

Hospital Internal Medicine Meets Critical Care: Patient Cases

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MAYO CLINIC

Disclosures

- This presentation has no current affiliations or financial arrangements.
- This presentation does not discuss off-label uses of products.

Objectives

- Identify critically ill patients that warrant early resuscitation.
- Recognize acute respiratory failure and review initial management options.
- Determine which types of shock can occur simultaneously.
- Review up to date treatment guidelines for sepsis.
- Discuss some current treatments for COVID-19, and ways to optimize patient care.

Time to start your work day!

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



Mr. Wilson

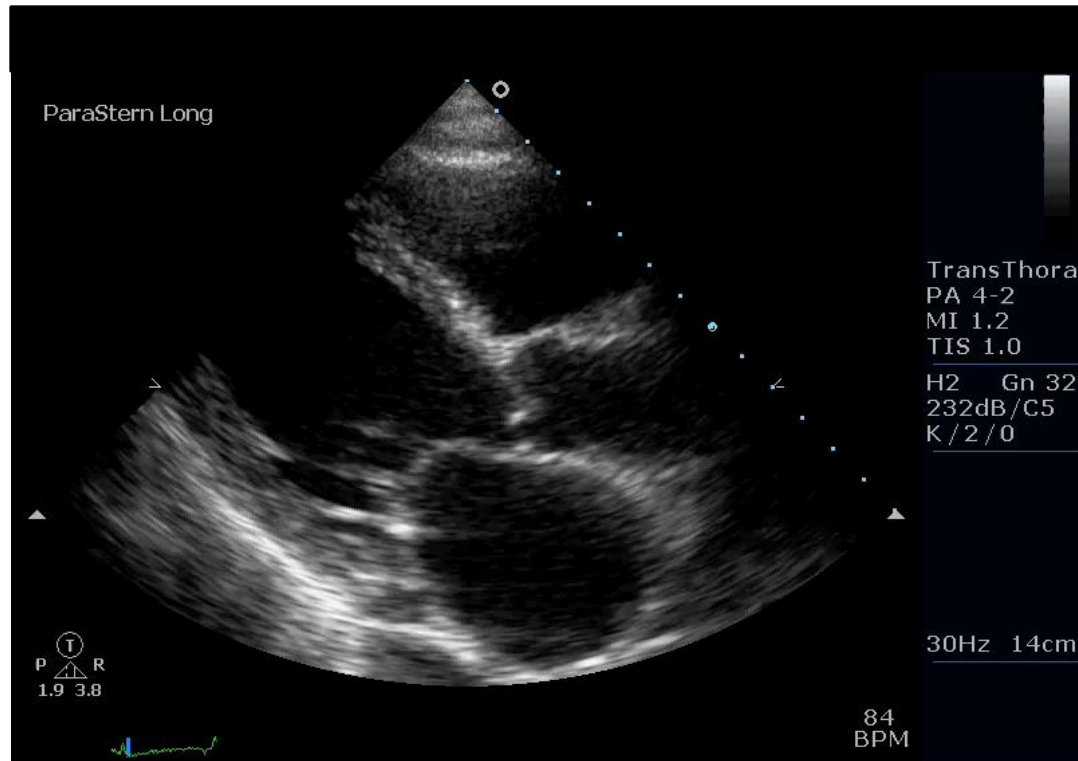
- 67M with hx nephrolithiasis, DM2, HTN who presented a few hours ago with **nausea, vague abdominal pain**. Now found to be **hypertensive, tachypneic** and **tachycardic**.
- 4L IVF given in the ER for hypotension a few hours ago
- Started on zosyn, IV flagyl and IV vancomycin
- A rapid response is called for a desaturation to 60%



Rapid response

- You rush to bedside to find the following:
 - HR**: 120, NSR
 - RR**: 40s
 - BP**: 180/120
 - Temp**: 38.6 C
 - O2**: 60% with good pleth, placed on NRB and saturating 100%
- Patient in distress, unable to talk in full sentences

POCUS - Heart



POCUS - Lung





Flash pulmonary edema

- Definition: acute decompensated heart failure
- Risk factors: coronary ischemia, HTN, valvular disease, diastolic dysfunction, bilateral renal artery stenosis
- Pathophysiology: endothelial dysfunction → circulating catecholamines → excessive pulmonary capillary permeability

