Hospital Internal Medicine Meets Critical Care: Patient Cases

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MAYO CLINIC

Disclosures

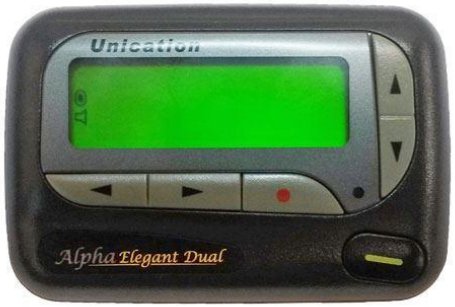
- This presentation has no affiliation or financial arrangements.
- Off-label use of two medications will be mentioned.

Objectives

- Identify patients who warrant evaluation by a critical care team and discuss early resuscitative measures.
- Evaluate the patient with early sepsis.
- Recognize acute respiratory failure and review and initial management strategies.
- Determine which types of shock can occur simultaneously.
- Learn how an arterial blood gas can assist in clinical decision making.

Time to start your work day!

- You are a busy hospital internal medicine NPPA and just arrived at work.
- You turn on your pager and within **seconds**, you recognize the familiar tone of a page…



Mr. Wilson

- 67M with hx nephrolithiasis, DM2, HTN who presented a few hours ago with **nausea** and vague **abdominal pain**.
- He remains hypotensive, despite 3 L of IV fluids in the ER
- A rapid response is called due to persistent hypotension

Rapid response

- You rush to bedside to find the following:
  HR: 120, NSR
  RR: 30s
  BP: 72/41 (51)
  Temp: 38.6 C
  O2: 93% on RA

Early signs of sepsis

- Fever or hypothermia
- **Tachypnea**, hypoxia
- Cold, clammy skin, poor cap refill
- **Tachycardia**
- **Hypotension**
- Hyper/hypoglycemia
- Decreased UOP

Gauer, Early Recognition and Management of Sepsis In Adults: the first six hours. AFP. 2013 July 1; 88 (44-53)

Battle of the Sepsis Scoring Systems

Sepsis Scoring Systems: Which do I use?

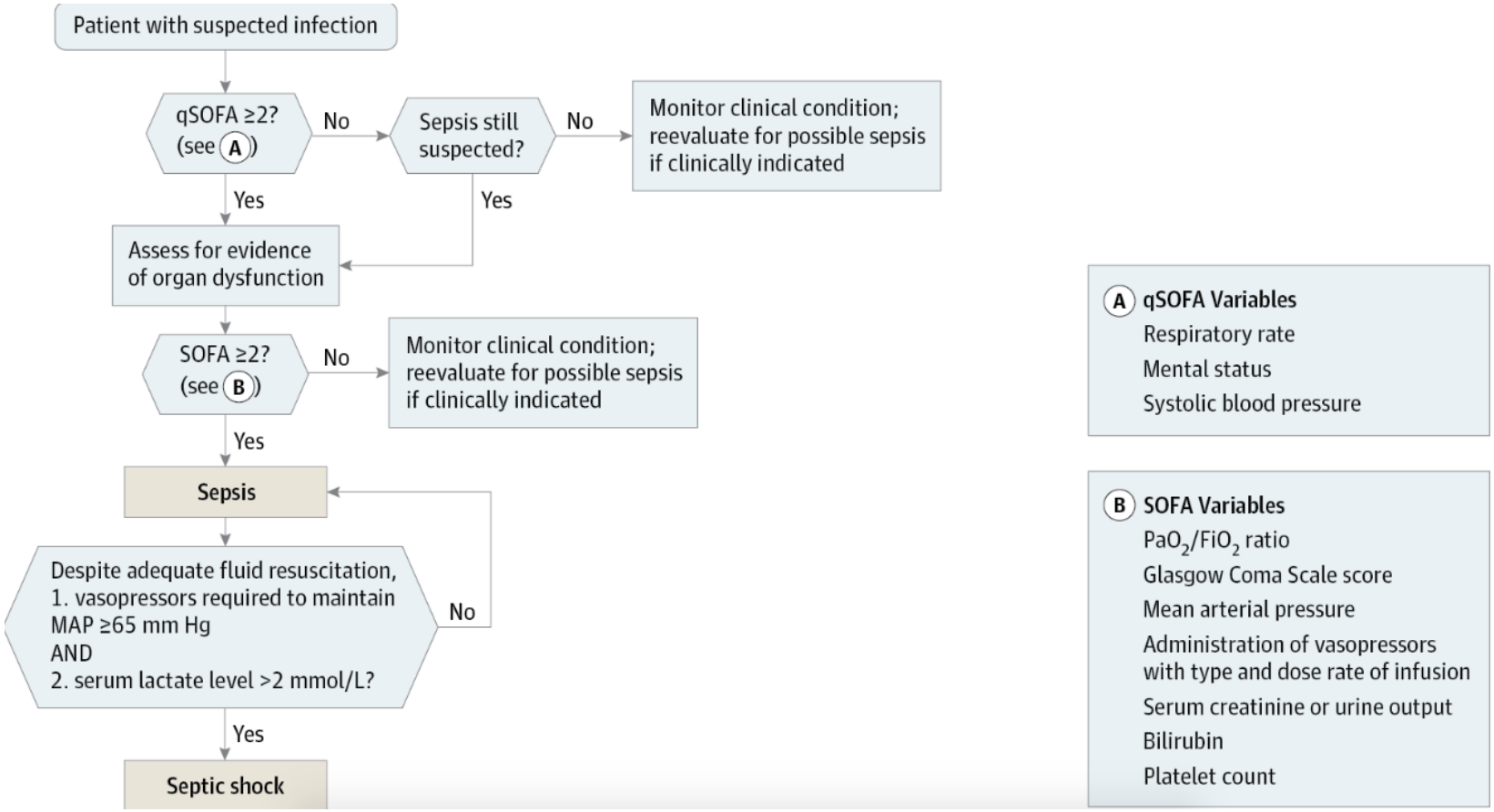
- SIRS → Sepsis → Severe Sepsis → Septic Shock → MODS/MSOF

