Critical Care of the Patient with COVID-19

What We Know, So Far

Steven Q Simpson, MD, FCCP, FACP

Professor of Medicine

Division of Pulmonary, Critical Care, and Sleep

University of Kansas

Senior Medical Advisor

Biomedical Advanced Research and Development Authority

US Dept. of Health and Human Services

Disclosures

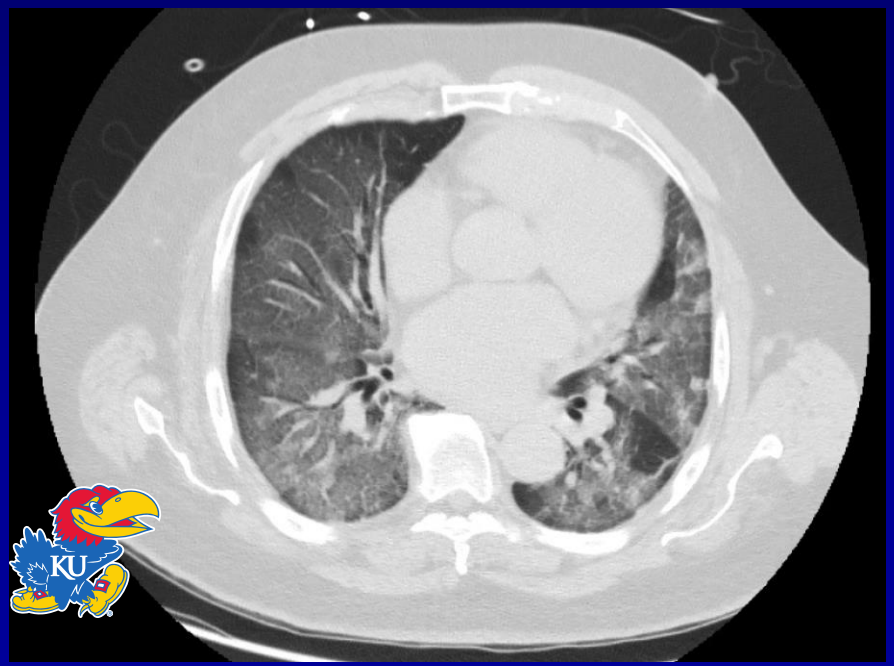
I have nothing to disclose.

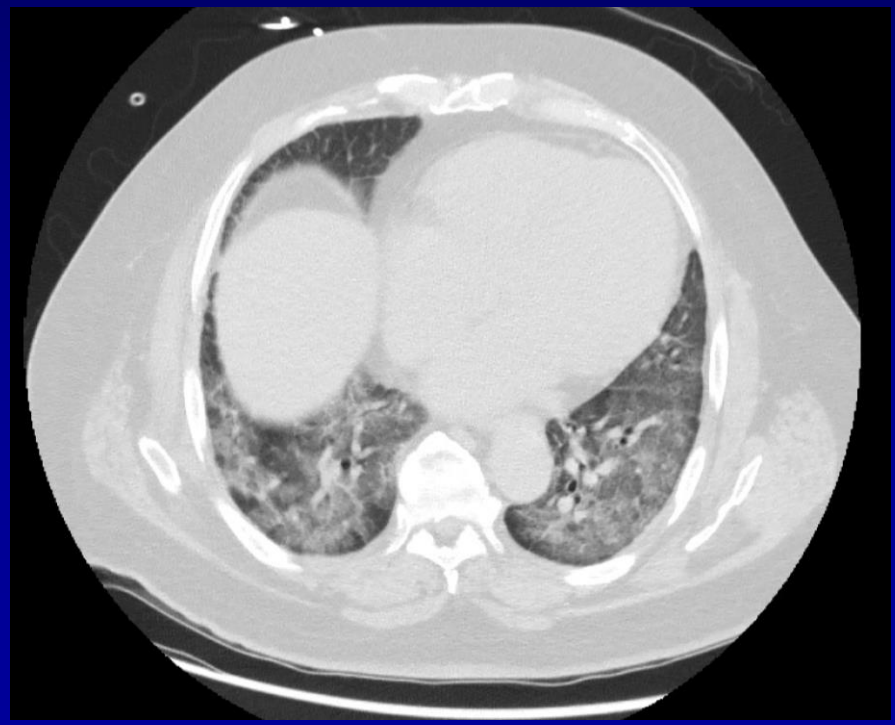
Severe COVID-19 is Sepsis

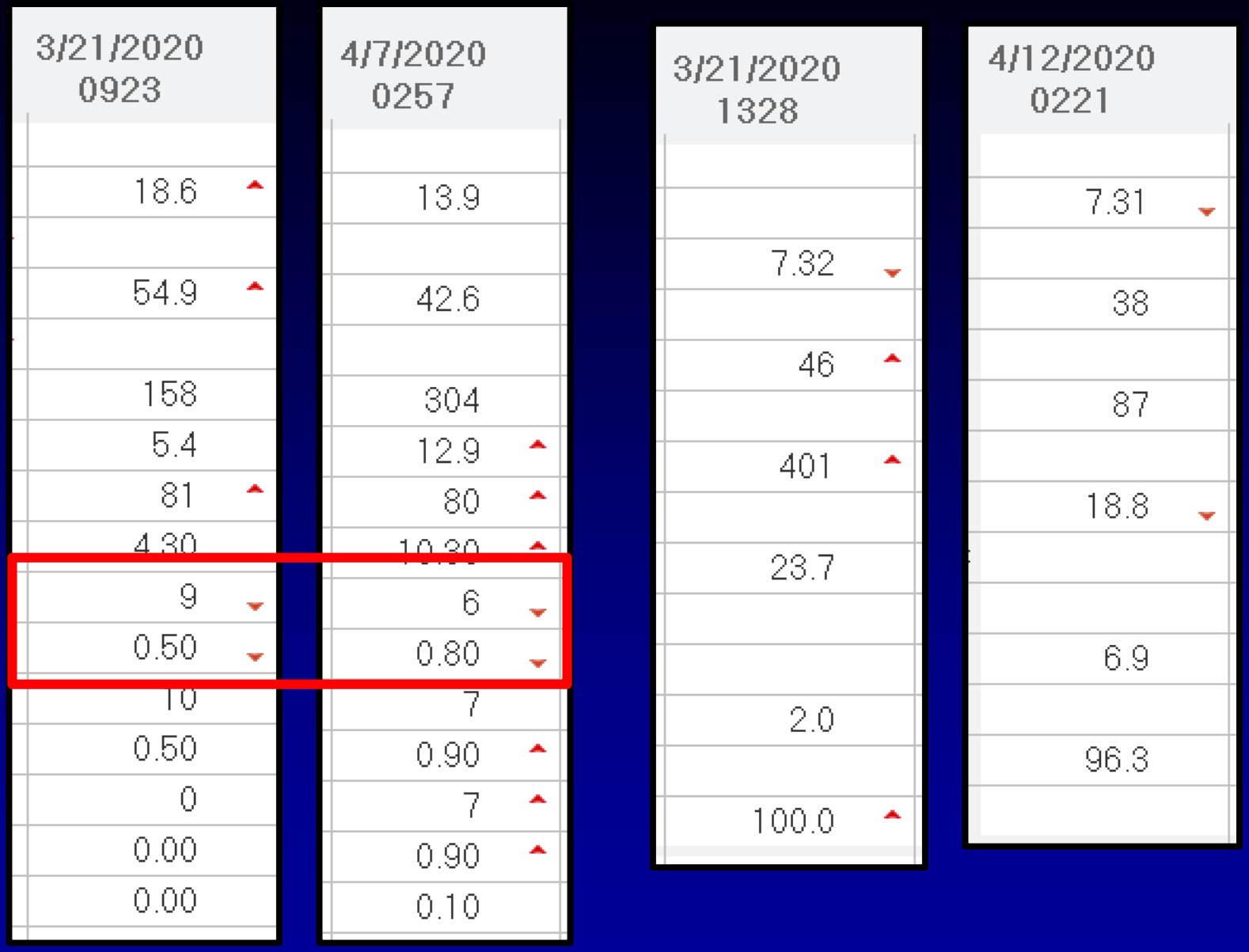
- Severe and critical COVID-19
  - Infection with SARS CoV-2
  - Organ dysfunction – pulmonary, renal, cardiovascular
- Sepsis
  - Life threatening organ dysfunction due to a dysregulated host response to infection
- Some COVID-19 is septic shock

