI 10.1007/s00134-005-0024-2

BRIEF REPORT

M Balik
P Plasil
P Waldauf

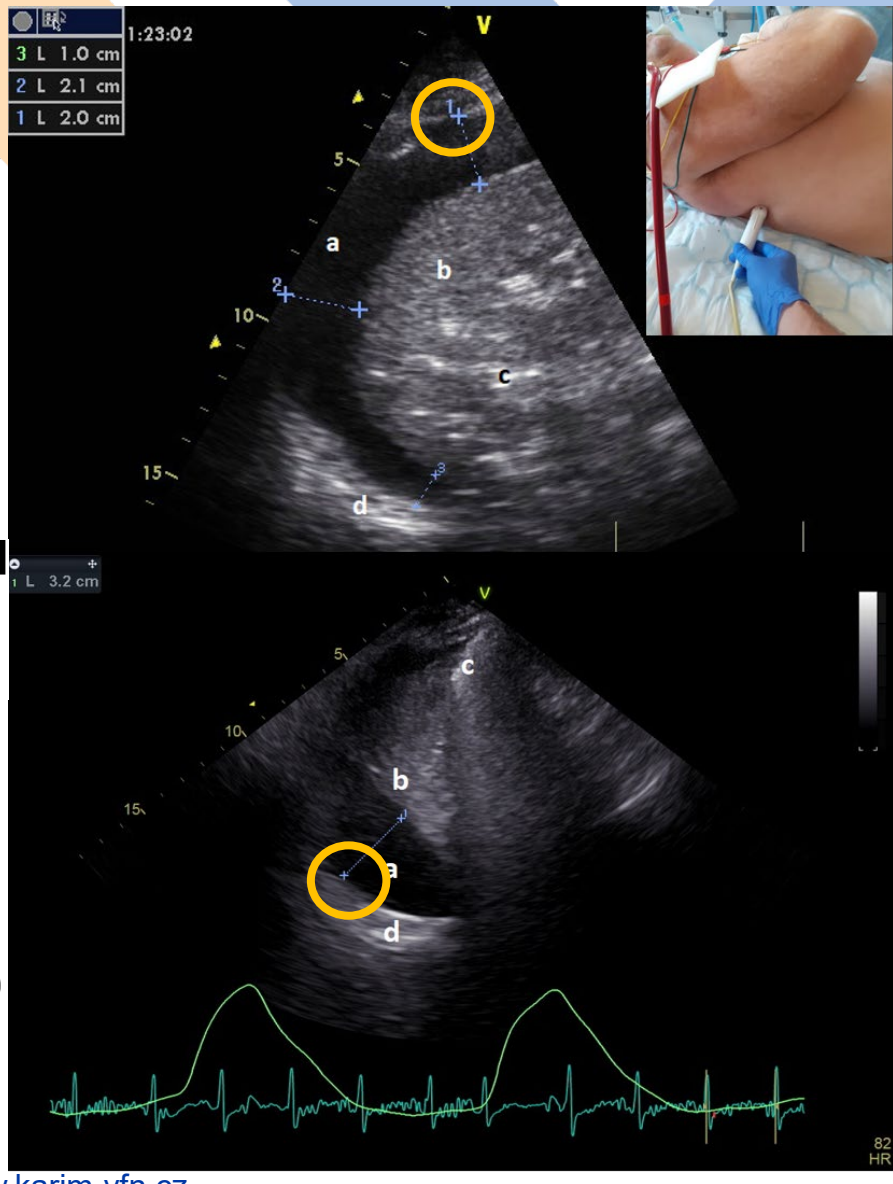
Ultrasound estimation of volume of pleural fluid in mechanically ventilated patients

The Use of Point-of-Care Bedside Lung Ultrasound Significantly Reduces the Number of Radiographs and Computed Tomography Scans in Critically Ill Patients

Adriano Peris, MD,* Lorenzo Tutino, MD,* Giovanni Zagli, MD,* Stefano Batacchi, MD,* Giovanni Cianchi, MD,* Rosario Spina, MD,* Manuela Bonizzoli, MD,* Luisa Migliaccio, MD,* Lucia Perretta, MD,* Marco Bartolini, MD,† Kevin Ban, MD,† and Martin Balik, MD, PhD§

(Anesth Analg 2010;111:687–92)