- **qSOFA score (range 0-3)**: 1 point each for:
  - systolic hypotension (<100)
  - tachypnea (>22)
  - altered mental status

- **SOFA score:** PaO2, FiO2, PLT, GCS, Bilirubin, Creatinine, Vasopressor requirement

Raith, EP. JAMA Jan 2017; 317(3): 290-300

How do I use the SOFA score?



Singer M, Deutschman CS, Seymour CW, et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA*. 2016;315(8):801–810.

Resuscitation

- Physiology stabilization and resuscitation precedes definitive diagnosis & treatment of underlying cause

- What are your initial interventions for Mr. Wilson?

2018 Surviving Sepsis Bundle Update

One-hour Bundle

- Measure lactate level. Remeasure if initial lactate is >2 mmol/L.
- Obtain blood cultures prior to administration of antibiotics.
- Administer broad-spectrum antibiotics.
- Begin rapid administration of 30ml/kg crystalloid for hypotension or lactate ≥4 mmol/L.
- Apply vasopressors if patient is hypotensive during or after fluid resuscitation to maintain MAP ≥65 mm Hg.

**"Time zero" or "time of presentation" is defined as the time of triage in the Emergency Department or, if presenting from another care venue, from the earliest chart annotation consistent with all elements of sepsis (formerly severe sepsis) or septic shock ascertained through chart review.*

