Managing Patients in the Transition Between Floor and ICU

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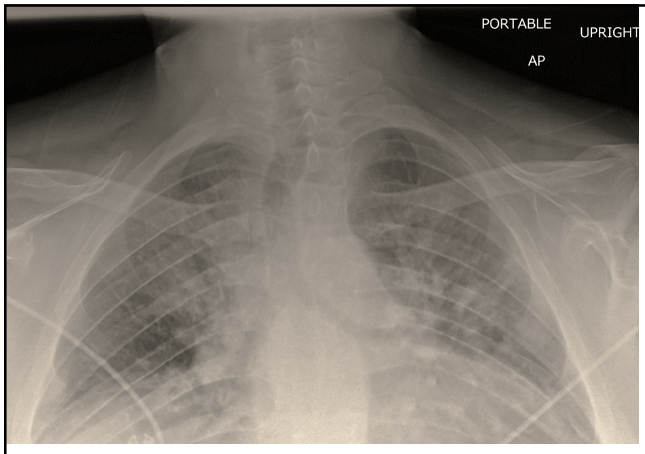
Brigham and Women's Hospital
2024

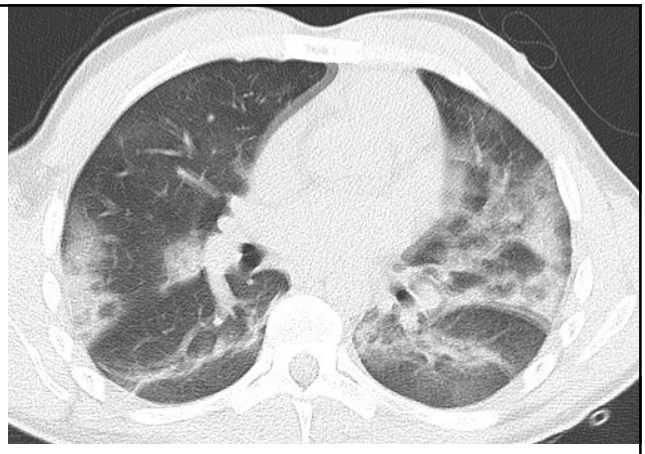
Disclosures

- None

Case 1

- 37 M mild asthma, type 2 diabetes, morbid obesity, recent new smoker
- Presents with 5 days of productive cough, fever, progressive dyspnea
- Exam: T 38.7 ^{o}C (101.7 ^{o}F), RR 20, Sat 90% on room air, bibasilar crackles, mild expiratory wheezing
- WBC 16, Na 131
- ABG on room air: pH 7.31, $PaCO_2$ 52, PaO_2 63
- CXR: bilateral infiltrates
- CT chest: ground-glass opacities, worse in bases and periphery