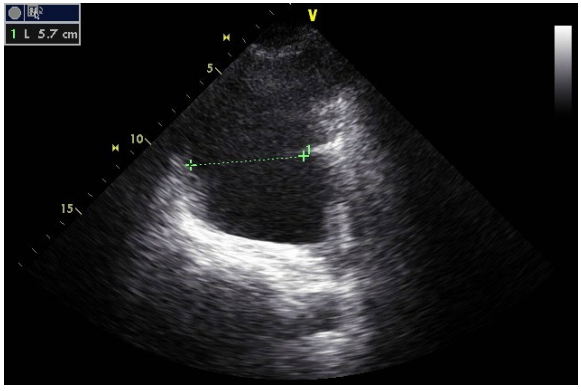
- Volume = separation [mm] * 20 (prediction error 150 ml)

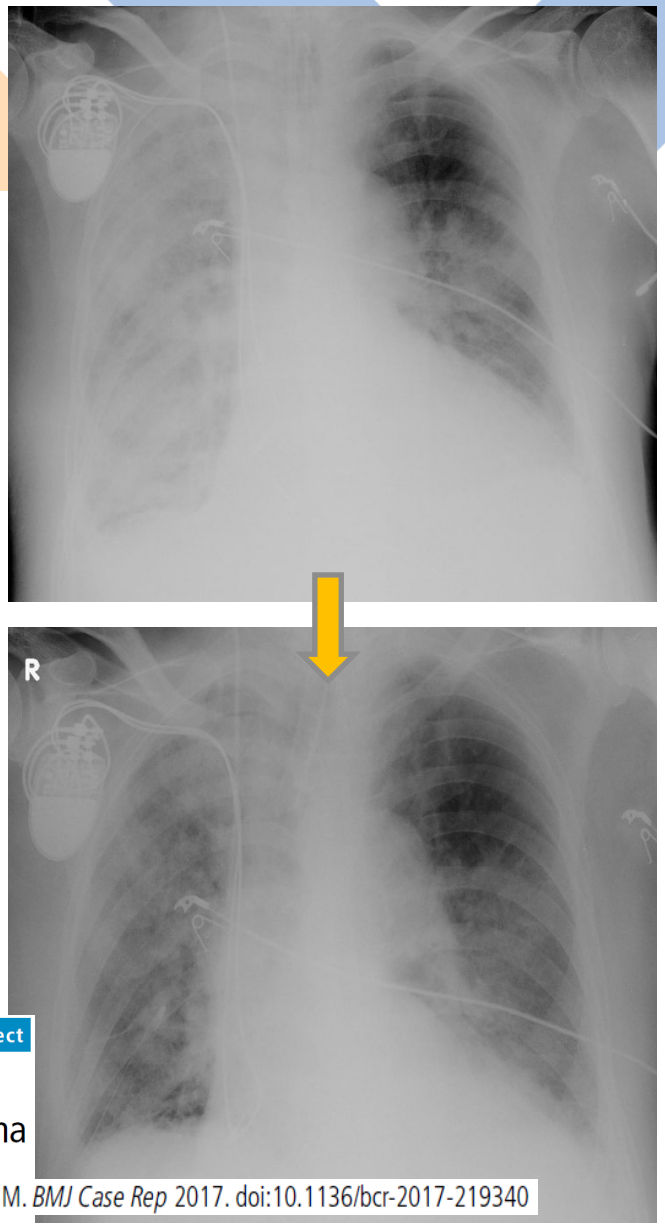


KARIM
1.LF UK A VFN V PRAZE

www.karim-vfn.cz

What is the LVEDP pre-drainage of large enough fluidothorax ?





LVEDP 26 mmHg on TTE: 800 ml of transudate evacuated without neg. pressure….

…resulting in pulmonary edema with a need for rising PEEP, FiO_2 and addition of Dobutamine 5.0 ug/kg.min

Findings that shed new light on the possible pathogenesis of a disease or an adverse effect

OPEN ACCESS

CASE REPORT

Is the mechanism of re-expansion pulmonary oedema in a heart–lung interaction?