An Early KU Admission

- 68 year old African American man
- Church pastor
- Exposed to a COVID-19 + parishioner
- History from daughter:
  - No fever or chills, no myalgia (but mother, yes)
  - Cough, then dyspnea for about 24 hours
- PMH: CVA, HTN, hernia repair
- Meds: atorvastatin, ASA, amlodipine



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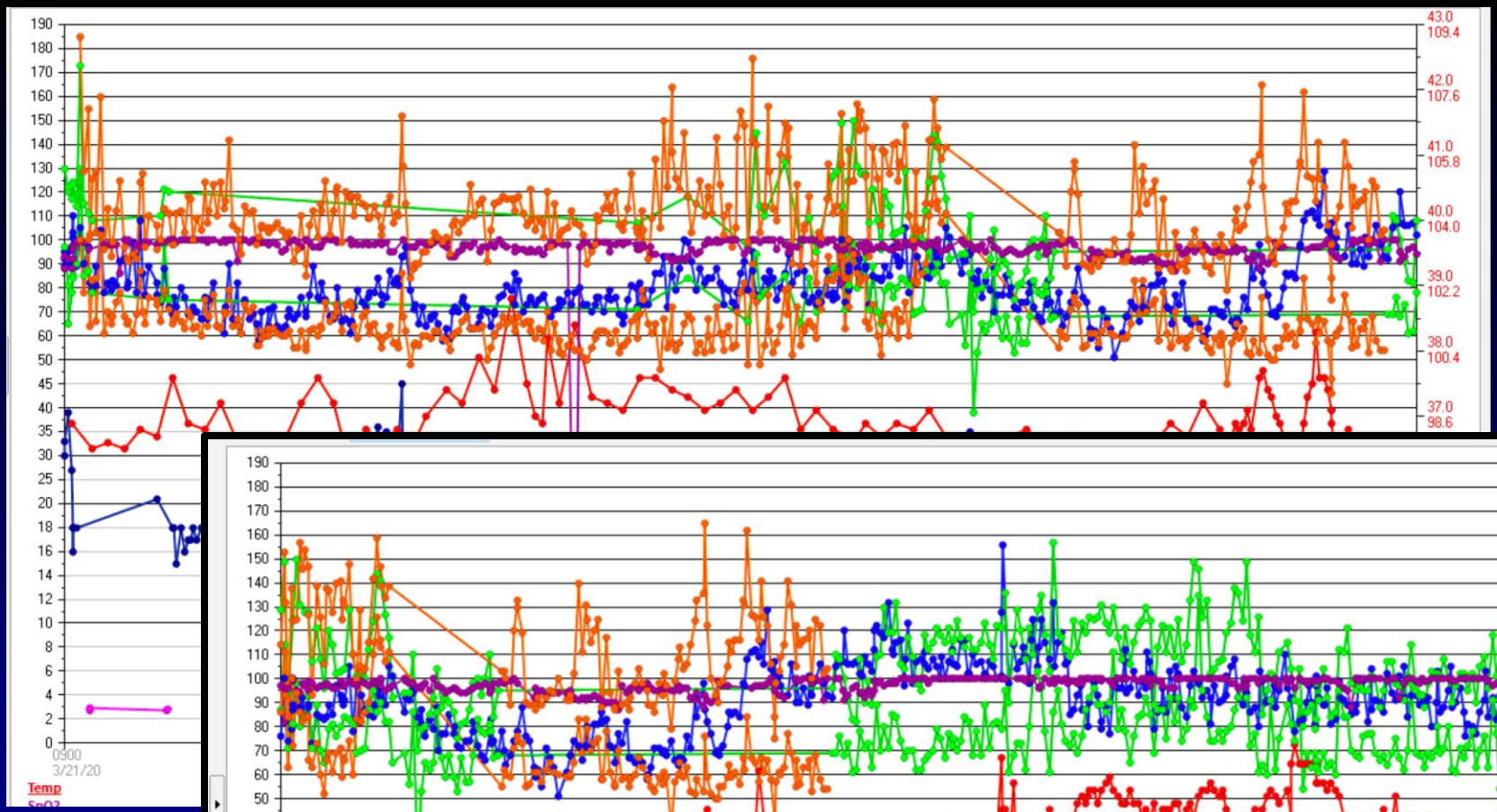
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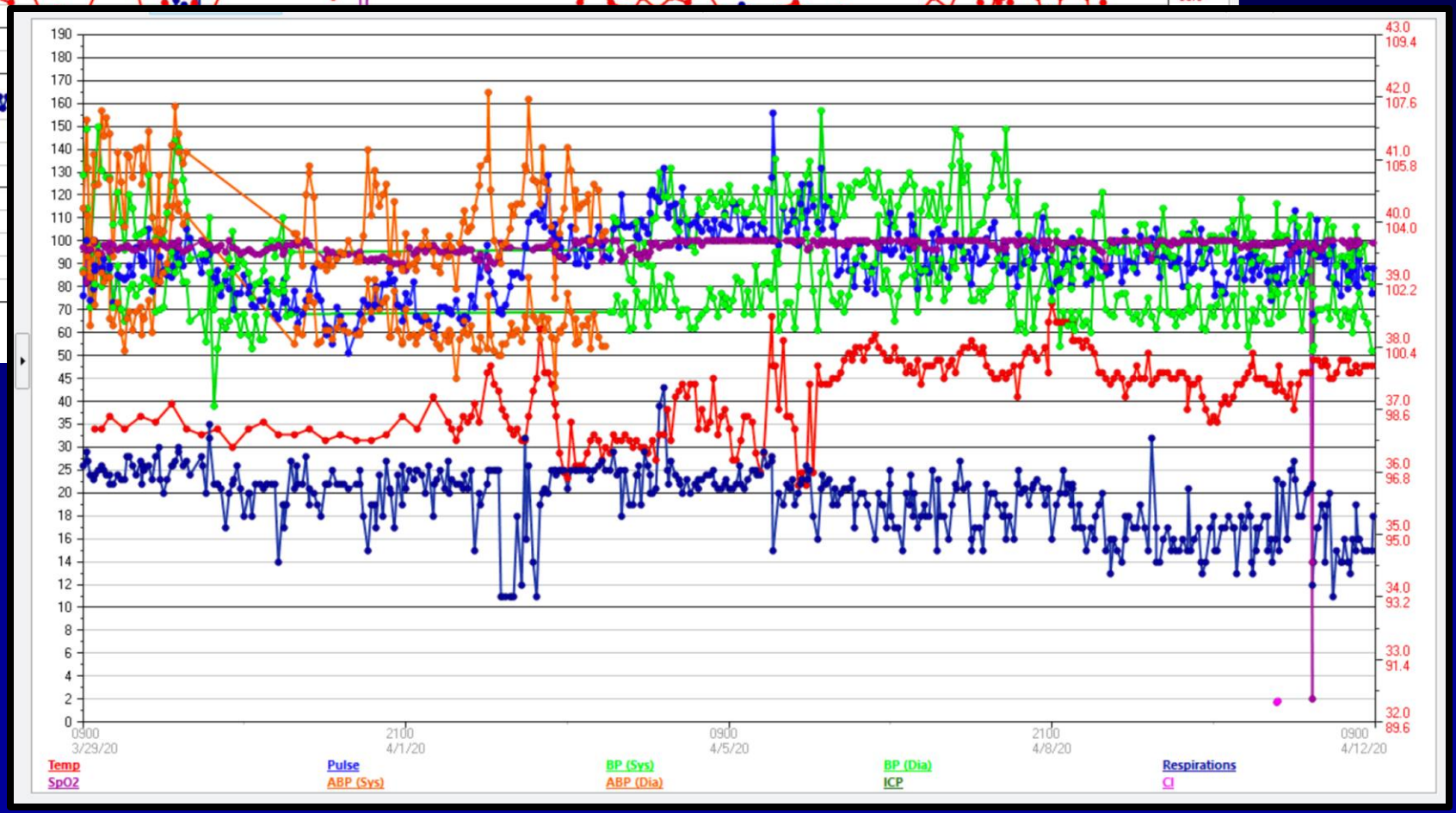
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Temp
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ABP (Sys)
BP (Sys)
ABP (Dia)
BP (Dia)
ICP
Respirations
CI