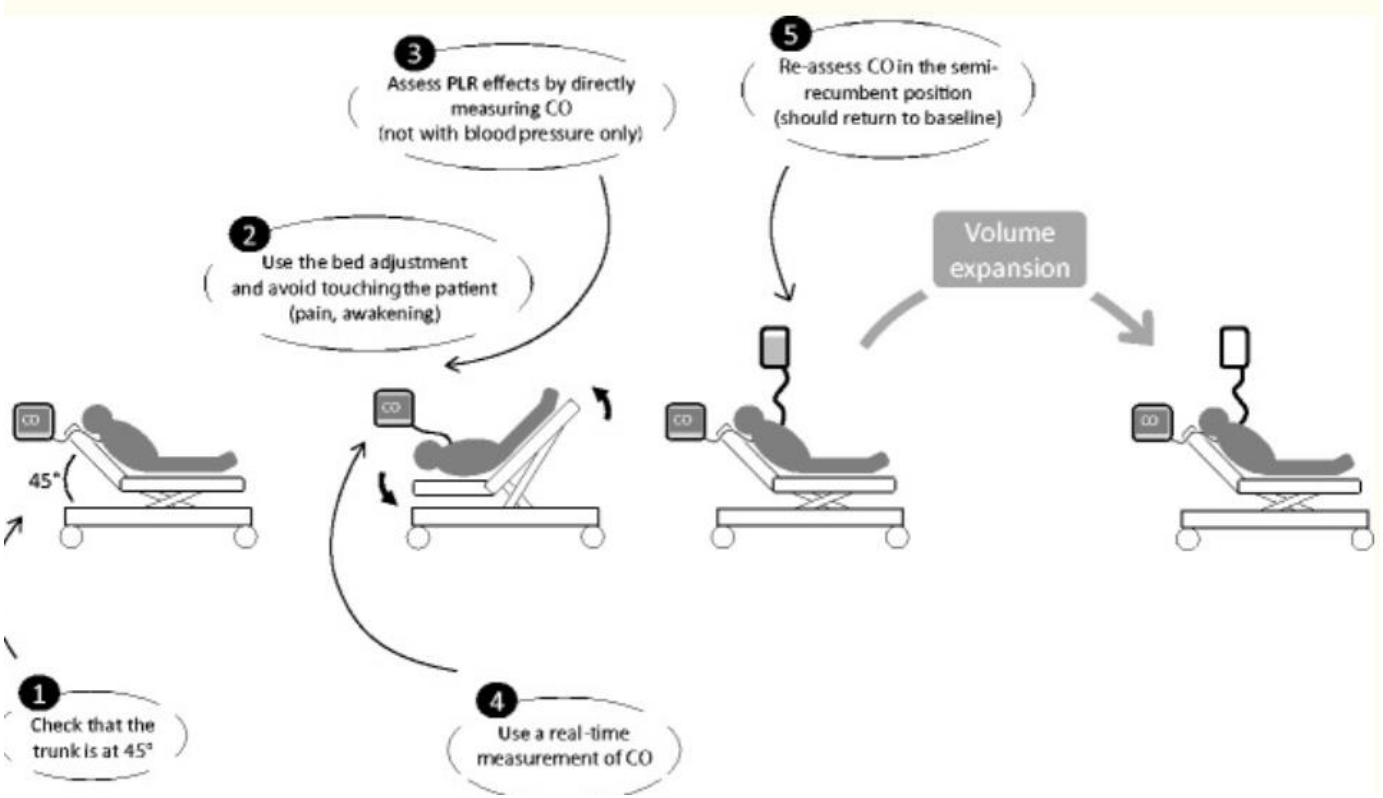
Crit Care Med 2018;46(6):997

Resuscitation

- Mr. Wilson is still hypotensive, despite the 3L of fluid he received, what are some strategies to assess fluid status?

Fluid vs. Pressors

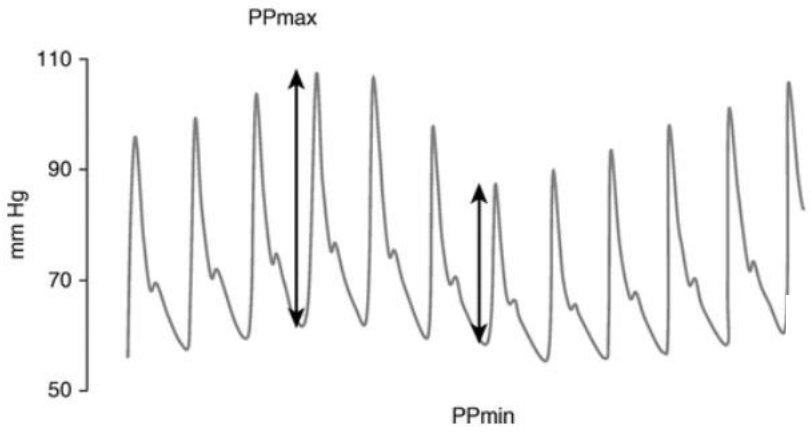
Passive Leg Raise

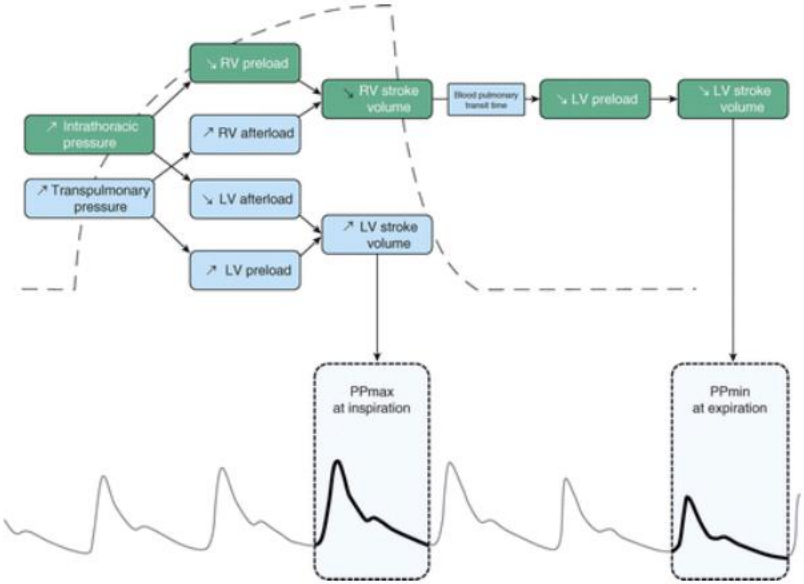


Monnet, Teboul. Crit Care. 2015; 19(1): 18.

Pulse Pressure Variability

$$PPV = \frac{PPmax - PPmin}{(PPmax + PPmin) / 2}$$





Jean-Louis Teboul et al. American Journal of Resp and Critical Care Medicine. Volume 199, Issue 1. 2018. https://doi.org/10.1164/rccm.201801-0088CI

Unfortunately, Mr. Wilson remains hypotensive, plus he develops increased work of breathing…

In the ICU…

- Patient becomes more tachypneic, increased work of breathing with some hypoxia
  - ABG on nasal cannula: 7.21/23/55/9
- Intubated & started on pressors
  - **Would you have intubated this patient??**

Progressive shock

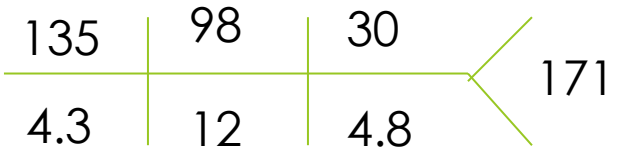
- Central line and arterial line placed
  - Started on pressors: norepinephrine first, then vasopressin added
- Workup for source of infection only c/w abnormal UA.
  - Sent to CT for CT head/chest/abd/pelvis
  - **Would you have sent this patient to CT?**

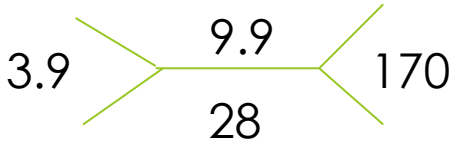
ICU Course

- Labs:

  AST 1670

  ALT 1455





- CT A/P: Obstructive R renal calculus, 8x6mm with mild R hydroureteronephrosis
  - STAT IR placement of R nephrostomy tube

ICU Course

- No longer making urine → worsening metabolic acidosis → started on CRRT

ICU Course

What are some other options to treat Mr. Wilson's refractory vasodilatory shock?

