Hospital Internal Medicine Meets Critical Care: Patient Cases

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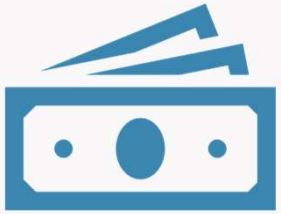
MAYO CLINIC

Disclosures



This presentation has no affiliation or financial arrangements.

Off-label use of medications will be mentioned.

Objectives

1. Identify patients who warrant evaluation by a critical care team and discuss early resuscitative measures.
2. Evaluate the patient with early sepsis.
3. Recognize acute respiratory failure and review and initial management strategies.
4. Determine which types of shock can occur simultaneously.
5. 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 history of 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
Cold, clammy skin, poor cap refill
Tachycardia
Hypotension
Hyper/hypoglycemia
Decreased UOP

AFP. 2013 July 1; 88 (44-53)

Battle of the Sepsis Scoring Systems

Sepsis Scoring Systems: Which Do I Use?

Surviving Sepsis:

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

qSOFA score (range 0-3) :

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

Soooo...which do I use?!

It is good to be familiar with **both**!

SIRS = more sensitive

SOFA = more specific

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.*

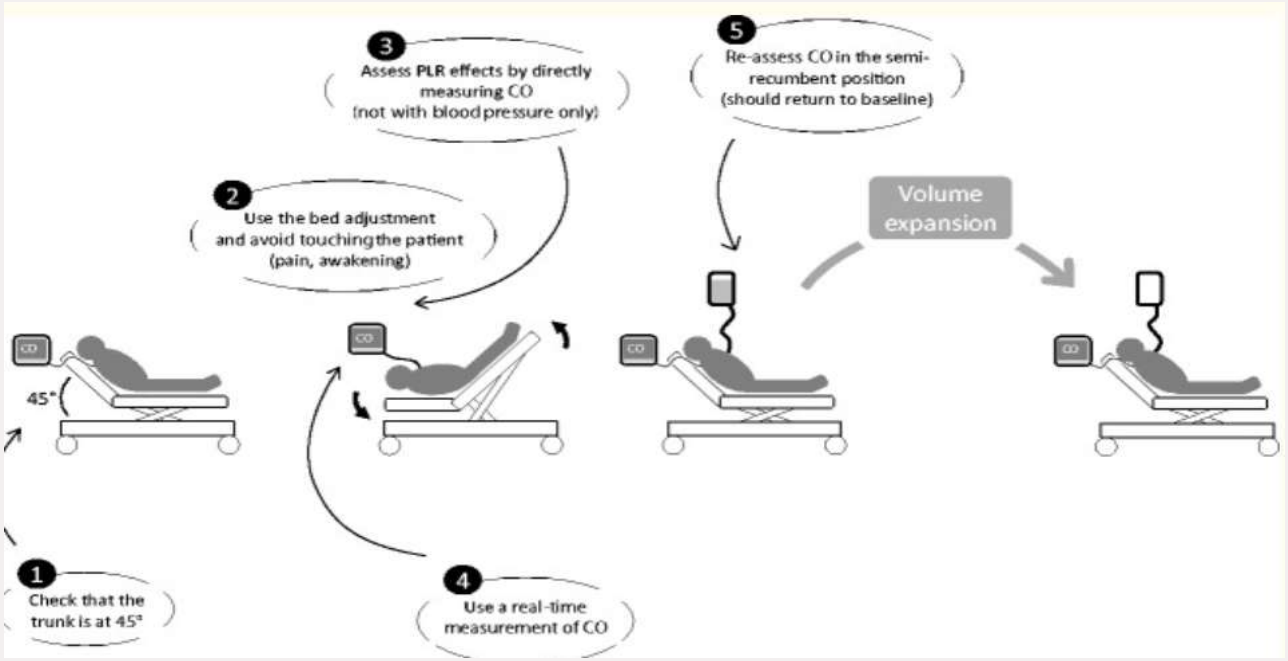
Crit Care Med 2018;46(6):997

Resuscitation

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

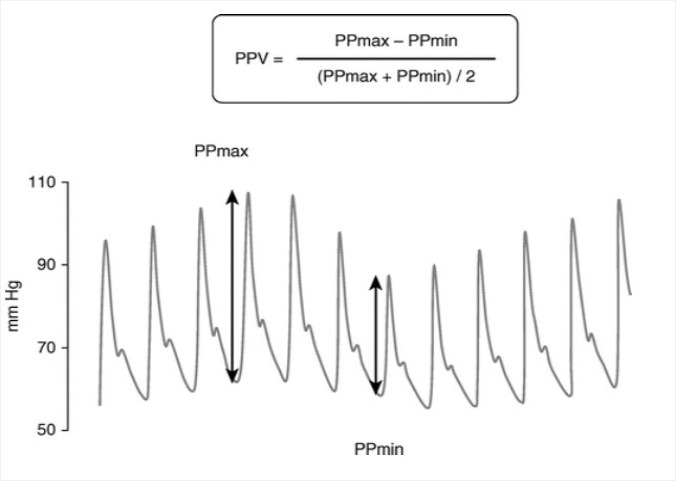
Fluid vs. Pressors

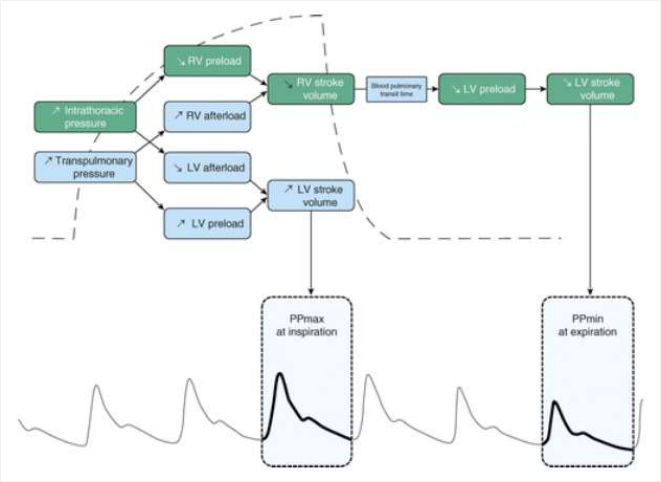
Passive Leg Raise



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

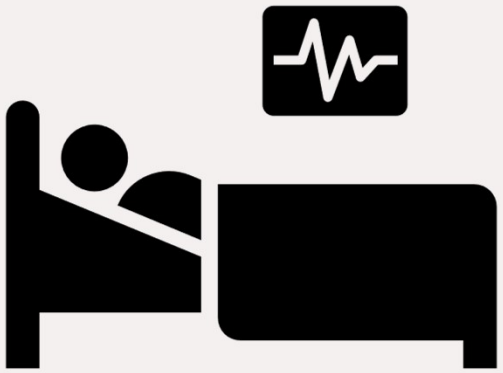
Pulse Pressure Variability





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…



ICU

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.

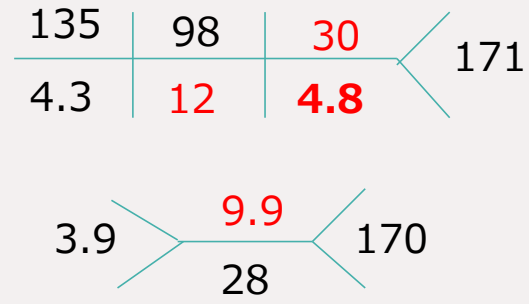
- Sent to CT for CT head/chest/abd/pelvis
- **Would you have sent this patient to CT?**

ICU Course

Labs:

ALT: 1455

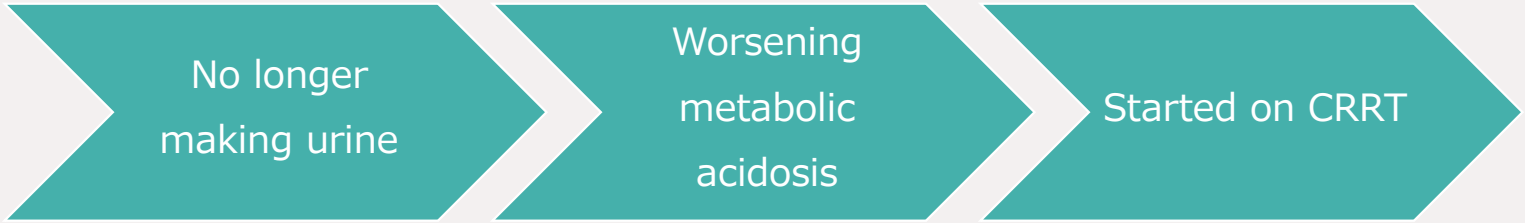
AST: 1670



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

Other pressors:
- Angiotensin II?
  - ATHOS-3 trial

HAT (Hydrocortisone, Vitamin C, & Thiamine) therapy is **NOT** recommended

[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

Mrs. Lewis

79yo female with history of **COPD**, admitted a few hours ago with generalized **weakness, nausea, vomiting and abdominal pain.**

- She received 2 doses of **morphine** for the abdominal pain and some **IVF** (in the ED).
- CT abdomen is pending.

Her bedside nurse is calling you in a panic because she is now slow to respond and slurring her speech.

Mrs. Lewis

You arrive to find her arousable to sternal rub, but otherwise extremely lethargic.

Her nurse tells you she 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

pH	7.11
pCO2	85
pO2	79
HCO2	19

Mrs. Lewis

While you are getting your labs results, she 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
- Provides some positive pressure
- Improves dead space
- Helps with mucociliary clearance

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

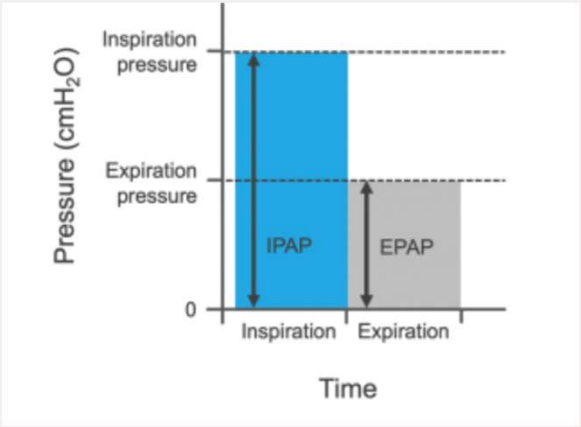
BiPAP

HOW DOES IT WORK?