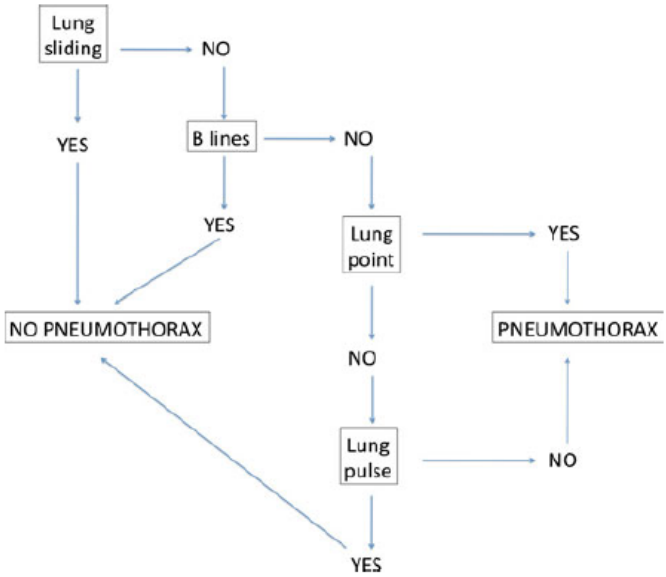
Candy Masego Mokotedi, Martin Balik

Mokotedi CM, Balik M. *BMJ Case Rep* 2017. doi:10.1136/bcr-2017-219340

Intensive Care Med (2012) 38:577–591
DOI 10.1007/s00134-012-2513-4

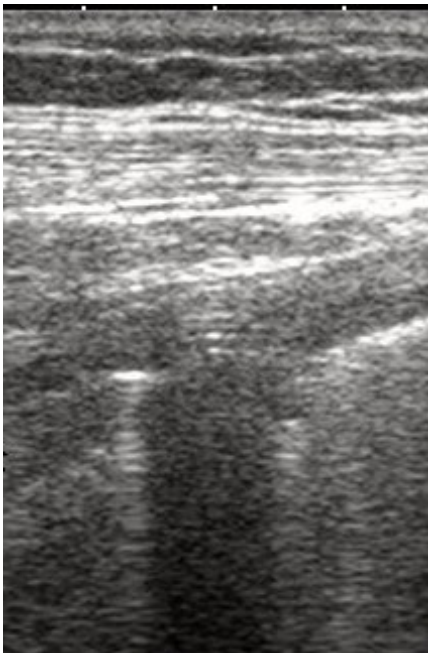
Giovanni Volpicelli
Mahmoud Elbarbary
Michael Blaivas
Daniel A. Lichtenstein
Gebhard Mathis
Andrew W. Kirkpatrick

International evidence-based recommendations for point-of-care lung ultrasound



CUS a drenáž: Poloha hrudního drenu jako 5. příznak vylučující pneumothorax ?