- Stress dose steroids[1]
- Other pressors:
  - Angiotensin II?
    - ATHOS-3 trial
- HAT (Hydrocortisone, Vit C, & Thiamine) therapy is **NOT** recommended
  - ACTS trial[2]
  - CITRIS-ALI trial[3]
  - VICTAS trial[4]

[1]Sprung CL, et al. Hydrocortisone therapy for patients with septic shock. N Engl J Med. 2008 Jan 10;358(2):111-24
[2]JAMA 2020;324(7):642
[3]JAMA 2019;322(13):1261
[4]JAMA 2021;325(8):742

*** Off-label use!**

ICU Course

What are some other options to treat Mr. Wilson's refractory vasodilatory shock?

- Methylene Blue*
- Hydroxycobalamin (CyanoKit)*

Kwok ESH, Howes D. *Journal of Intensive Care Medicine*. 2006;21(6):359-363
Park BK, Shim TS, Lim CM, et al. . *Korean J Intern Med*. 2005;20(2):123-128.
Can J Anaesth. 2017 Jun;64(6):673-674.
J Cardiothorac Vasc Anesth. 2018 Aug 11
Feih, et al. Journal of Cardiothoracic and Vascular Anesthesia, Volume 33, Issue 5, 2019,Pages 1301-130

Mr. Wilson

- After nephrostomy tube placement, started to improve slowly.
- UOP starting to pick up
- Pressors weaned
- Extubated

- Transferred to medical floor on hospital day #2.

Just as you are about to get a coffee…you get another page!

Mr. Lewis

- 79yo male with history of **COPD**, admitted a few hours ago with generalized **weakness, nausea, vomiting and abdominal pain.**
  - He received 2 doses of **morphine** for the abdominal pain and some **IVF** (in the ED).
  - CT abdomen is pending.

- His bedside nurse is calling you in a panic because he is now slow to respond and slurring his speech.

Mr. Lewis

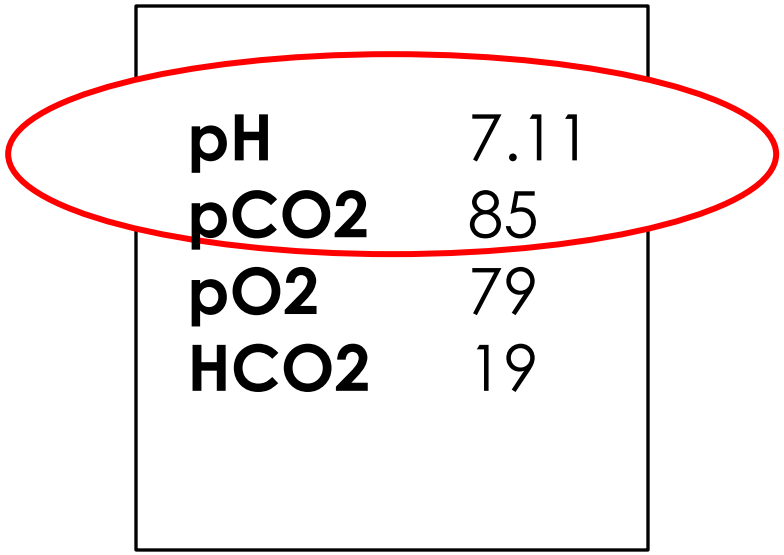
- You arrive to find him arousable to sternal rub, but otherwise extremely lethargic.
- His nurse tells you he had vomited twice right before this change in mental status.
- **What do you think could be going on and what is your initial workup?**

Altered mental status

- **A** Alcohol, ammonia, Alzheimer's
- **E** Endocrine, electrolyte abnormalities
- **I** Infection, intoxication
- **O** Opiates, oxygen, C**O**2
- **U** Uremia
- **T** Tumor, trauma, toxins
- **I** Insulin
- **P** Psych/psychogenic
- **S** Stroke, seizure, syncope, shock

How do we assess if a patient is able to “protect their airway”?

ABG



Mr. Lewis

- While you are getting your labs results, he becomes entirely unresponsive (even to painful stimulus) .
- Intubated and transferred to the ICU.

Is there a non-invasive ventilation strategy that would have been helpful here?