Utilizes 2 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

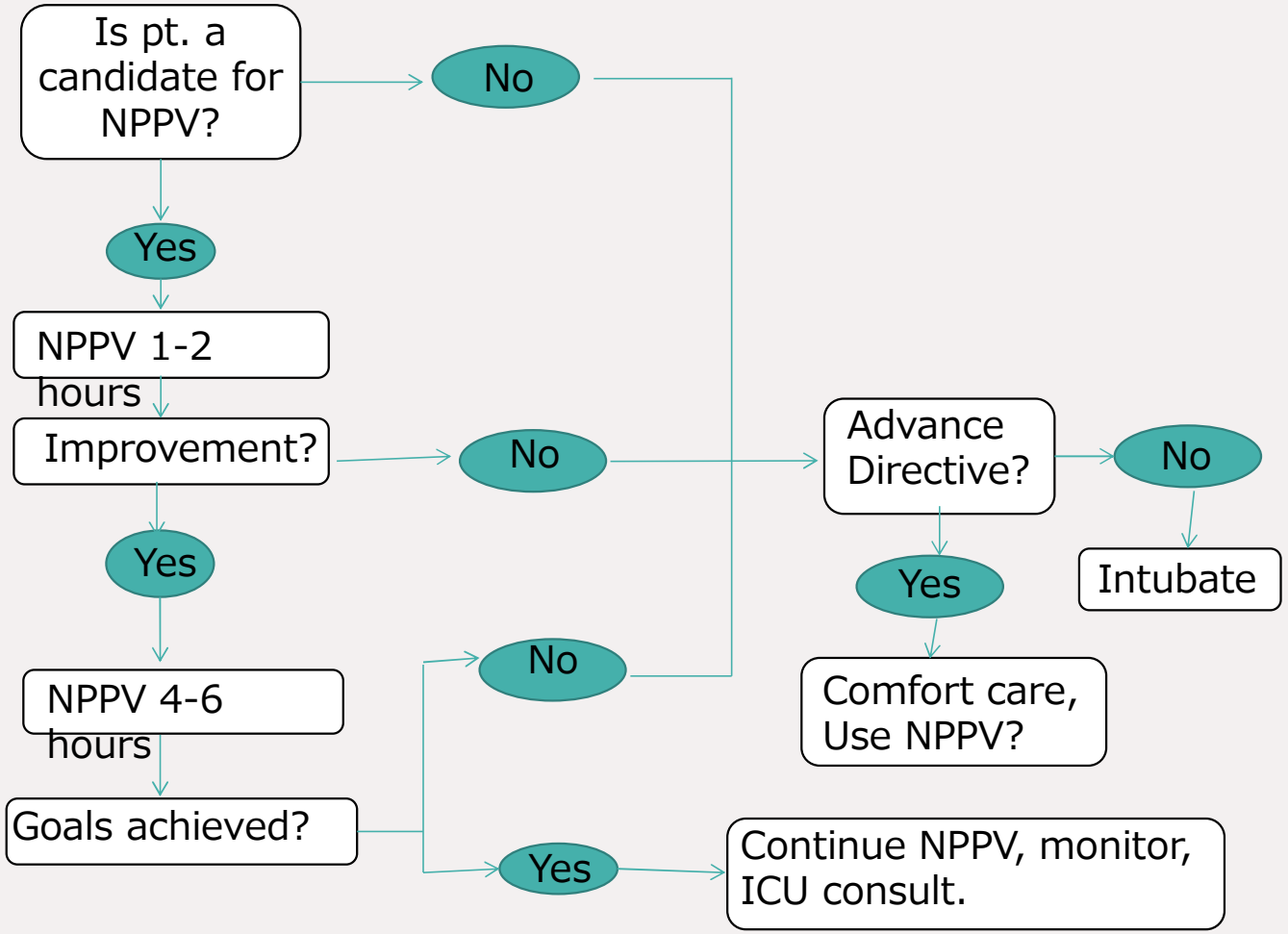
- EPAP: 5 cm H2O
- IPAP: 10-15 cm H2O

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)

- Backup rate: 6-8/min

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...

Mr. Scott

59yo male admitted with what seemed to be a straightforward CAP.

Unfortunately, his course was complicated by an **aspiration** event that required a brief stay in the ICU where he received **mechanical ventilation** x 3 days.

He is now on the hospital medicine service, where he continues to improve on **pipercillin/tazobactam.**

Mr. Scott

Your page is from the patient's nurse, stating he 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.

His other vitals:

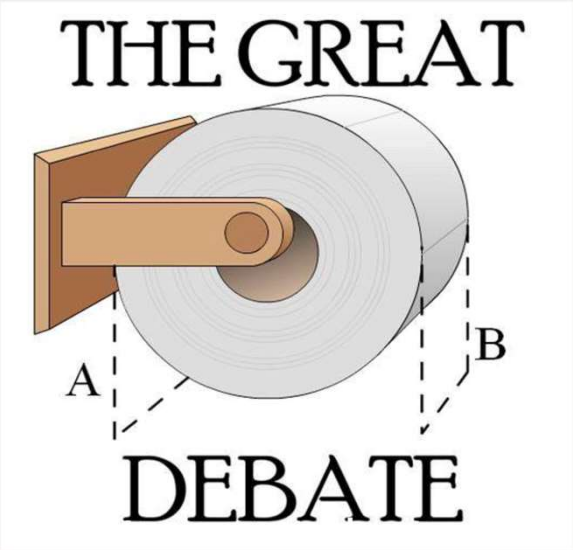
HR 110 **BP** 83/52 **RR** 30 **SpO2** 99% on 2L NC

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!

Which IV fluid should I use?



Which IV fluid should I use?