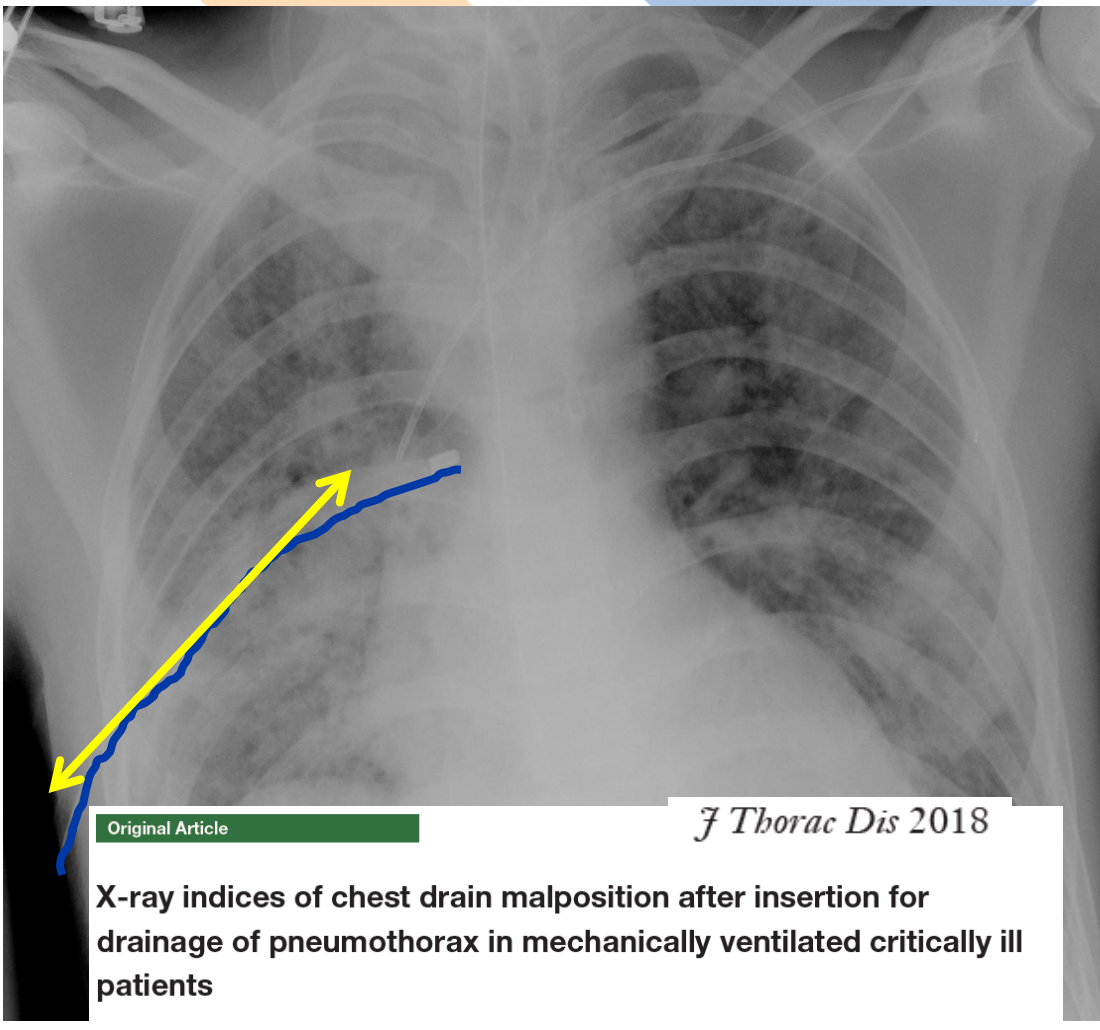
- Význam ventroapikálně – omezený sliding
- Malpozice HD až 30% (Remerand F, Anesthesiology 2007)
- Riziko okultního ventrálního PNO ! ……



Malý M, et al: Interpleural location of chest drain on ultrasound excludes pneumothorax and associates with a low degree of chest drain foreshortening on the anteroposterior chest X-ray, under review 2022