What Can We Learn? Ask?

- Is this ARDS?
- What should be our approach to treatment?
- Is intubation appropriate now?
- Are low tidal volumes appropriate? PEEP?
- Why is he hypotensive? And how should be approach that?
- Renal failure??? In COVID?
- Is tracheotomy important? Contra-indicated?
- What is cytokine storm, and what is its importance?
- What if there's a code blue?

Is this ARDS?

Definition of ARDS

Table 3. The Berlin Definition of Acute Respiratory Distress Syndrome

	Acute Respiratory Distress Syndrome
Timing	Within 1 week of a known clinical insult or new or worsening respiratory symptoms
Chest imaging[a]	Bilateral opacities—not fully explained by effusions, lobar/lung collapse, or nodules
Origin of edema	Respiratory failure not fully explained by cardiac failure or fluid overload Need objective assessment (eg, echocardiography) to exclude hydrostatic edema if no risk factor present
Oxygenation[b]	
Mild	200 mm Hg $<$ Pa_{O_2}/F_{IO_2} $\leq$ 300 mm Hg with PEEP or CPAP $\geq$5 cm H_2O[c]
Moderate	100 mm Hg $<$ Pa_{O_2}/F_{IO_2} $\leq$ 200 mm Hg with PEEP $\geq$5 cm H_2O
Severe	Pa_{O_2}/F_{IO_2} $\leq$ 100 mm Hg with PEEP $\geq$5 cm H_2O

Abbreviations: CPAP, continuous positive airway pressure; F_{IO_2}, fraction of inspired oxygen; Pa_{O_2}, partial pressure of arterial oxygen; PEEP, positive end-expiratory pressure.