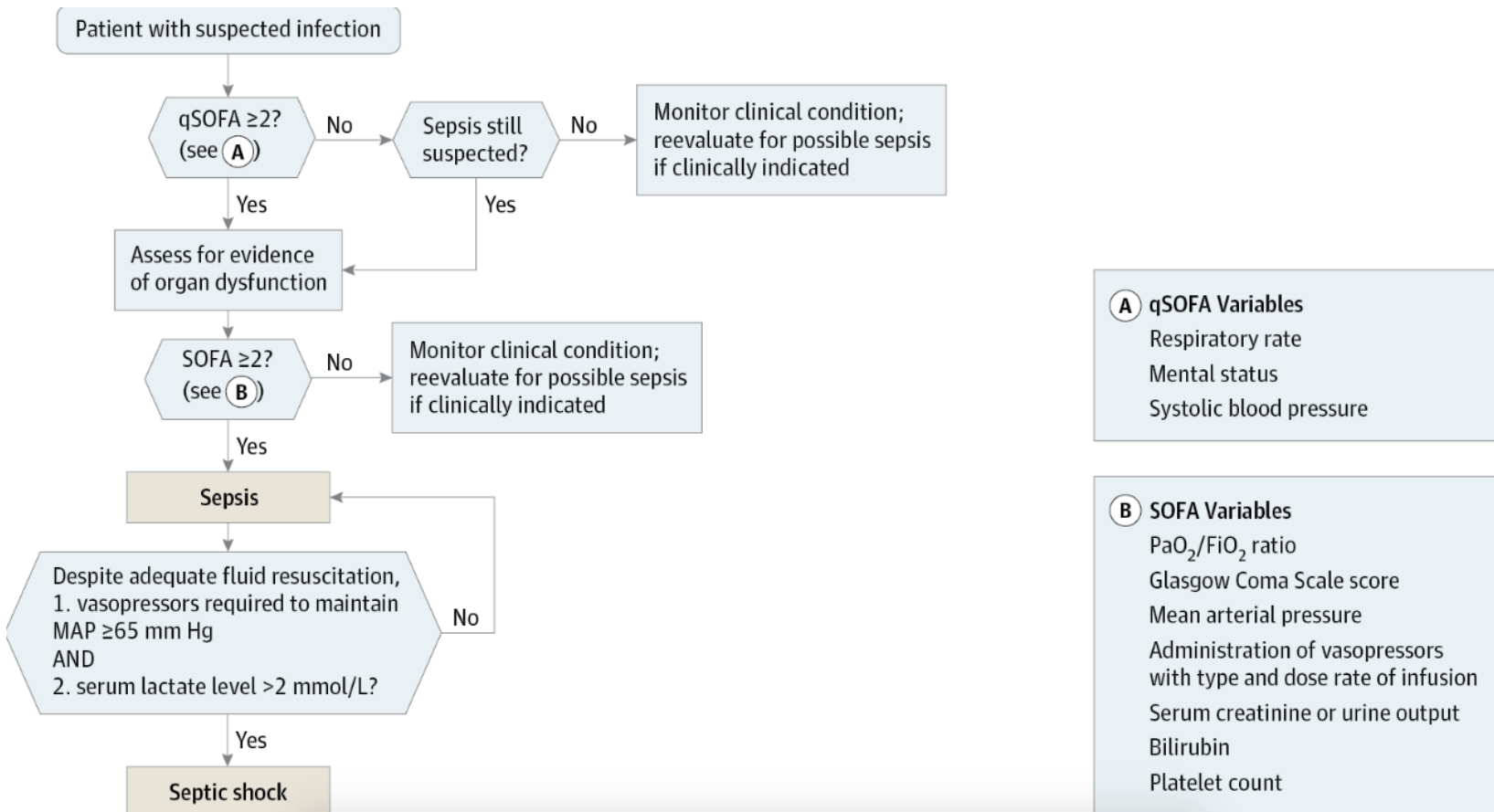
Early signs of sepsis

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

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

How do I use the SOFA score?