High Flow Nasal Cannula

- Enhances gas exchange
- More comfortable than BiPAP
- Improves work of breathing
- Decreased intubation rates

Briel M, Higher vs lower PEEP in patients with ALI and ARDS. JAMA 2010; 303:865-873

BiLevel Positive Airway Pressure (BiPAP)

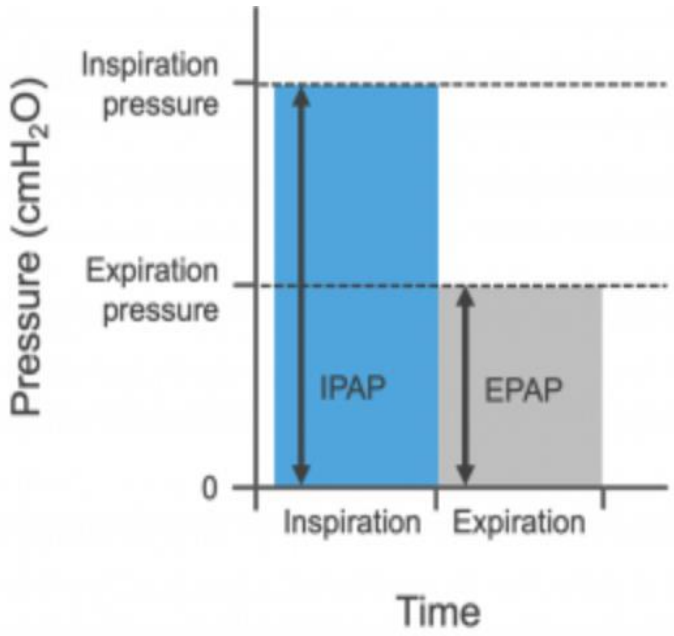
INDICATIONS	CONTRAINDICATIONS
• Hypercapnia and acidosis • Cardiogenic pulmonary edema • COPD/asthma exacerbation • Weaning and post-extubation failure • Post surgical period • Obesity hypoventilation syndrome • Neuromuscular disorders • Poor alveolar oxygen exchange	• Cardiac or respiratory arrest • Hemodynamic instability • Inability to protect the airway • Patient who is unable to cooperate • Severe encephalopathy • Significant agitation • High risk of aspiration • Active upper GI hemorrhage • Facial trauma, recent surgery and/or burns

Liesching, Timothy et al. CHEST , Volume 124 , Issue 2 , 699 - 713

BiPAP

HOW DOES IT WORK?

- Utilizes two levels of positive airway pressure combining pressure support ventilation (PSV) and continuous positive airway pressure (CPAP)
  - The PSV modality is referred to as IPAP (inspiratory positive airway pressure)
  - The CPAP modality is referred to as EPAP (expiratory positive airway pressure)
- The difference between these two pressure levels (**Δ** P) determines tidal volume generated.



Mechanical Ventilation. FCCS 5th Ed. SCCM, 2012. pp 5-3

Image: https://www.medmastery.com/guide/noninvasive-ventilation-clinical-guide/deciphering-acronyms-noninvasive-ventilation-niv

BIPAP

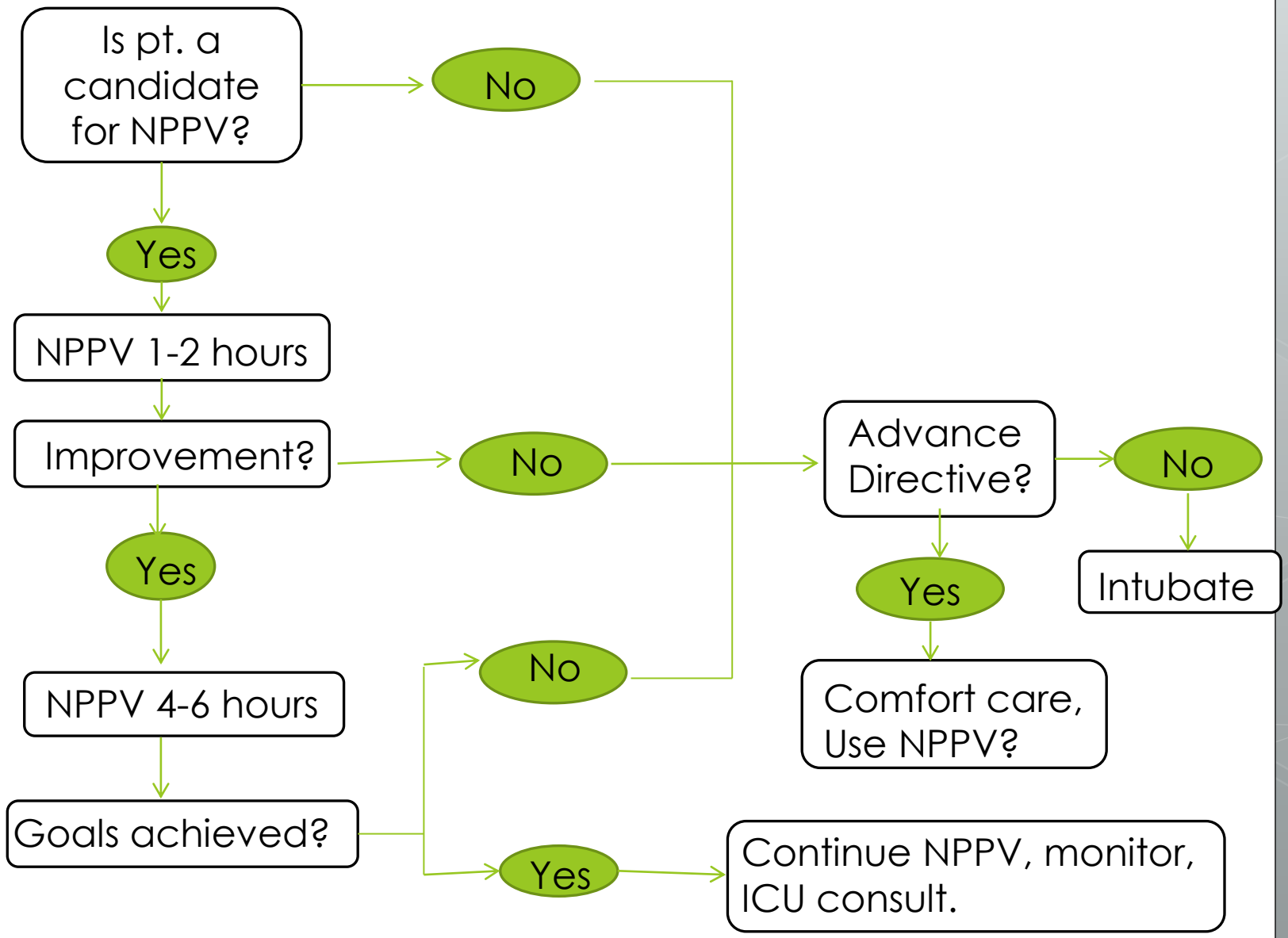
HOW DOES IT WORK?