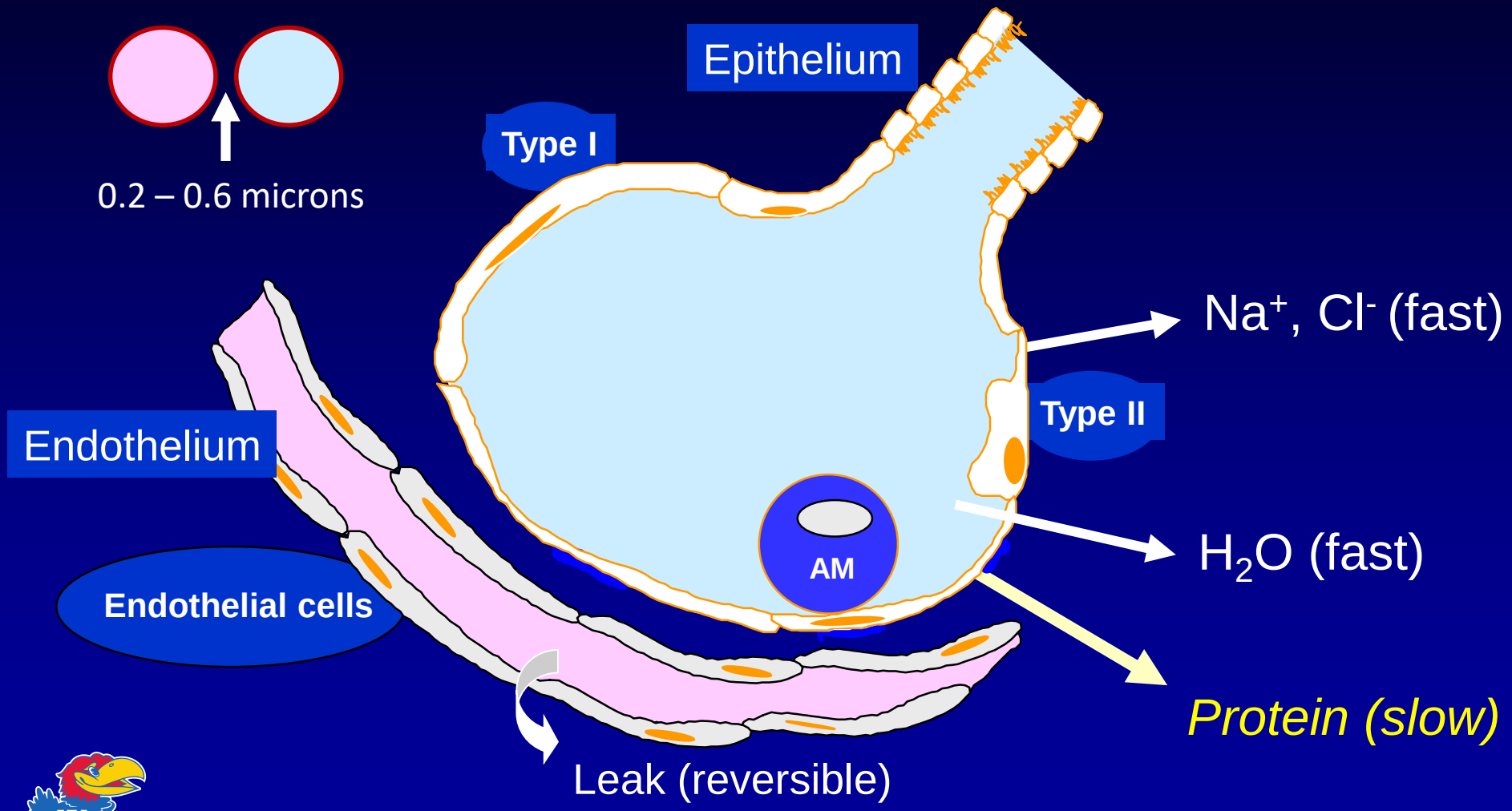
[a] Chest radiograph or computed tomography scan.

[b] If altitude is higher than 1000 m, the correction factor should be calculated as follows: [Pa_{O_2}/F_{IO_2} × (barometric pressure/760)].

[c] This may be delivered noninvasively in the mild acute respiratory distress syndrome group.