SMART trial, 2018

Balanced crystalloids (LR, Plasma-Lyte) >>> NS

- Lower 30-day mortality
- Less need for renal-replacement therapy
- Lower rate persistent renal dysfunction

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

But wait!

BaSICS trial, 2021

Plasma-lyte vs. NS

- No difference in 90-day survival
- No difference in incidence of AKI, need for RRT, hospital or ICU death, length of stay

JAMA. 2021;326(9):818–829.

The verdict

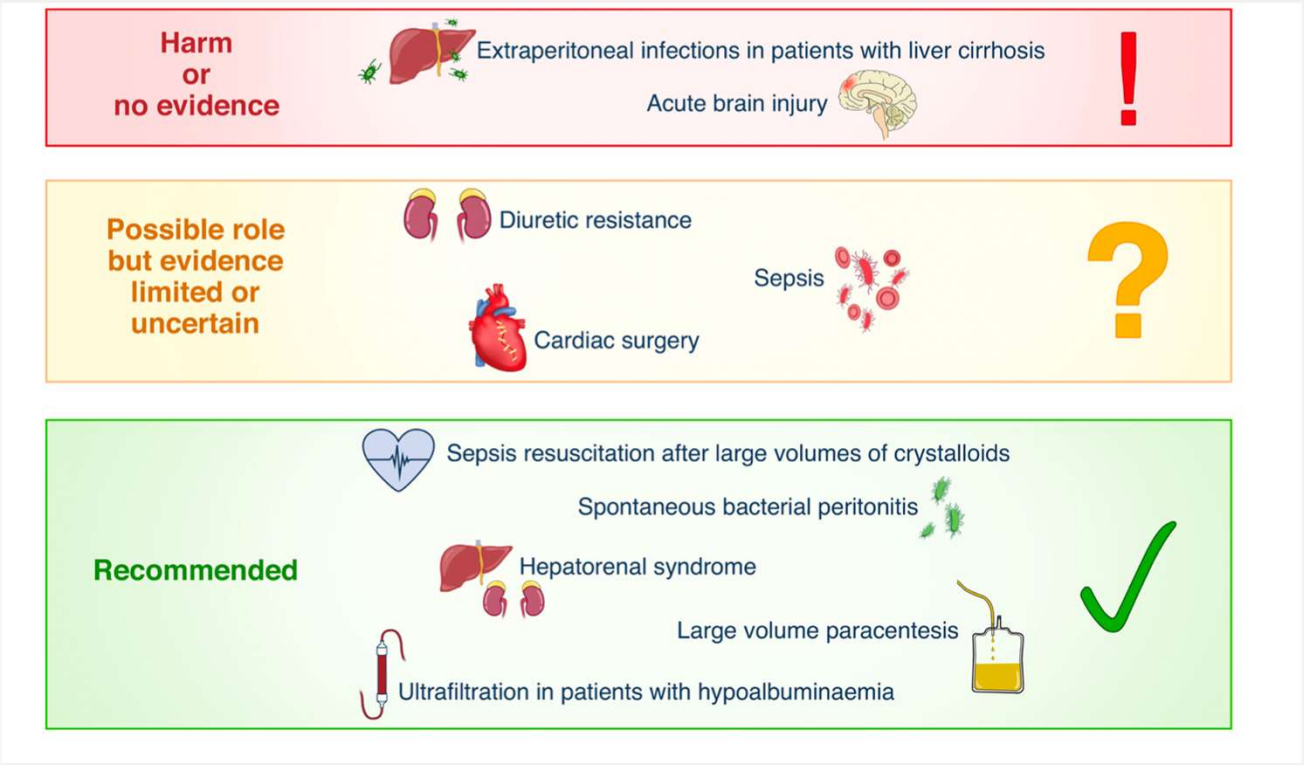
NS may not be as bad we thought!