Kontrola polohy drenu a drenáže: RTG a CUS

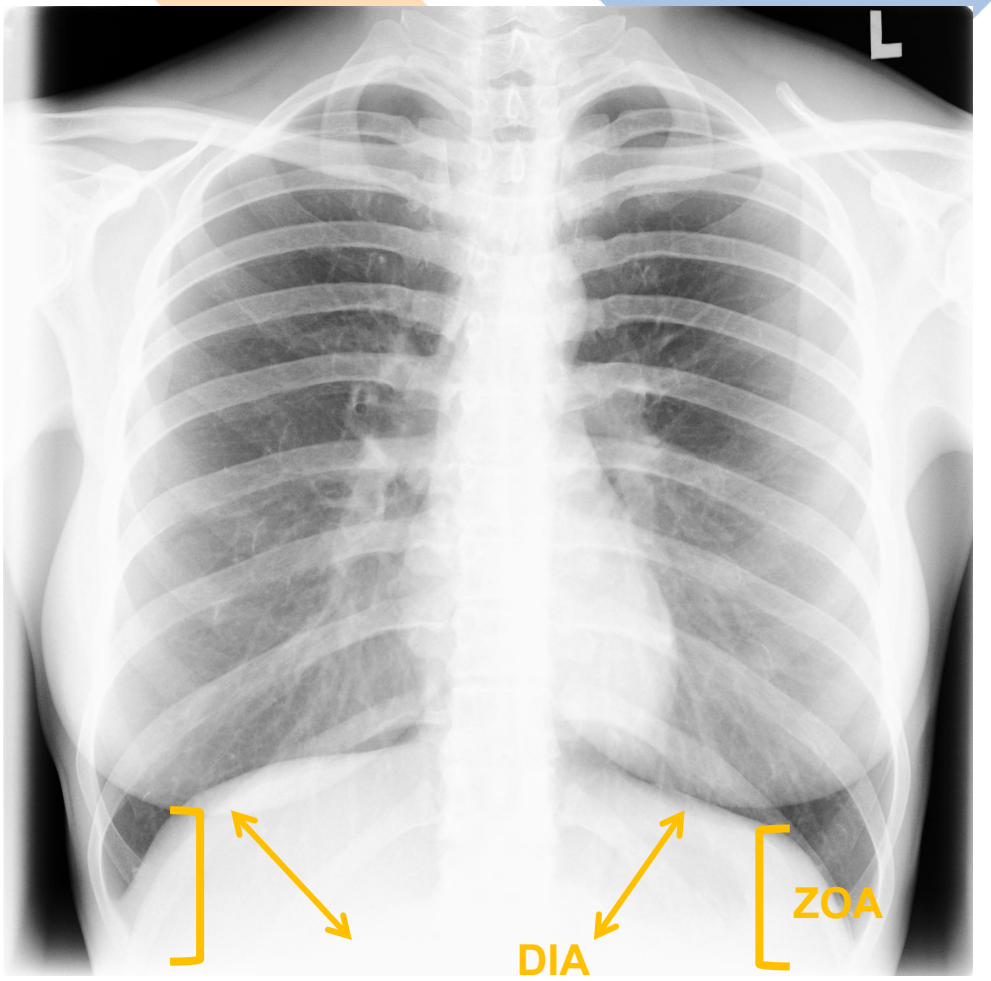
- U drenáže PNO: „vlaštovkovité zalomení“ v místě přitištění drenu plicí pod hrudní stěnu.
- Cm na drenu by měly odpovídat průběhu v AP projekci (10cm = 10 cm + 5 cm)
- Tortuosita HD zvýšená: ventrálně nebo dorsálně zavedený dren v AP postavení – v plíci !!!



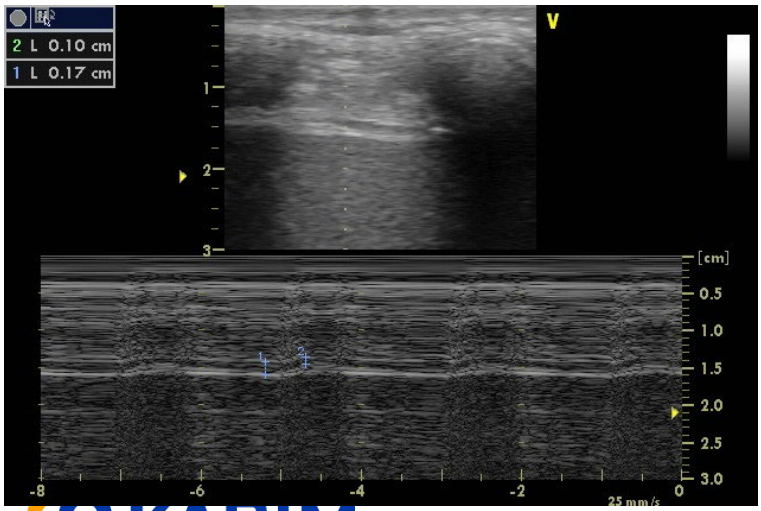
KARIM
1.LF UK A VFN V PRAZE

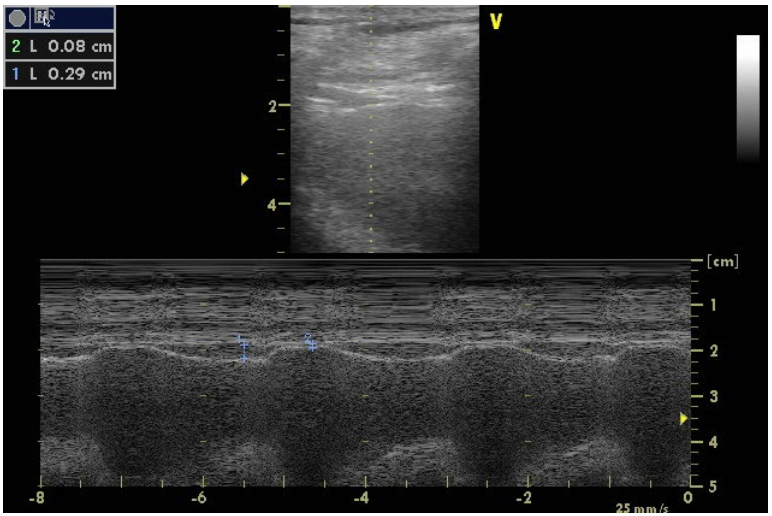
Weaning: diaphragm as major respiratory muscle