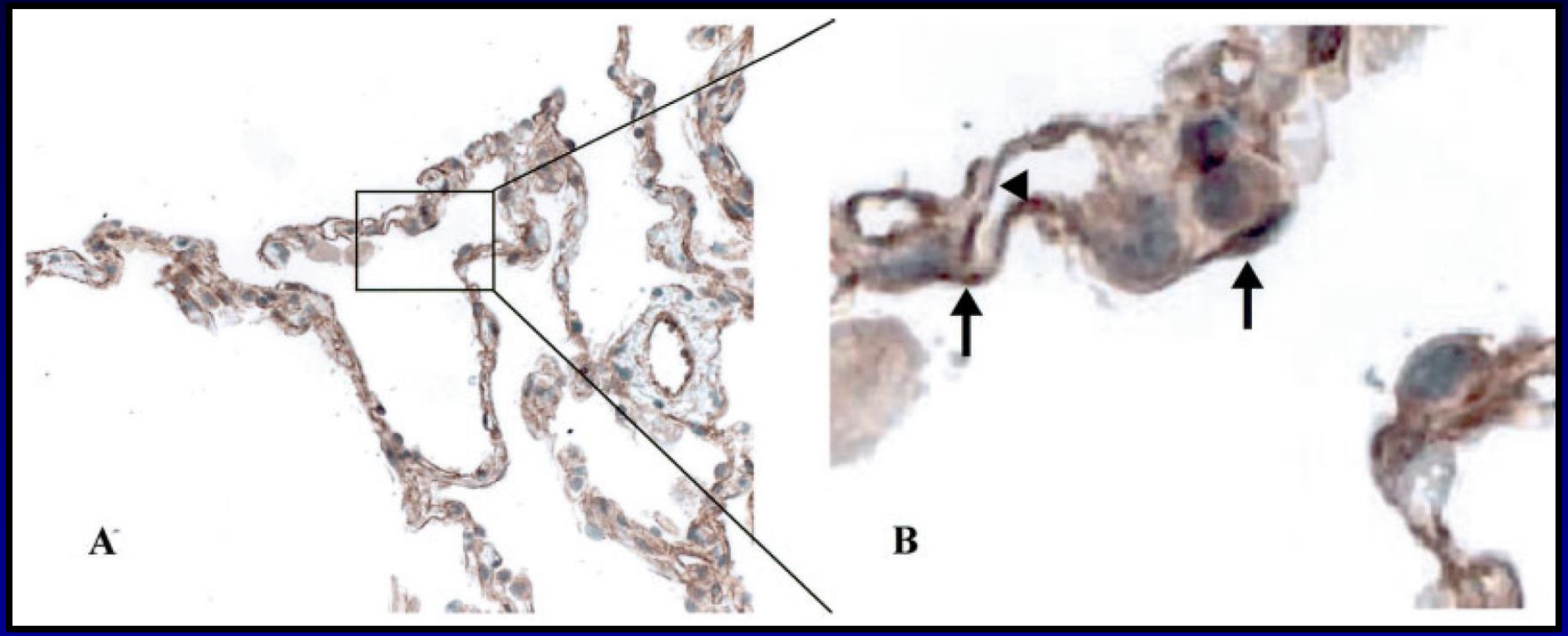
JAMA, June 20, 2012—Vol 307, No. 23

Critical Barriers in the Lungs



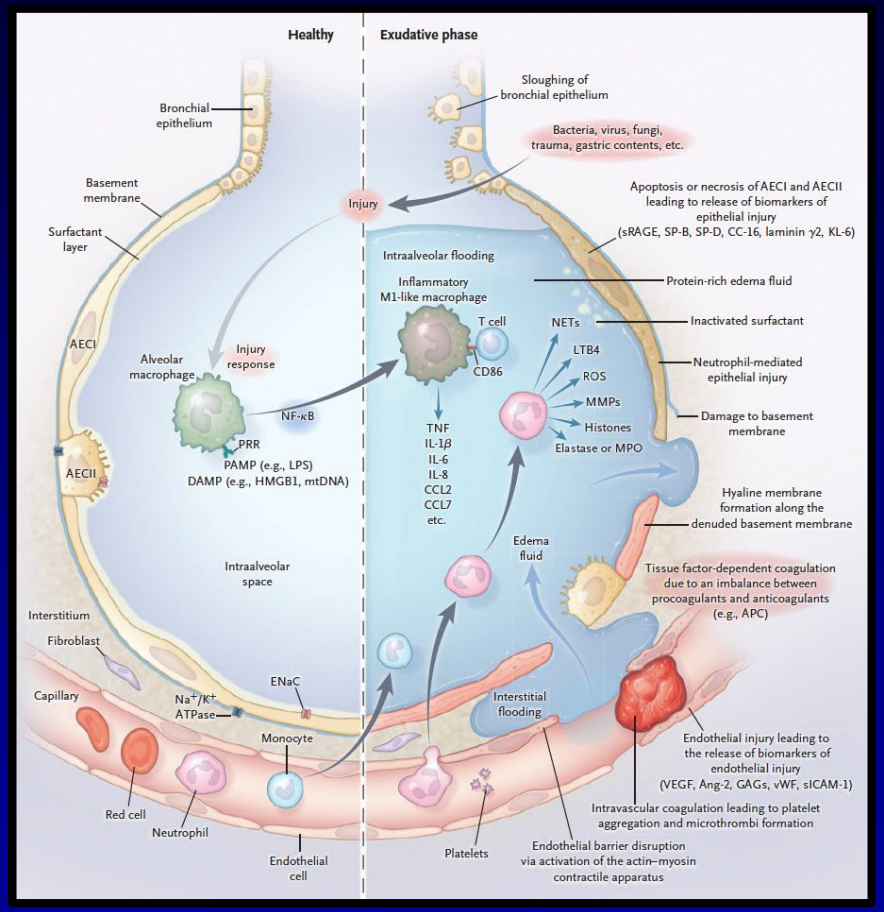
Tom Martin, MD

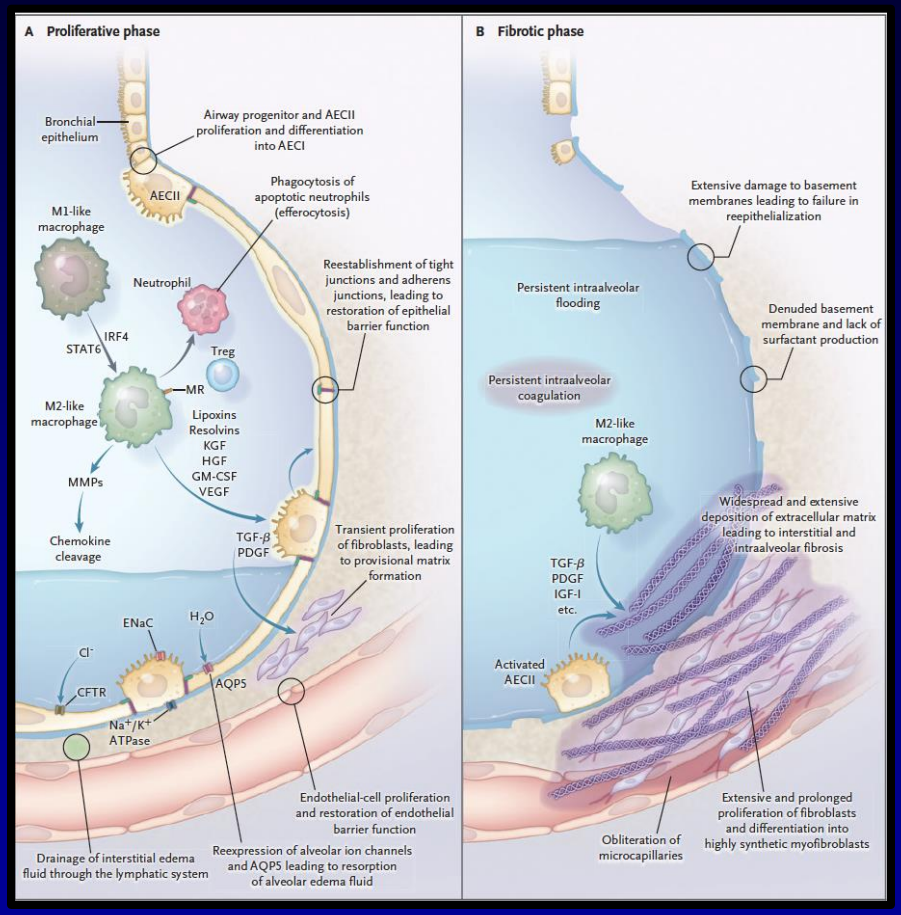
Localization of ACE2 Receptor



J. Pathol 203:631 – 637, 2004.

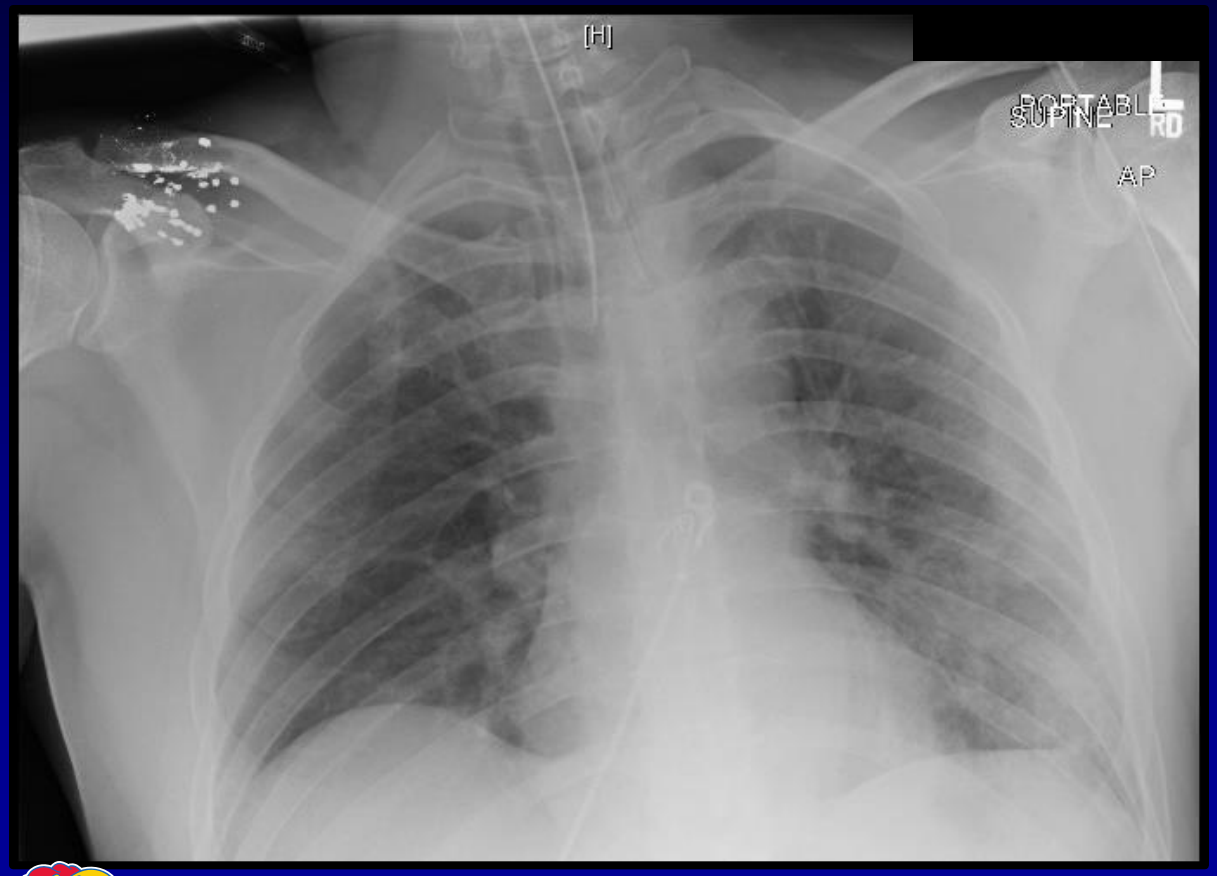
Phases of ARDS





N ENGL J MED 377;6 NEJM.ORG AUGUST 10, 2017

ARDS, or Not?



Admission:

50 y.o. man

PaO_2/FiO_2 = 107

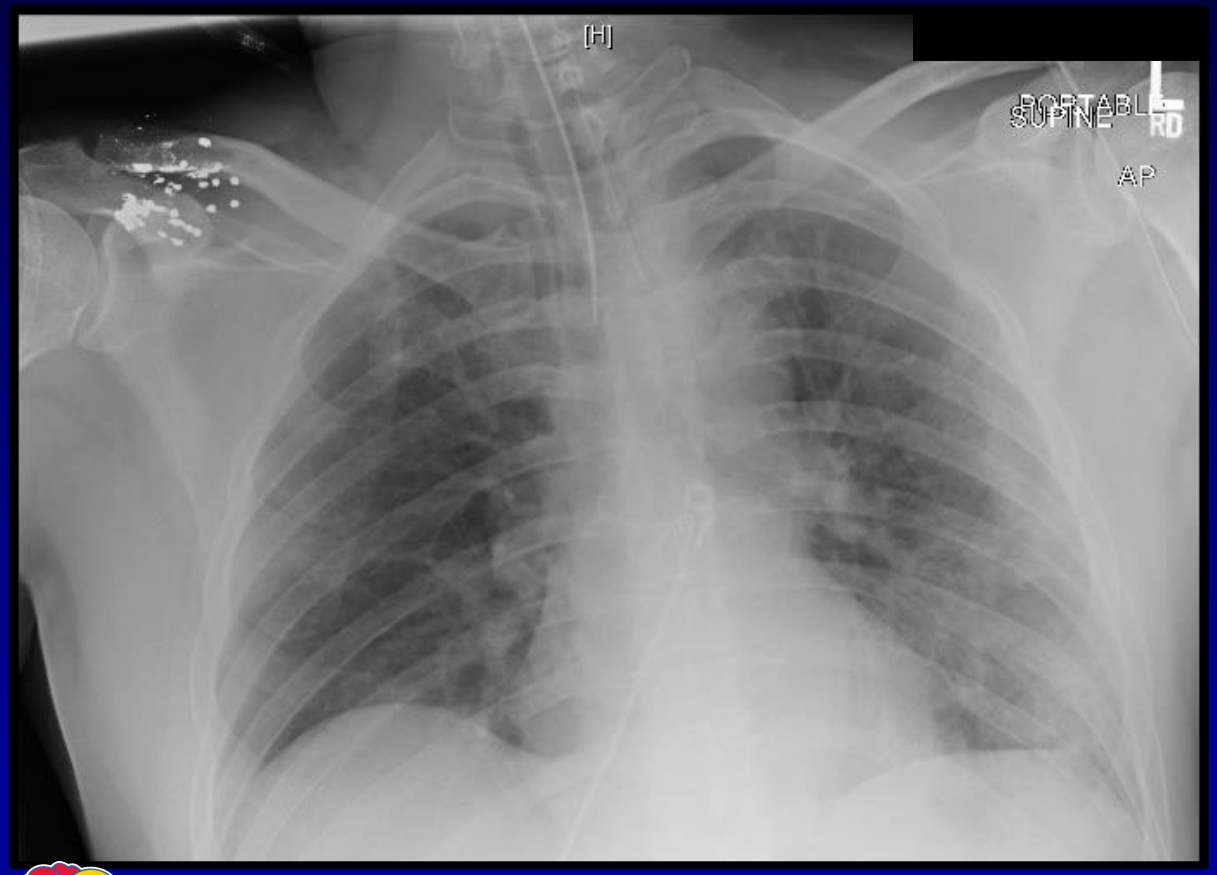
Driving Pressure: 12 cm H_2O

VT: 430 mL (5 mL/kg)

PEEP: 8 cm H_2O

PIP: 20 cm H_2O

ARDS, or Not?



Admission:
50 y.o. man
PaO_2/FiO_2 = 107
Driving Pressure: 9 cm H_2O
VT: 430 mL (5 mL/kg)
PEEP: 8 cm H_2O
PIP: 20 cm H_2O

4 Days Later:
PaO_2/FiO_2 = 128
Driving Pressure: 35 cm H_2O
VT: 447 mL (5.25 mL/kg)
PEEP: 10 cm H_2O
PIP: 45 cm H_2O

Surviving Sepsis Guidelines for COVID-19

30	In mechanically ventilated adults with COVID-19 and ARDS, we ***recommend*** using low tidal volume (Vt) ventilation (Vt 4-8 mL/kg of predicted body weight), over higher tidal volumes (Vt>8 mL/kg).	Strong
31	For mechanically ventilated adults with COVID-19 and **ARDS**, we ***recommend*** targeting plateau pressures (Pplat) of < 30 cm H_2O.	Strong
32	For mechanically ventilated adults with COVID-19 and moderate to severe ARDS, we ***suggest*** using a higher PEEP strategy, over a lower PEEP strategy. **Remarks**: If using a higher PEEP strategy (i.e., PEEP > 10 cm H_2O), clinicians should monitor patients for barotrauma.	Strong
33	For mechanically ventilated adults with COVID-19 and ARDS, we ***suggest*** using a conservative fluid strategy over a liberal fluid strategy.	Weak
34	For mechanically ventilated adults with COVID-19 and **moderate to severe ARDS**, we ***suggest*** prone ventilation for **12 to 16 hours**, over no prone ventilation.	Weak

Crit Care Med 2020; XXX:00–00

Early or Late Intubation?