- Example for initial BiPAP settings:
  - Mode: Spontaneous
  - Trigger: Maximum sensitivity
  - FiO2: 1.0
  - EPAP: 5 cm H2O
  - IPAP: 10-15 cm H2O
  - Backup rate: 6-8/min

Adjust **Δ** to achieve an effect V_T and CO_2 clearance

if oxygenation needs improving, increase EPAP for alveolar recruitment (however, will then need to also adjust IPAP to keep the same **Δ)

Mechanical Ventilation. FCCS 5th Ed. SCCM, 2012. pp 5-3



Mechanical Ventilation. FCCS 5th Ed. SCCM, 2012. pp 5-7

The second you sit down to try to write some notes….

Ms. Burton

- 72yo female admitted with what seemed to be a straightforward CAP.
- Unfortunately, her course was complicated by an **aspiration** event that required a brief stay in the ICU where she received **mechanical ventilation** x 3 days.
- She is now on the hospital medicine service, where she continues to improve on **pipercillin/tazobactam.**

Ms. Burton

- Your page is from the patient's nurse, stating she had a fever of 38.9°C four hours ago.
- She tried to call the attending and didn't get through, so nothing has been done for the fever.
- Her other vitals:
  - **HR** 110 **BP** 83/52 **RR** 30 **SpO2** 99% 2L NC

What's your next step?

Initial Resuscitation

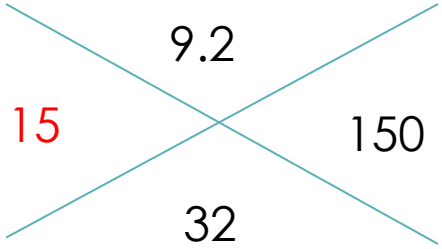
- **30 mL/kg crystalloids** within the first 3 hours if evidence of hypoperfusion
- Dynamic reassessment of volume status
- Target MAP ≥ 65 mm Hg
- Goal is to clear lactate
- **Crystalloids first!**
  - ? Albumin

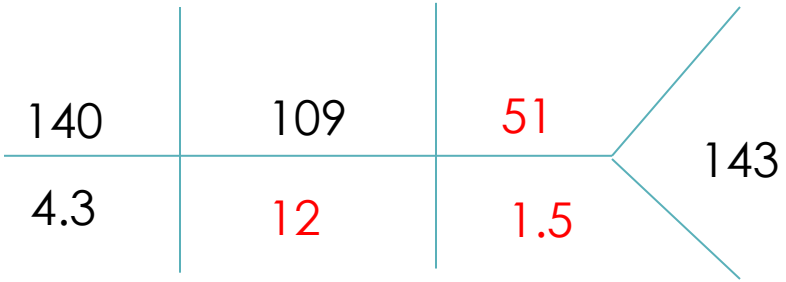
Which IV fluid should I use?

- **SMART trial, 2018**
  - **Balanced crystalloids (LR, Plasma-lyte) >> NS**
    - Balanced fluids (compared to NS) had:
      - Lower 30-day mortality
      - Less need for renal-replacement therapy
      - Lower rate persistent renal dysfunction
- **ALBIOS trial**
  - Adding albumin to crystalloid is safe, but there's no difference in mortality, new organ failure, or LOS at 28 and 90 days.

N Engl J Med 2018;378:829 & NEJM 2014;370(15):1412 7 *AMA*. 2013;310(17):1809-1817.