In large volume resuscitation, consider using a balanced crystalloid

	Na	Cl	K	Mg	Ca	HCO3	Glucose	Acetate	Osm	pH
Plasma	140	104	4.5	1.25	2.5	24	0.08		290	7.4
0.9% NaCl	154	154							308	5.5
0.45% NaCl	77	77							406	
LR	130	109	4		1.5	28 (as lactate)			273	6.5
Plasma-Lyte	140	98	5	1.5				27	294	7.4
D5W							5		278	
Albumin	130-160	100-130	<2						309	

1 L of NS = 9 g Na
WHO recommendation = 2g/day
Average Na intake in the US = 3.3 g/day

What about albumin?

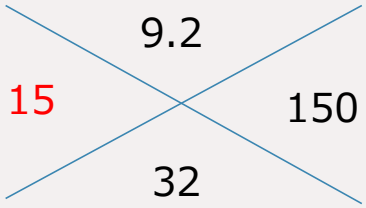


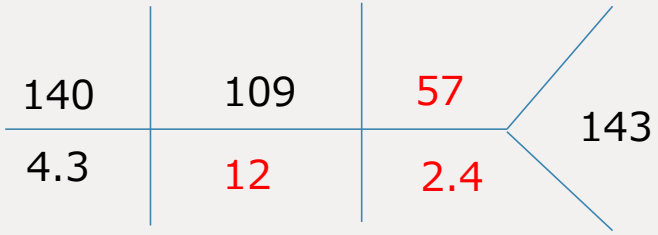
Intensive Care Med (2022) 48:602–605

Which IV fluid should I use?

Type of Fluid	Hospital Cost	Patient Cost
NS	$ 1.25	$78.40
LR	$ 2.00	$82.00
Plasma-Lyte	$ 2.00	$82.00
500 mL 5% albumin	$33.25	$266.00
100ml 25% albumin	$66.30	$234.00

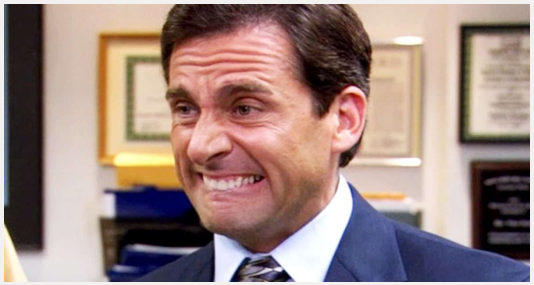
Mr. Scott





Lactate: 8.7

Procalcitonin: 5



Bicarb?

BICAR-ICU trial, 2018

When do we give bicarb in metabolic acidosis?

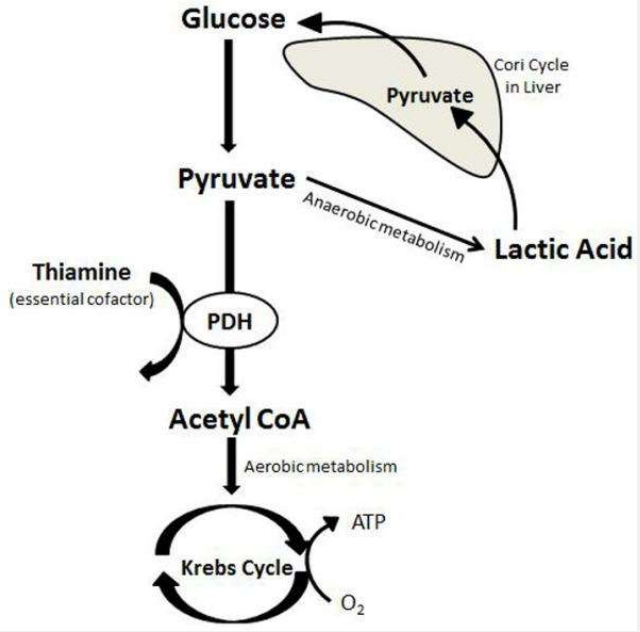
- 28 day mortality was no different (bicarb vs. placebo).
- No difference in LOS, ICU days
- ?less RRT

JAMA. 2021;326(9):818–829.

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

Which IV fluid should I use?

Does LR affect lactate levels?

No!