- Initial reports of rapid decompensation
- Risks of aerosol generation from HFNC and NIPPV
- Intubation is an aerosol generating procedure
- Desire controlled circumstances
- KU early efforts – also those of many top centers around the country
- 6 L/minute to Intubation

Surviving Sepsis Campaign: Guidelines on the Management of Critically Ill Adults with Coronavirus Disease 2019 (COVID-19)

Ventilation:

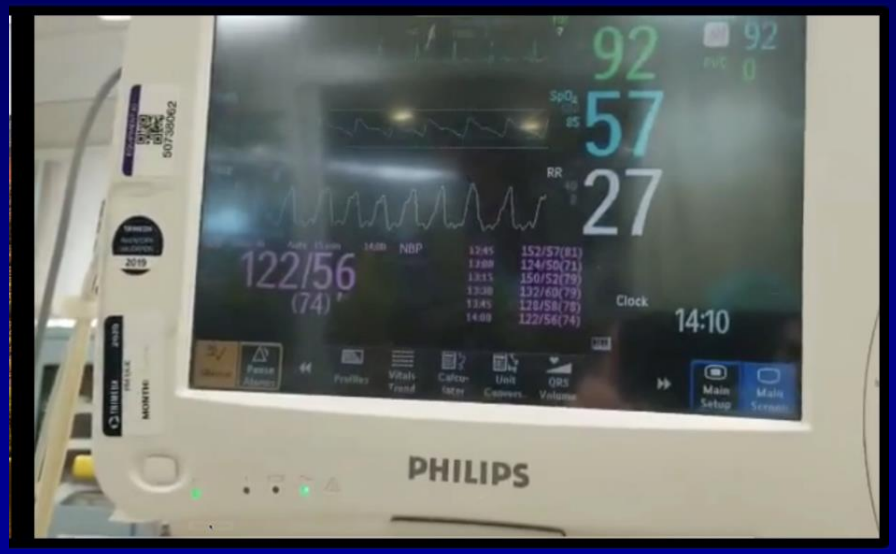
23	In adults with COVID-19, we ***suggest*** starting supplemental oxygen if the peripheral oxygen saturation (Spo_2) is < 92%, and ***recommend*** starting supplemental oxygen if Spo_2 is < 90%	Weak Strong
24	In adults w... ***mend*** t...	...ong
25	For adults ... oxygen ...	...eak
26	In adults w... over NI...	...eak
27	In adults w... and ther... close monitoring and short interval assessment for worsening of respiratory failure.	...eak
28	**We were not able to make a recommendation** regarding the use of helmet NIPPV compared with mask NIPPV. It is an option, but we are not certain about its safety or efficacy in COVID-19.	No recommendation
29	In adults with COVID-19 receiving NIPPV or HFNC, we ***recommend*** close monitoring for worsening of respiratory status, and early intubation in a controlled setting if worsening occurs.	Best practice statement

Federal Guidelines (NIAID):

1) Intubation is an aerosol generating procedure; all should be in airborne precautions
2) To avoid multiple passes, the operator should be very experienced, if at all possible

Crit Care Med 2020; XXX:00–00

Is There "Bland" Hypoxemia?



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The New England
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Volume 33

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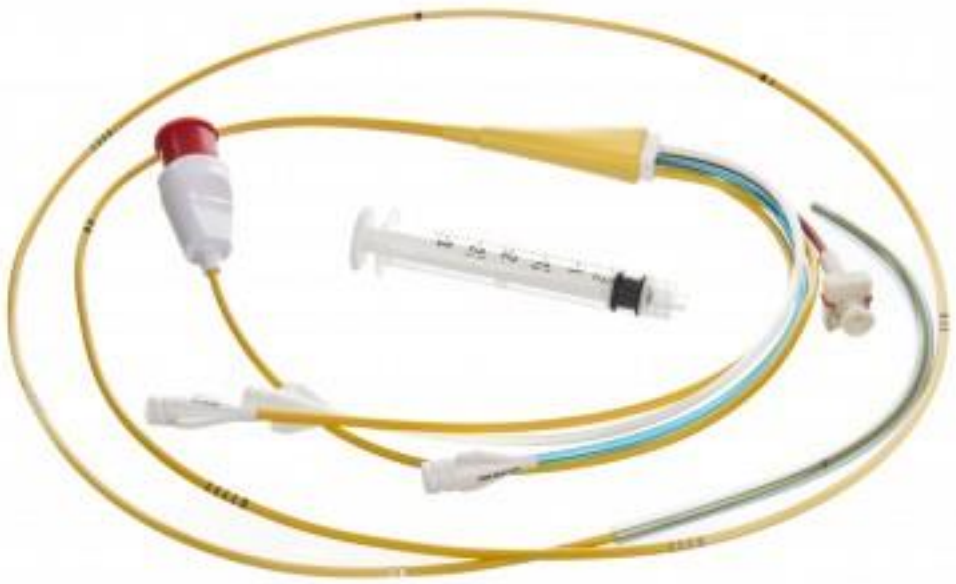


rd MD;

Author Information

Critical Care Medicine: February 1998 - Volume 26 - Issue 2 - p 409-414

How Should We Manage Fluids?

Fluid Therapy

Recommendation:

8. In adults with **COVID-19 and shock**, we ***suggest*** using dynamic parameters skin temperature, capillary refilling time, and/or serum lactate measurement over static parameters in order to assess fluid responsiveness (weak recommendation, low-quality evidence).

Crit Care Med 2020; XXX:00–00

"Perfusion"

Supply

$\dot{D}O_2 = CO \times Hgb(SaO_2)1.36$

$SV \times HR \times Hgb(SaO_2)1.36$

Only SV can be "directly" altered with IV fluids

Why give IV Fluids?

The principal, perhaps the only reason to administer IV fluids in the resuscitation of sepsis (or any other shock state) is to increase the stroke volume.