Resuscitation

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

Sepsis Bundle

Surviving Sepsis Bundles Goals (within 6 hours)

1. Send appropriate cultures
2. Initial plasma lactate, followed by repeat within 4 hours if elevated
3. Administer initial antibiotics (ideally within 1-2 hours)
4. Achieve the following goals:
 - CVP 8-12 mmHg
 - MAP \geq 65 mmHg
 - UOP \geq 0.5 ml/kg/hr
 - SVO₂ \geq 65%

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.*

After initial resuscitation...

- **HR**: 101, NSR on telemetry
- **BP**: 168/100 mmHg
- **RR**: 37
- **O2 sat**: 85% on NRB, placed on BiPAP
- **Temp**: 39°C

- BP drops to 83/49 after BiPAP placed



Once in the ICU...

- ABG on BiPAP: 7.44/24/111/16
- Wants to come off BiPAP, trialed on HFNC with increasing WOB, now on vasopressors
- Intubated
- CT abd/pelvis: Obstructive R renal calculus, 8x6mm with mild R hydroureteronephrosis

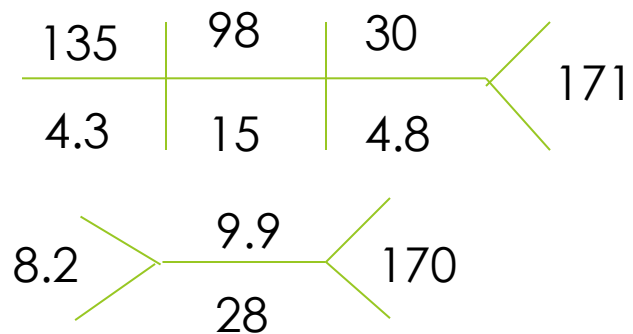
ICU Course

- STAT IR placement of R nephrostomy tube
- Returns from IR, nephrostomy tube has zero output

- Labs:

AST 1670

ALT 1455



Progressive shock

- Central line & arterial lines placed
 - Started on norepinephrine, then vasopressin
 - Another fluid bolus given
 - Blood pressure stabilizes
- No longer making urine
- Severe metabolic acidosis

Mr. Wilson

- **What are some other options to bring up BP?**

Mr. Wilson

- Returned to IR earlier that night for confirmation of neph tube placement
- UOP starting to pick up
- Pressors weaned
- Extubated to HFNC

- Transferred back to the medical floor the following day.

Just as you're 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, CO2
- **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

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?