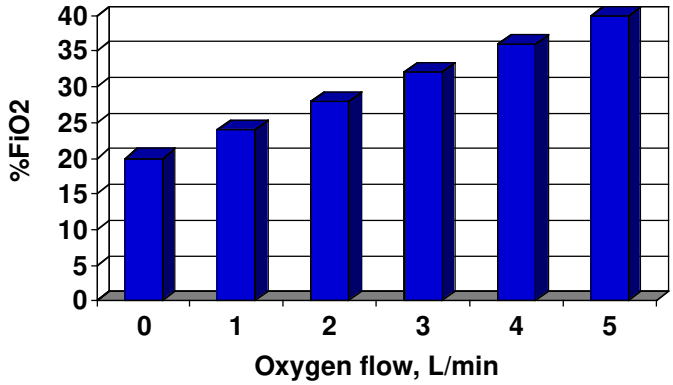


Case 1: Imaging

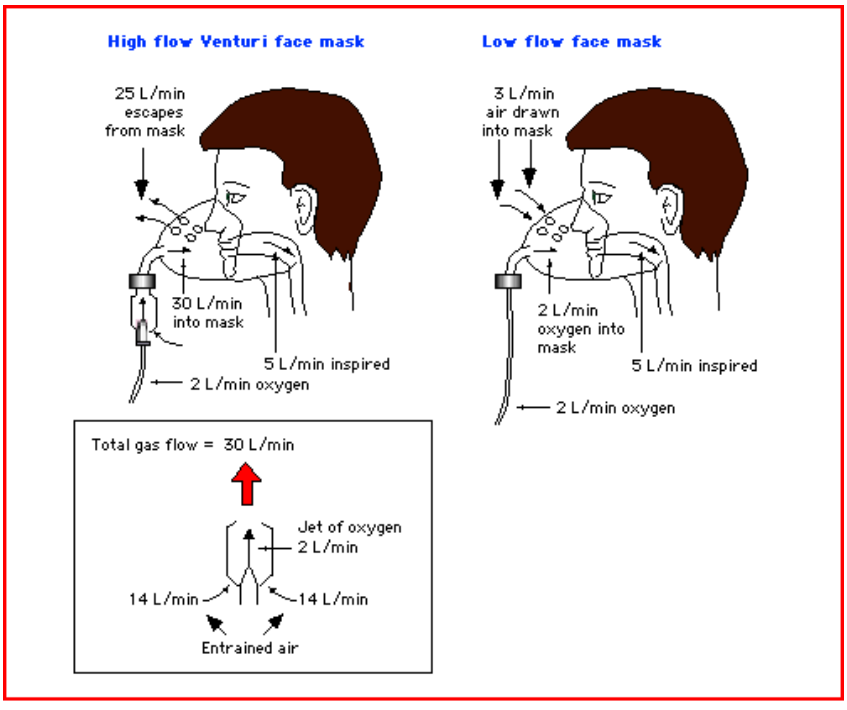
Case 1

- Started on ceftriaxone/azithro for presumed community-acquired pneumonia, bronchodilators
- On hospital day 2, respiratory status is worse
- RR 30, on 50% face mask
- ABG: pH 7.46, $PaCO_2$ 33, PaO2 66
- What options can be used to increase respiratory support on the floor?

Oxygen supplementation



Method	FiO2 (Approximate)	Flowrate (L/min)
Non rebreather Mask	60-80%	10-15
Venti Mask	24% 26% 28% 31% 35% 40% 50%	3 3 6 6 9 12 15
Simple Face Mask	35-55%	5-10 lpm
Nasal Cannula	24% 28% 32% 36% 40% 44%	1 2 3 4 5 6



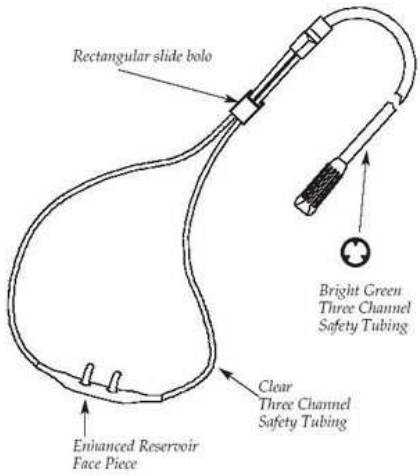
Case 1 continued

- Increasing O2 requirements to 10L
- Continued desaturations and increased work of breathing
- Next steps?
- High flow NC vs NIPPV?

High-flow nasal cannula (HFNC)

- 30 to 60 LPM oxygen heated to body temperature at 100% relative humidity
- Dramatically reduces dilution of inspired oxygen by room air
- Washes out dead space in the airways
- Can generate low-level continuous positive airway pressure (CPAP) at higher flows
- Moistens secretions, improves mucociliary transport
- Greater comfort and adherence
- Limitations: doesn't provide as much positive pressure or reduce the work of breathing as much as non-invasive ventilation; does it help prevent intubation, or "delay the inevitable"?

Fancy New Nasal Cannulas, e.g., "Salter"
Higher Flows, 6-15L and perhaps higher (e.g. 70L)



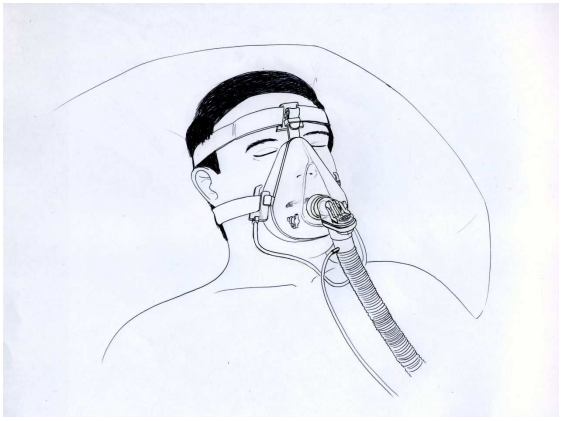
Facilitated by tubing diameters and humidification of O2 delivery.

Non-invasive ventilation: bilevel intermittent positive air pressure (BiPAP)

- Baseline positive pressure
  - Expands areas of atelectasis, and prevents other areas from becoming atelectatic
- Inspiration raises the system to a higher positive pressure, reducing the work of breathing
- May also provide supplemental oxygen
- Limitations: uncomfortable, may be poorly tolerated, unclear benefit vs. harm in ARDS

NIV Mask Fashion Show

Most common in the ICU.