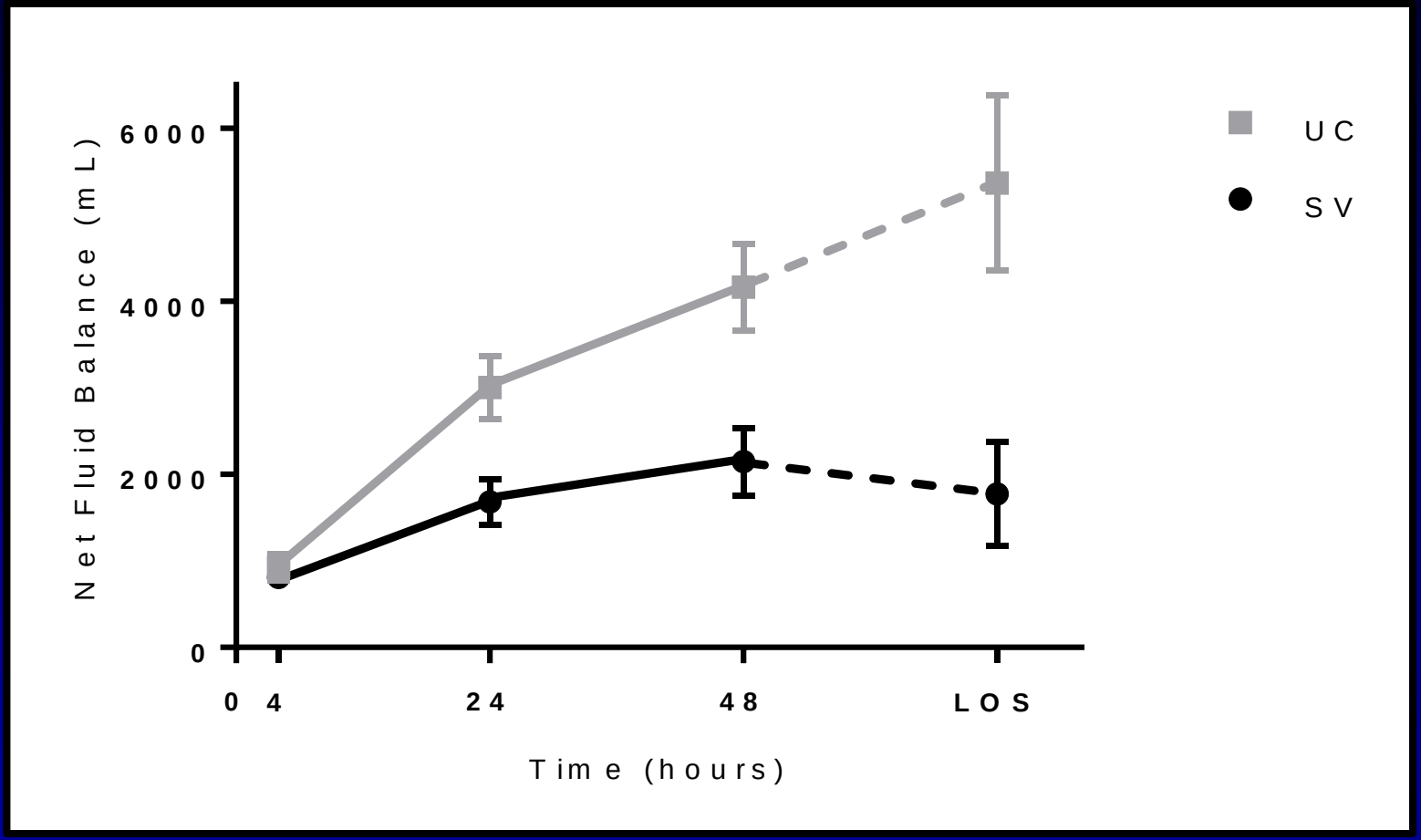
Stroke volume guided resuscitation in severe sepsis and septic shock improves outcomes

Heath E. Latham [a,*], Charles D. Bengtson [a], Lewis Satterwhite [a], Mindy Stites [b], Dipti P. Subramaniam [c], G. John Chen [c], Steven Q. Simpson [a]

- Stroke volume protocol:
  - Initial assessment via passive leg raise or 500 mL crystalloid bolus
  - If >10% increase give 500 mL bolus
  - Repeat until bolus fails to result in SV increase, then stop – with no maintenance fluid rate

Journal of Critical Care 42 (2017) 42–46

KU Data – Septic Shock



Journal of Critical Care 42 (2017) 42–46

Comparison of SV vs UC for patient outcomes in univariate analyses.

Patient outcomes	SV	UC	p-Value
Net-fluid balance – 4 h	808 ± 118 mL	926 ± 153 mL	0.54
Net-fluid balance – 24 h	1.68 ± 0.27 L	3.00 ± 0.36 L	0.004
Net-fluid balance – 48 h	2.14 ± 0.39 L	4.16 ± 0.50 L	0.002
Net-fluid balance – ICU LOS	1.77 ± 0.60 L	5.36 ± 1.01 L	0.002
In-hospital mortality	21/100 (21)	18/91 (20)	0.86
ICU LOS – all patients (days)	6.22 ± 0.58	8.91 ± 0.96	0.015
ICU LOS – survivors (days)	5.98 ± 0.68	8.87 ± 1.18	0.03
Mechanically ventilated	29/100 (29)	52/91 (57)	0.0001
Ventilator days	6.28 ± 1.40	6.71 ± 0.67	0.76
Vasopressor initiated	48/100 (48)	52/91 (57)	0.25
Vasopressor duration (hours)	32.08 ± 5.22	64.86 ± 8.39	0.001
Acute dialysis initiated[a]	6/96 (6.25)	16/82 (19.5)	0.01

Journal of Critical Care 42 (2017) 42–46

Reasonable Recommendation

1. Many patients appear to be intravascularly depleted at presentation
2. Some fluid is likely important
3. Without a PA catheter, without a means for evaluating SV?
4. Begin with 1 to 1.5 L of LR; ask patient to drink; re-assess via oxygenation, BP, capillary refill

The NEW ENGLAND JOURNAL of MEDICINE

Covid-19 in Critically Ill Patients in the Seattle Region — Case Series

Vital signs on ICU admission — no./total no. (%)	
Temperature >100.4°F or 38°C	12/24 (50)
Heart rate >100 beats per min‖	11/23 (48)
Respiratory rate ≥20 breaths per min‖	19/23 (83)

Lowest Pao_2:FIo_2 ratio during mechanical ventilation — median (IQR)‡	
Day 1	142 (94–177)
Day 2	139 (112–171)
Day 3	134 (108–171)

17/24 (71%) Hypotensive and requiring vasopressor at admission

Bhatraju, PK, et al. NEJM, 2020.

The NEW ENGLAND JOURNAL of MEDICINE

Covid-19 in Critically Ill Patients in the Seattle Region — Case Series

Outcomes	
Median length of stay (IQR) — days	
In hospital	12 (8–18)
In ICU	9 (4–14)
In hospital, survivors	17 (16–23)
In ICU, survivors	14 (4–17)
Median duration of mechanical ventilation (IQR) — days	
Overall	10 (7–12)
In patients who were extubated	11 (7–12)
Extubated — no./total no. (%)	6/18 (33)
Died in hospital — no. (%)	12 (50)
Discharged from hospital — no. (%)	5 (21)

Bhatraju, PK, et al. NEJM, 2020.