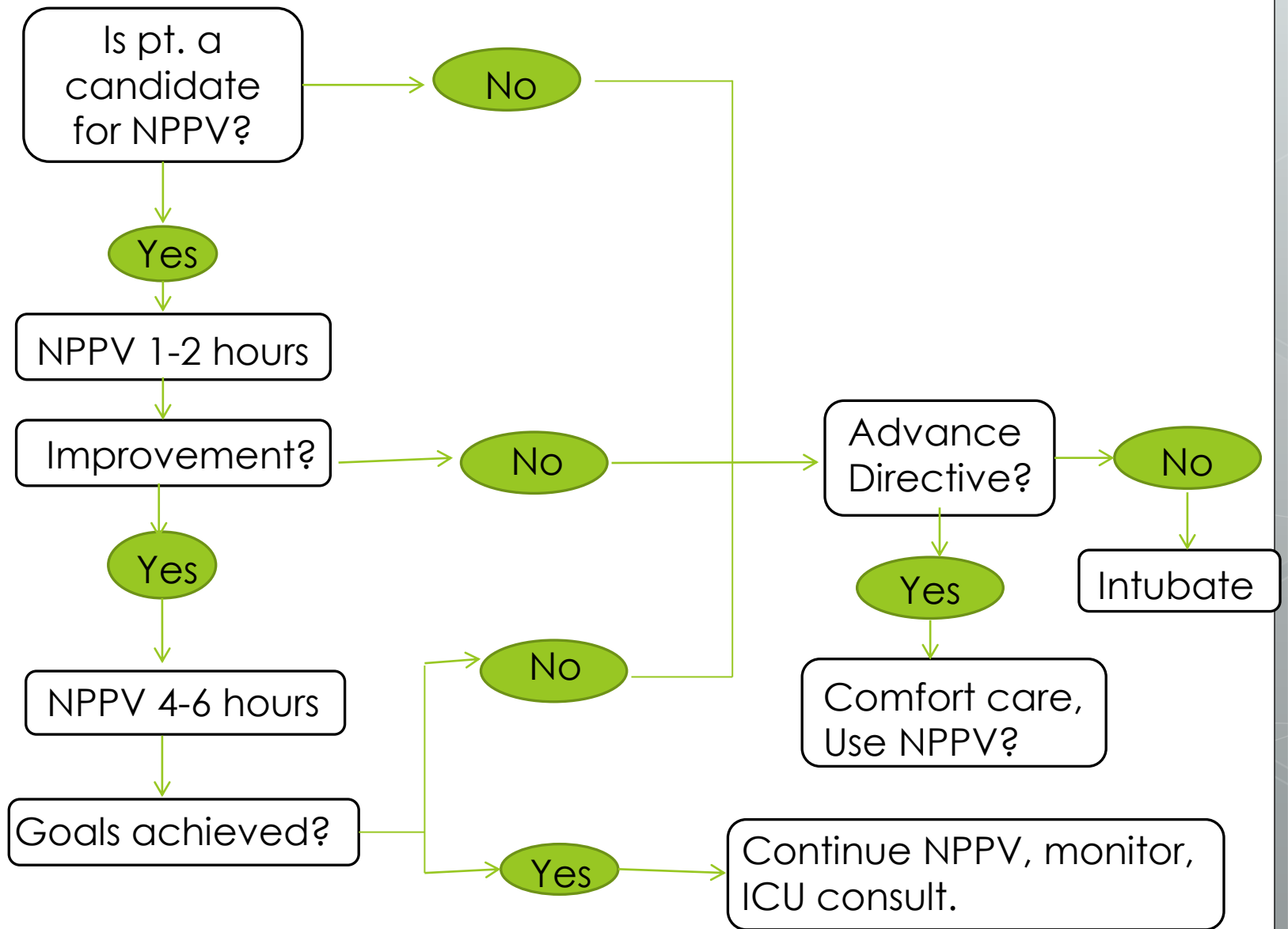
High Flow Nasal Cannula

- Enhances gas exchange
- More comfortable than BiPAP
- Improves work of breathing
- decreased intubation rates **up to 75%** in hypoxemic respiratory failure



BiPAP

INDICATIONS	CONTRAINDICATIONS
<ul style="list-style-type: none">• Hypercapnia and acidosis• Cardiogenic pulmonary edema• COPD exacerbation• Weaning and post-extubation failure• Post surgical period• Obesity hypoventilation syndrome• Neuromuscular disorders• Poor alveolar oxygen exchange	<ul style="list-style-type: none">• Impaired neurological state• Respiratory arrest• Shock or severe cardiovascular instability• Excessive airway secretions• Facial lesions preventing good mask fit (trauma, burns, etc.)• Vomiting• Significant agitation



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 **piperillin/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 \geq 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

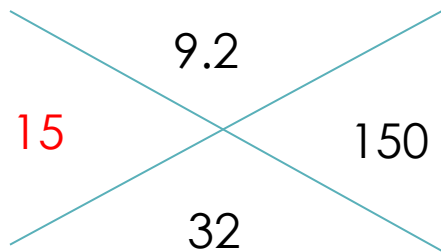
- **ALBIOS trial**

- Adding albumin to crystalloid is safe, but there's no difference in mortality, new organ failure, or LOS at 28 and 90 days.

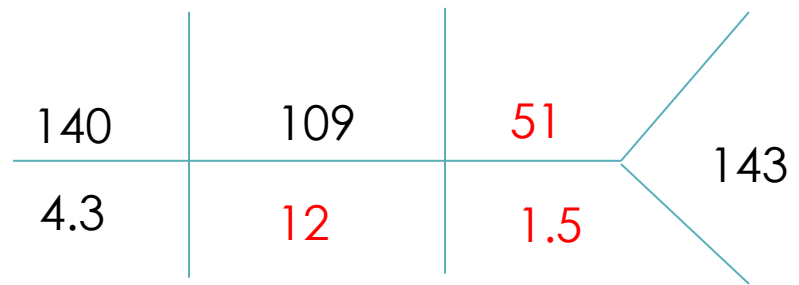
- **CRISTAL trial**

- In patients with hypovolemic shock, colloid vs. crystalloid:
 - No difference in 28 day mortality
 - 90 day mortality was better in the colloid group.