Ms. Burton



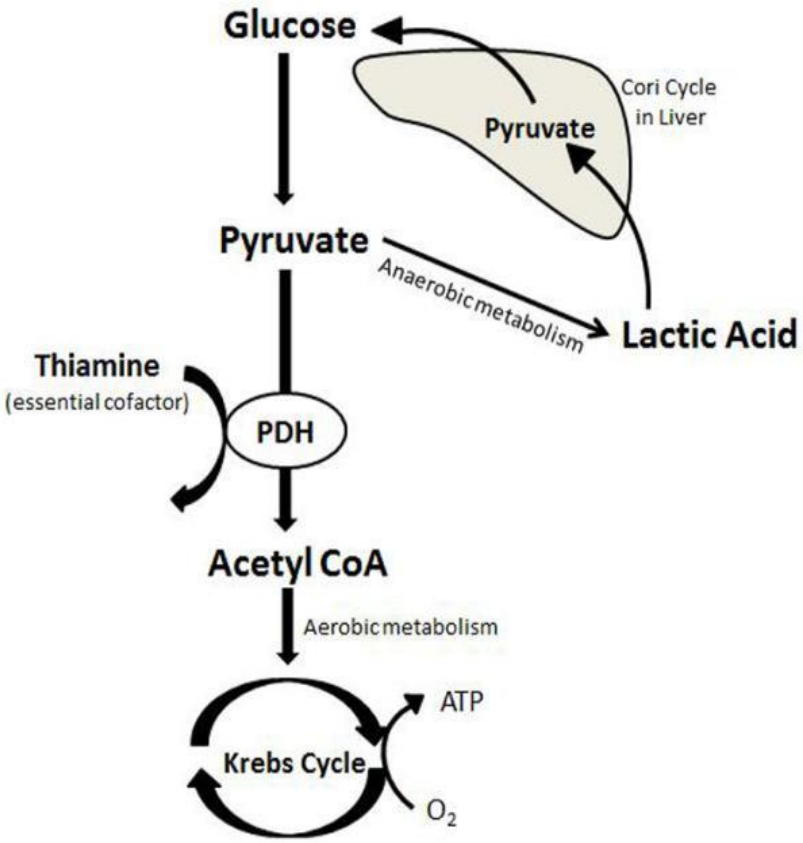


Lactate: 8.7

Procalcitonin: 5

Lactate

- Produced by most tissues (mostly muscle)
- Cleared mostly by the liver.



Causes of elevated lactate

- **Shock**
- **Post-cardiac arrest**
- **Regional tissue ischemia**
  - Mesenteric ischemia
  - Limb ischemia
  - Burns
  - Trauma
  - Compartment syndrome
  - Necrotizing soft tissue infections
- **DKA**
- **Drugs/toxins**
  - Alcohols
  - Cocaine
  - CO
  - Cyanide
- **Thiamine deficiency**
- **Medications**
  - Linezolid
  - NRTIs
  - Metformin
  - Epinephrine
  - Propofol
  - Acetaminophen
  - Beta2 agonists
  - Theophylline
- **Anaerobic muscle activity**
  - Seizure
  - Heavy exercise
  - Increased WOB/asthma exacerbation
- **Malignancy**
- **Liver insufficiency**
- **Mitochondrial disease**