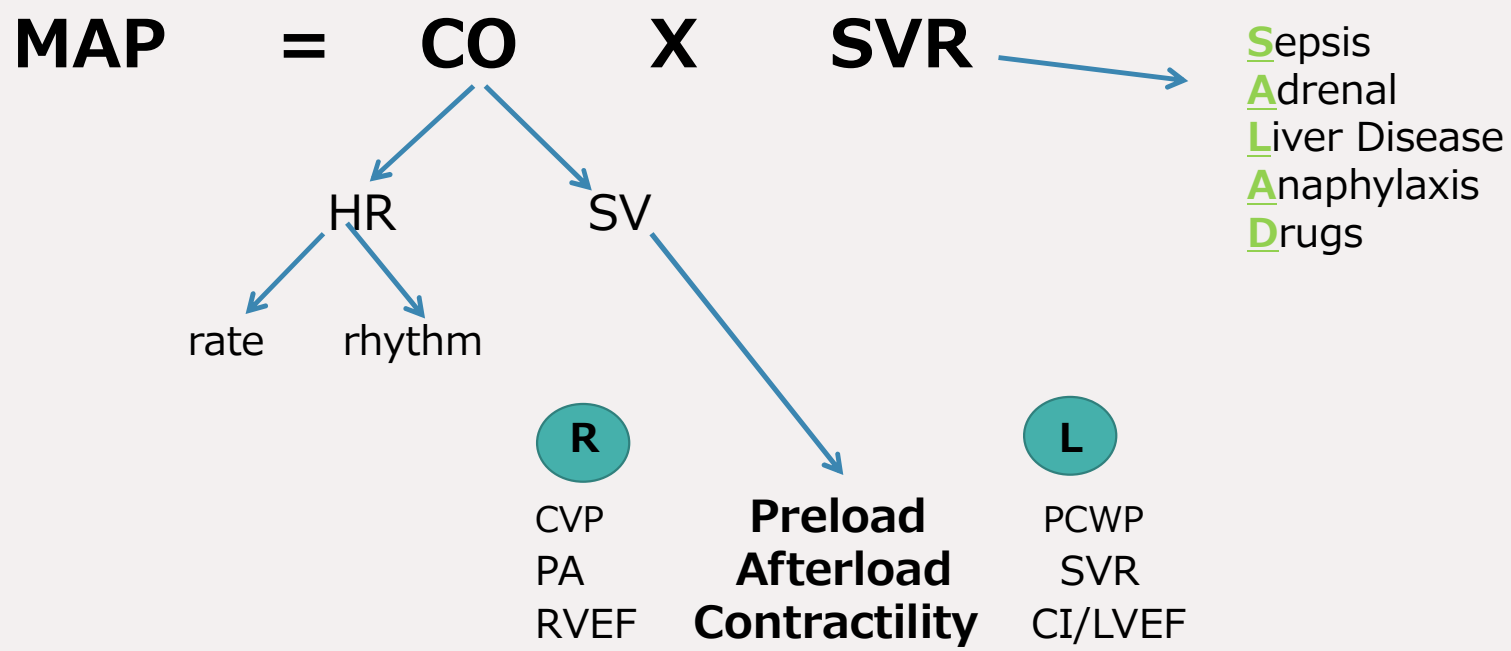
- LR contains *sodium* lactate (not lactic acid), and is therefore not acidotic
- Lactate is very rapidly metabolized to bicarbonate
- Also you can use it even in hyperkalemia (it doesn't have a ton of K and NS can actually worsen HyperK if hyperchloremic acidosis created)

Mr. Scott

He continues to have a fever of 38.7 even after a dose of Tylenol.

After you give him a 500cc fluid bolus···his 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!!

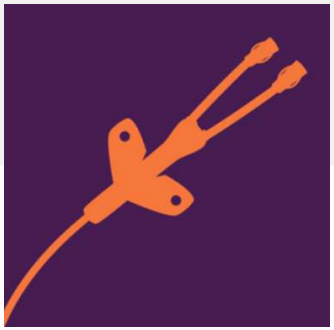
Mr. Scott

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:

Assess & manage pain

Breathing trials & spontaneous awakening

Choice of sedative (non-benzodiazepine)

Daily delirium monitoring

Early mobility

Family 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)

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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