- Zone of aposition (ZOA): caudal movement
  - chest wall ventral and lateral
- Diaphragmatic amplitude (DIA)

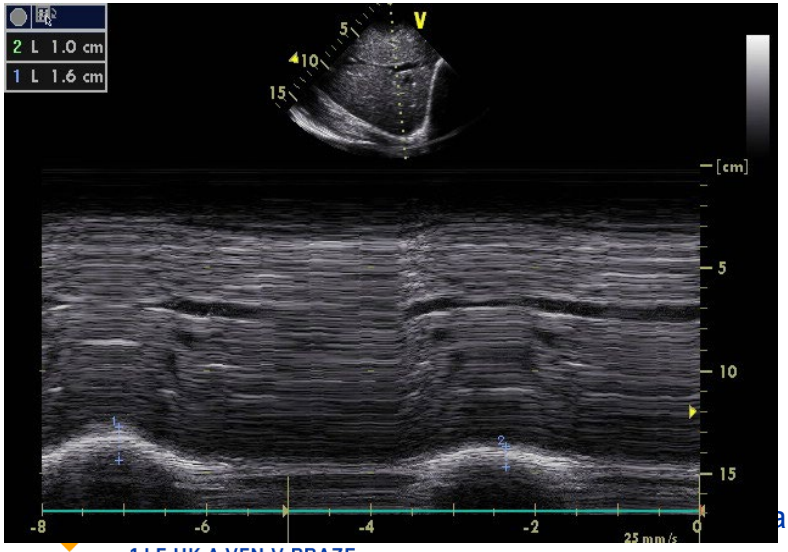


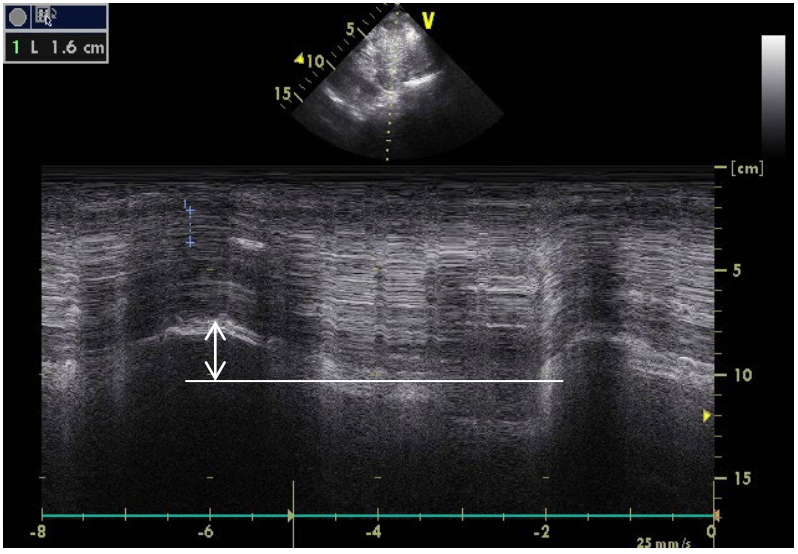
ZOA: Zltušťování bránice (TF min 20-25%)