Ms. Burton



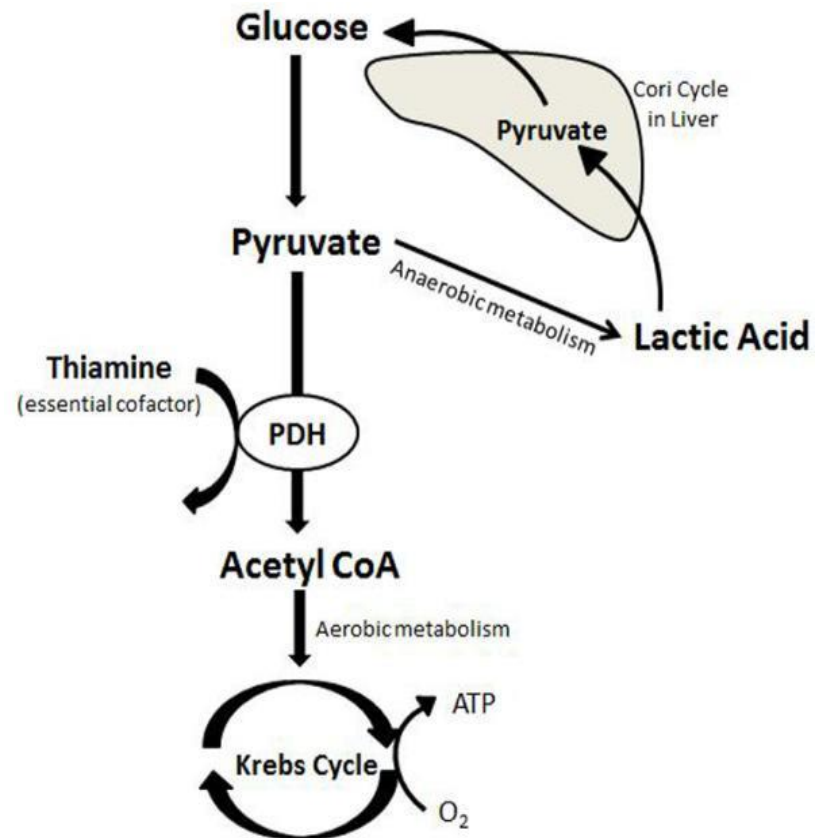
Lactate: 8.7



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**

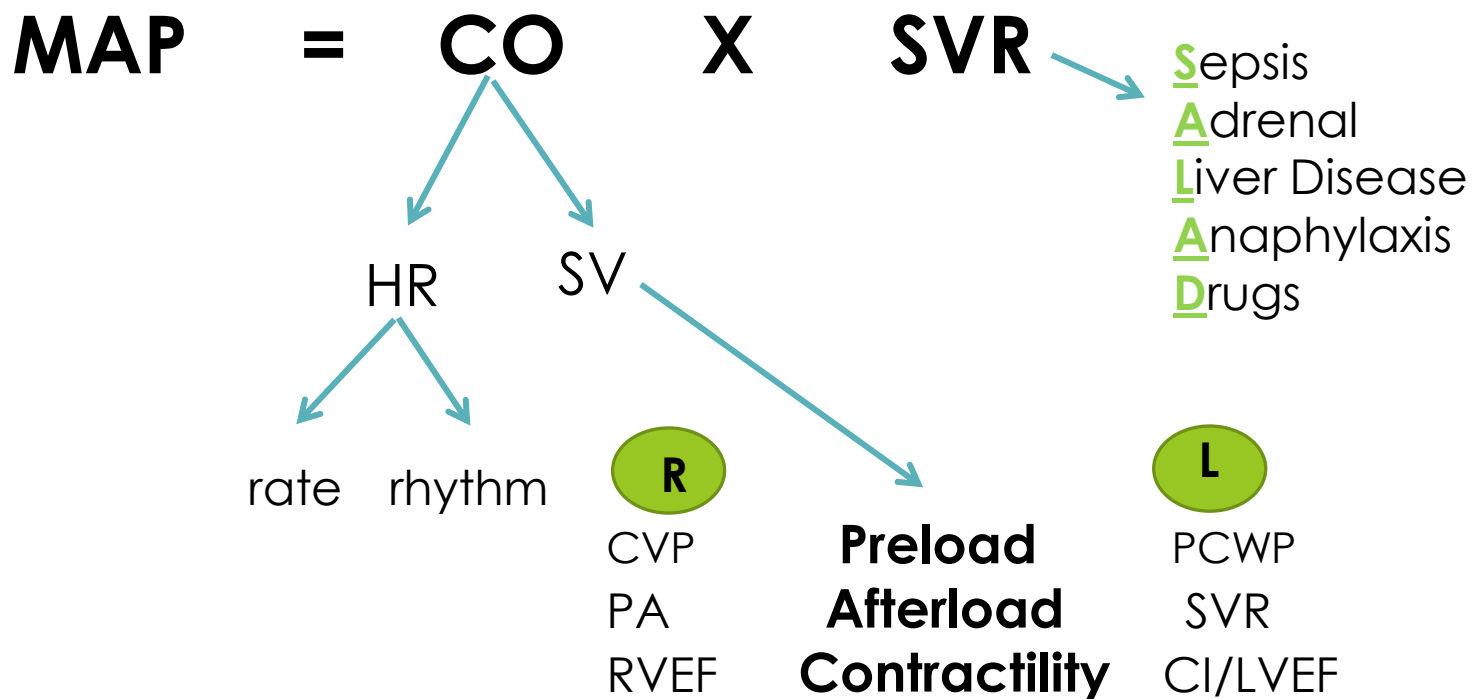
Lactate Clinical Pearls

- Lactate ≥ 4 mmol/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



Shock

Poor tissue perfusion & oxygenation

High output state (septic)

PE: warm hands, brisk cap refill, bounding pulse

Low output state

PE: cold hands, poor cap refill, weak pulse

Tank full (Cardiogenic)

PE: + JVD, S₃ gallop, rales

Tank empty (Hypovolemic)

PE: dry membranes, flat neck veins

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)



Type of Shock	HR	CO/CI	Ventricular Filling Pressures (preload)	SVR (afterload)	Pulse pressure	SVO2	Infusions to consider
Cardiogenic	↑	↓	↑	↑	↓	↓	Inotrope +/- vasopressor
Hypovolemic	↑	↓	↓	↑	↓	↓	Replace volume!
Distributive/ Vasodilatory	↑	↑ (or normal)	↓	↓	↑	↑ (or normal)	Vasopressors (Norepi is first line)
Obstructive	↑	↓	↑ (or normal)	↑	↓	↓	Relieve the obstruction

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)



You have one hour left in your shift, and still haven't had a chance to sit, eat...and certainly not to write any notes.