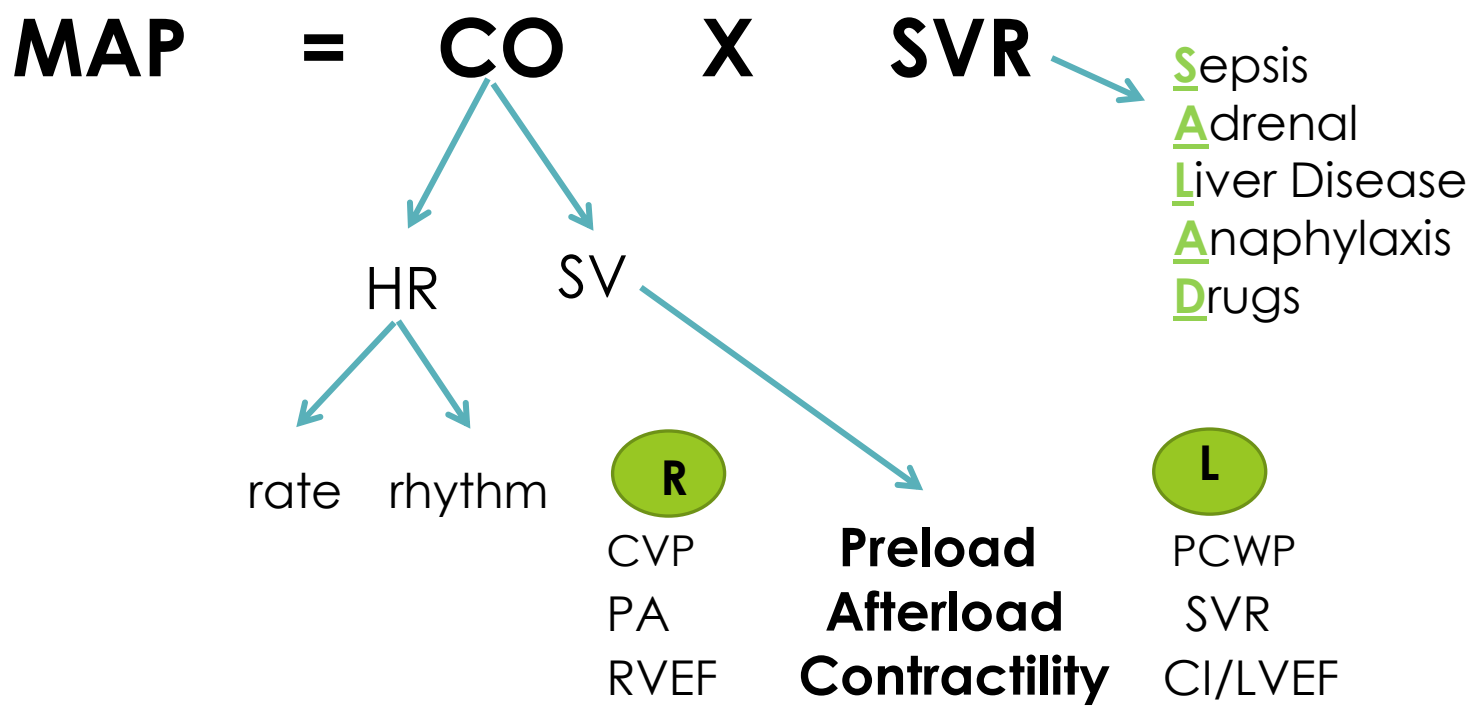
Lactate Clinical Pearls

- Lactate ≥4mmol/L is associated with an increased mortality within 72 hours
- Lactate clearance has a greater prognostic value than the initial lactate level
- Can obtain by either arterial or venous samples

Ms. Burton

- She continues to have a fever of 38.7 even after a dose of Tylenol.
- After you give her a 500cc fluid bolus…her BP is still low at 87/49.

Hypotension



SVO2/ScVO2

- SVO2 = venous O2 saturation
  - The amount of O2 "left over" after the tissues have used up everything they need
  - Normal = 65-70%

- A true SVO2 is drawn from a PA catheter, but you can get an ScVO2 from any central line (including PICC)

SVO2

High SVO2

- ↑**O2 delivery** (increased FiO2)
- ↓**O2 demand** (hypothermia, anesthesia)
- **High flow states** (sepsis, hyperthyroid, etc)

Low SVO2

- ↓ **O2 delivery**
  - ↓ Hgb
  - ↓ SaO2 (hypoxemia)
  - ↓ forward flow (heart failure)
- ↑ **O2 demand** (hyperthermia, shivering, pain, seizures)

Hypotension Clinical Pearls

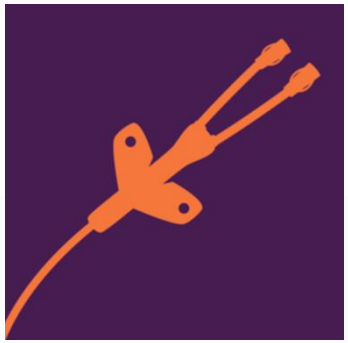
- Monitor clinical response by
  - UOP
  - Peripheral perfusion assessment
  - Mental status
  - Lactate/acidosis
- Not all patients with hypotension have shock!!

Ms. Burton

- Blood cultures started growing GPC within three hours
  - ScVO2 came back at 39%
  - Stat echo showed an EF of 25% (from a previous normal)

Did we even need the PICC?

DOWNLOAD MICHIGAN MAGIC - IOS



DOWNLOAD MICHIGAN MAGIC - ANDROID

You get a full 2 minutes to sit and attempt to write a note, when you are asked to do an ICU transfer….

- The patient is a 43 female, Ms. Smith, who has been in the ICU for the past **64 days** with COVID-19 ARDS….

Post ICU Considerations

- **PICS (Post ICU Syndrome)** = term that describes the cognitive, psychological, physical and other consequences that plague ICU survivors
  - Cognitive impairment occurs in 30-80% of ICU survivors
  - Anxiety, depression, PTSD occur in 8-57%
  - New physical impairments in 25-80%
  - Others can develop other new symptoms including: dyspnea and DOE, reduced exercise tolerance, sexual dysfunction, etc.

Colbenson GA, Johnson A, Wilson ME. Post-intensive care syndrome: impact, prevention, and management. Breathe 2019; 15: 98–101.

Prevention of PICS

- During ICU care:
  - **A**ssess & manage pain
  - **B**reathing trials & spontaneous awakening
  - **C**hoice of sedative (non-benzodiazepine)
  - **D**aily delirium monitoring
  - **E**arly mobility
  - **F**amily engagement & empowerment

Big emphasis on prevention & treatment of delirium

Colbenson GA, Johnson A, Wilson ME. Post-intensive care syndrome: impact, prevention, and management. Breathe 2019; 15: 98–101.

Treatment of PICS

- PICS clinics are becoming more prevalent & have had a lot of success with this patient population
  - Their aim is to help connect post ICU patients to the resources they need following discharge, to help them achieve the most successful recovery available to them

Post ICU Considerations

- **Opioid use after intensive care**
  - Study examined opioid-naïve patients, who received invasive mech vent in the ICU
  - 20% on opioids after hospital discharge
    - 7.6% from MICU, 33% from SICU
  - 2.6% filled the following year – new persistent opioid use
    - 1.3% from MICU, 4.1% from SICU

Take Home Point: Always assess need for opioids prior to discharge!

Wunsch H, et al. New Opioid Use after Invasive Mechanical Ventilation and Hospital Discharge. Am J Respir Crit Care Med 2020;202(4):568

Time to go home!

Questions?

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