Diafragmatická amplituda: DIA min 1.0-1.5 cm



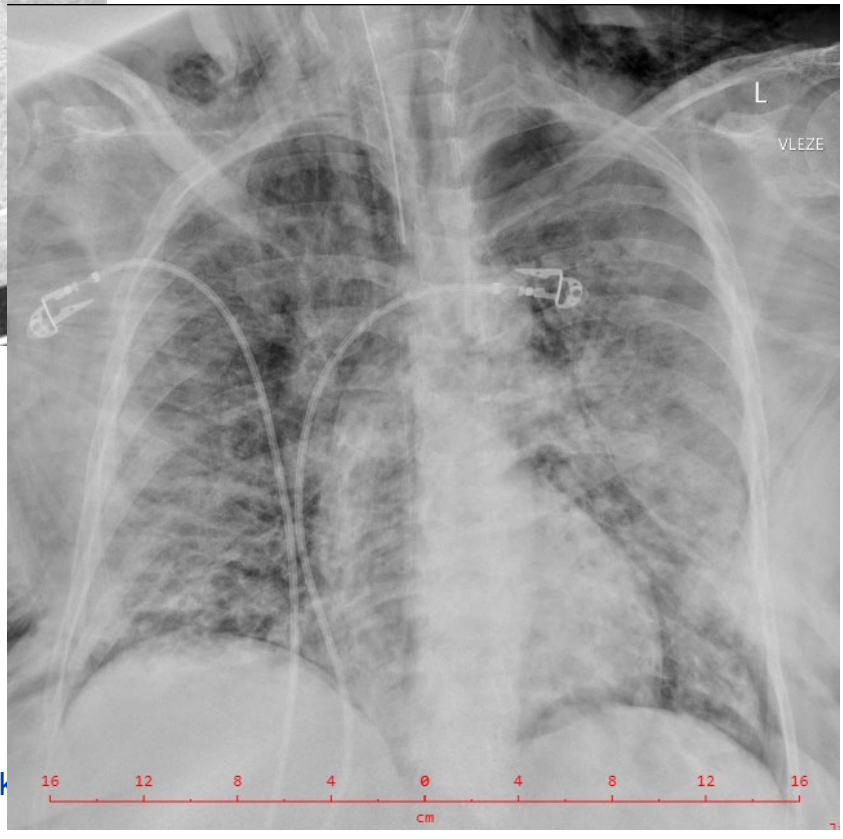


DIA: Pareza bránice (AMM)

Airway: CUS před tracheostomií

- Infra or supraisthmic dissection expected ?
- Depth of trachea from not compressed skin: Portex or Rusch/Mallincrodt ?
- Size of trachea ?
- ET pulled out under US control
- Vessel structures ?
- Infectious issues – elimination of soiling from trachea

Limitace CUS

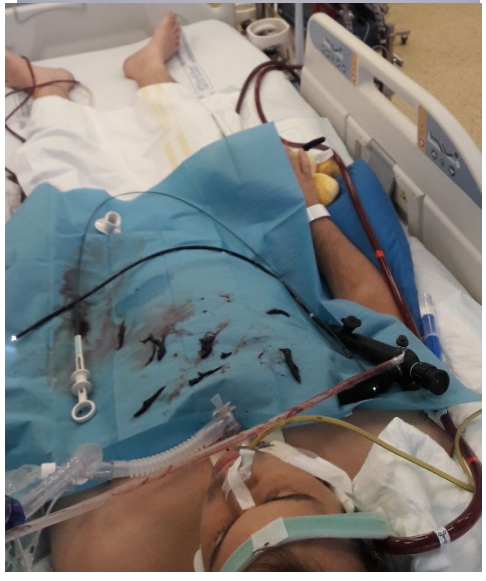


VŠEOBECNÁ FAKULTNÍ NEMOCNICE V PRAZE
1. LÉKAŘSKÁ FAKULTA Univerzita Karlova
KARIM
KLINIKA ANESTEZIOLOGIE, RESUSCITACE A INTENZIVNÍ MEDICÍNY
U Nemocnice 499/2, 128 08 Praha 2
Tel.: 224 961 111, www.vfn.cz

Vážená paní, vážený pane,
dovolujeme si Vás pozvat na již:

XVII. Workshop bronchoskopie v anesteziologii a intenzívní péči,

který pořádají KARIM a Centrum plicní endoskopie VFN a 1.LF UK a Společnost pro anesteziologii, resuscitaci a intenzivní medicínu pod záštitou České společnosti intenzivní medicíny (ČSIM)



Akce proběhne **16.12. 2022**

Program workshopu, možnost přihlášení a další podrobnosti naleznete na www.karim-vfn.cz

KARIM
1.LF UK A VFN V PRAZE

ČESKÁ SPOLEČNOST INTENZIVNÍ MEDICÍNY

Děkuji za pozornost !

Komplexní kardiovaskulární centrum
KARIM VFN a 1.LF UK

U nemocnice 2; 128 08 Praha 2
T: +420 224 963 366
F: +420 224 967 125
martin.balik@vfn.cz
www.karim-vfn.cz