Ms. Clark

55yo female with a history of diabetes, HTN, HLD and obesity presents to the ED with a one week history of cough, dyspnea on exertion, and fever.

Vitals on presentation:

HR 114 RR 32 BP 142/87 Temp: 38.9C
O2 : 83 % on RA



Acute Respiratory Distress Syndrome (ARDS)

Berlin Criteria

- **Acute onset**
- **Bilateral opacities** on CXR or CT within 24 hours
- No evidence of left heart failure or **fluid overload**
- Moderate to severe impairment of oxygenation
(**$\text{PaO}_2/\text{FiO}_2 \leq 300$**)
- Presence of a **predisposing condition**

Acute Respiratory Distress Syndrome (ARDS)

Severity of ARDS	PaO ₂ /FiO ₂ (mmHg)
Mild	200 – 300
Moderate	100 – 200
Severe	≤100

Pathophysiology

Acute, diffuse inflammatory lung or systemic injury

Damage to pulmonary capillary endothelial cells and alveolar epithelial cells

Increased vascular permeability and decreased production and activity of surfactant

Pulmonary edema and alveolar collapse

Hypoxemia/ARDS

Risk Factors

Systemic Insult

- Sepsis
- Shock
- Trauma
- Blood transfusions
- Burns
- Drug overdose
- Cardiopulmonary bypass

Pulmonary Insult

- Pneumonia
- Aspiration
- Lung contusion
- Toxic inhalation
- Near-drowning
- Pulmonary embolus

Treatment

- Identify the initial systemic or pulmonary insult and treat

Supportive Care

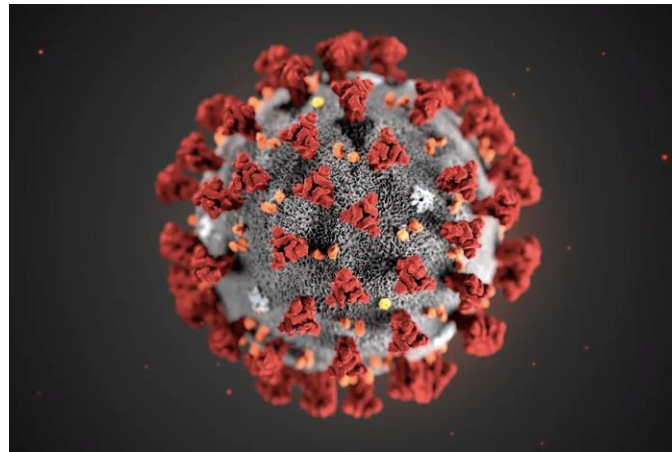
- Hemodynamic monitoring
- Intubation and mechanical ventilation
 - Lung protective ventilation
 - Prone positioning
 - ECMO
 - ? Role for Steroids

Villar. Dexamethasone Treatment for ARDS. The Lancet. Mar 2020. 8:3; pp 276

Meduri. Methylprednisolone Infusion in Early Severe ARDS. Chest. April 2007. 131:4; pp 954

Ms. Clark

- Ms. Clark's SARS-CoV-2 PCR test results **positive** for COVID-19 infection.



COVID-19

Current treatment options:

- Dexamethasone
- Convalescent plasma
- Remdesivir
- Tocilizumab (and other IL inhibitors)
- Role of antibiotics?

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Dexamethasone in Hospitalized Patients with Covid-19 — Preliminary Report

The RECOVERY Collaborative Group*

Use of dexamethasone (6 mg daily x 10 days) resulted in lower 28-day mortality among those receiving either invasive mechanical ventilation or oxygen (but not among those receiving no respiratory support)

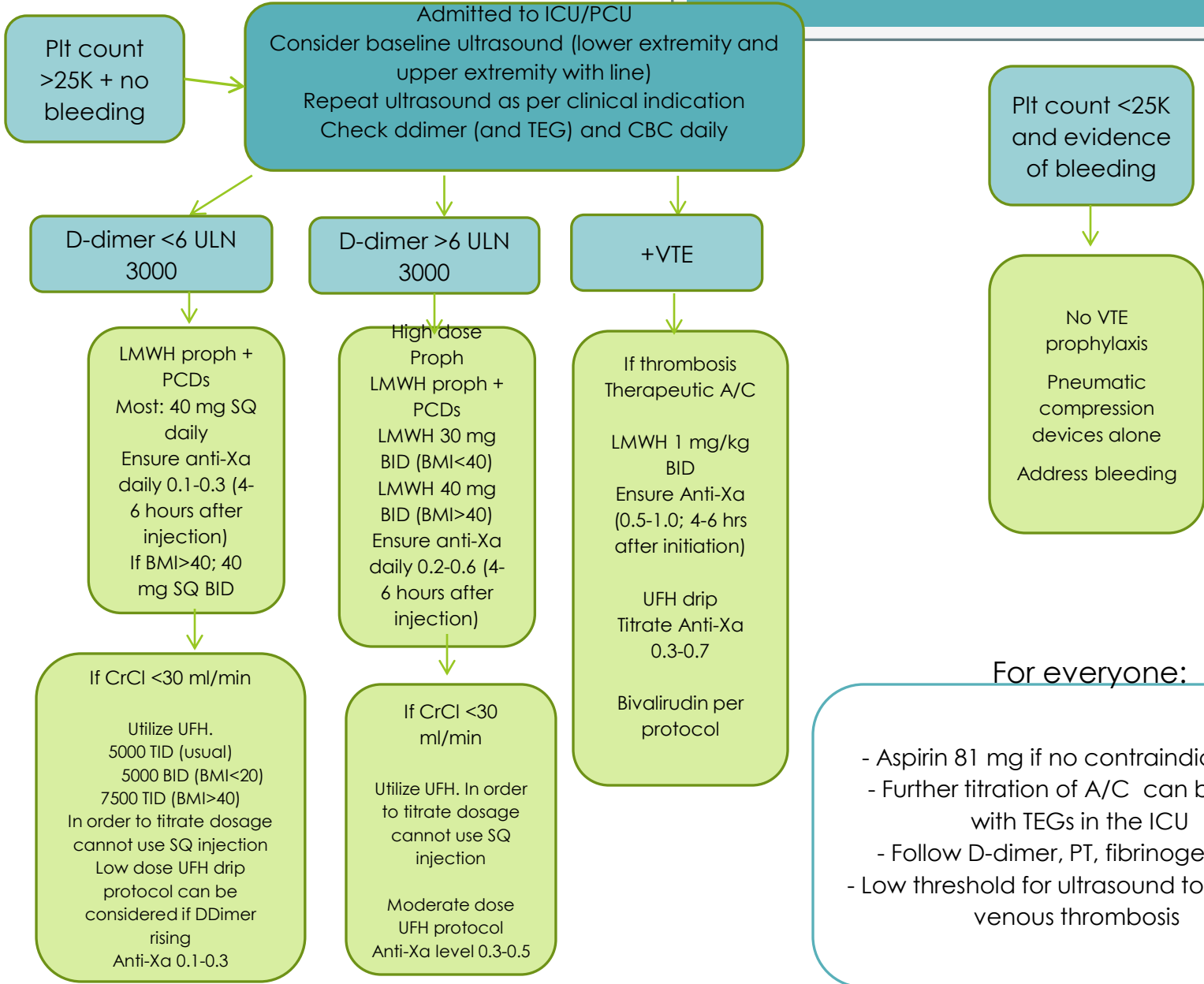
COVID-19

Respiratory support

- HFNC vs. BiPAP?
- Role of proning
- Ventilator support
- Role of ECMO

COVID-19

- Hypercoagulability with COVID and the role for anticoagulation



Admitted to ICU/PCU
Consider baseline ultrasound (lower extremity and upper extremity with line)
Repeat ultrasound as per clinical indication
Check ddimer (and TEG) and CBC daily

Plt count >25K + no bleeding

Plt count <25K and evidence of bleeding

D-dimer <6 ULN
3000

D-dimer >6 ULN
3000

+VTE

No VTE prophylaxis
Pneumatic compression devices alone
Address bleeding

LMWH proph + PCDs
Most: 40 mg SQ daily
Ensure anti-Xa daily 0.1-0.3 (4-6 hours after injection)
If BMI>40; 40 mg SQ BID

High dose Proph
LMWH proph + PCDs
LMWH 30 mg BID (BMI<40)
LMWH 40 mg BID (BMI>40)
Ensure anti-Xa daily 0.2-0.6 (4-6 hours after injection)

If thrombosis Therapeutic A/C
LMWH 1 mg/kg BID
Ensure Anti-Xa (0.5-1.0; 4-6 hrs after initiation)
UFH drip
Titrate Anti-Xa 0.3-0.7
Bivalirudin per protocol

If CrCl <30 ml/min
Utilize UFH.
5000 TID (usual)
5000 BID (BMI<20)
7500 TID (BMI>40)
In order to titrate dosage cannot use SQ injection
Low dose UFH drip protocol can be considered if DDimer rising
Anti-Xa 0.1-0.3

If CrCl <30 ml/min
Utilize UFH. In order to titrate dosage cannot use SQ injection
Moderate dose UFH protocol
Anti-Xa level 0.3-0.5

For everyone:
- Aspirin 81 mg if no contraindication
- Further titration of A/C can be done with TEGs in the ICU
- Follow D-dimer, PT, fibrinogen, CBC
- Low threshold for ultrasound to assess for venous thrombosis

Time to go home!



Questions?

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