Perhaps next? The helmet.

Patel BK et al. JAMA 2016; JAMA 2021: no difference in VFD with HFNC in COVID; more studies coming

HFNC vs BiPAP in clinical trials

In a meta-analysis of 29 RCTs, HFNC was associated with lower need for intubation, lower mortality, and greater comfort than non-invasive ventilation

ACP guidelines lean toward HFNC as the preference over NIV for acute AHRF (especially for mild disease) and over conventional oxygen for post-extubation AHRF (likely more beneficial in mild disease) with "low-certainty evidence"; (my own editorial: NIV has better rationale than HFNC for more significant *hypercapnic* respiratory failure)

Ann Intern Med 2021;174:952; Crit Care Med 2024; 52(9):e473

Case 1 continued

- Started on high flow NC
- Ongoing desaturations and escalating O2 requirement
- She unfortunately develops bradycardia and cardiac arrest
- A code is called

TOP 10 TAKE-HOME MESSAGES FOR THE 2023 FOCUSED UPDATE ON ADULT ADVANCED CARDIOVASCULAR LIFE SUPPORT

1. It is important for researchers to develop and implement methods to improve representation of participants from diverse backgrounds and to improve the accuracy of reporting study subject demographics.
2. Routine administration of calcium for treatment of cardiac arrest is not recommended.
3. Use of extracorporeal cardiopulmonary resuscitation for patients with cardiac arrest refractory to standard advanced cardiovascular life support is reasonable in select patients when provided within an appropriately trained and equipped system of care.
4. Emergency coronary angiography is not recommended over a delayed or selective strategy in patients with return of spontaneous circulation after cardiac arrest unless they exhibit ST-segment–elevation myocardial infarction, shock, electrical instability, signs of significant myocardial damage, or ongoing ischemia.
5. We recommend that all adults who do not follow commands after return of spontaneous circulation, regardless of arrest location or presenting rhythm, receive treatment that includes a deliberate strategy for temperature control.
6. We recommend selecting and maintaining a constant temperature between 32°C and 37.5°C during postarrest temperature control.
7. There is insufficient evidence to recommend a specific therapeutic temperature for different subgroups of patients with cardiac arrest.
8. Patients with spontaneous hypothermia after return of spontaneous circulation who do not follow commands should not be routinely actively or passively rewarmed faster than 0.5°C per hour.
9. A therapeutic trial of a nonsedating antiseizure medication may be reasonable in adult survivors of cardiac arrest with electroencephalography patterns on the ictal-interictal continuum.
10. Organ donation is an important outcome that should be considered in the development and evaluation of systems of care.

Circulation 2024

Key take-aways from my perspective:

1. Well-executed CPR remains critical
2. Increasing interest in eCPR in places where feasible
3. Increasing data supports use of low dose Epi when appropriate in cardiac arrest; not enthused about calcium
4. No clear data-driven temperature target in post arrest care, thus temperature "control" to avoid fever is important

What is the optimal timing for intubation in the patient with deteriorating respiratory status?

As an example: 2019 AHA update: Airways

- Data isn't clear when/how to intubate during a code situation due to varying patient and provider circumstances.
- Use best judgement based on situation and provider expertise.
- It is suggested that proficiency be encouraged to acquire and maintain airway insertion skills for relevant personnel.
- Recent report supports NIV pre-oxygenation resulted in less hypoxemia than pre-oxygenation by mask.

NEJM 2024; 390:2165

Case 1 evolution

- She is intubated and has return of circulation after one round of CPR.
- She is taken to the ICU and stabilized and upon a spontaneous awakening trial is able to follow commands.
- A bronchoscopy was performed with cell count/differential:
  - 685 RBC, 295 WBC (32% Neutrophils, 13% Lymphs, 8% Monos, 39% eosinophils)

Acute Eosinophilic pneumonia

- Known causes: e.g., meds, parasites, new onset smoking
- DDx: "PIE", e.g., Churg Strauss, CEP, ABPA, etc
- Idiopathic:
  - Similar presentation as CAP
  - Classically no circulating eosinophils detected, but eos seen in BAL
  - Can respond dramatically to steroids
  - One approach is to treat for 1 month after symptoms disappear and CXR normal (i.e., on the order of 4-6 weeks); inhaled steroids may be beneficial in relapse

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Hydrocortisone in Severe Community-Acquired Pneumonia

- 795 patients, randomized phase 3 RCT
- Hydrocortisone vs. Placebo 200 mg/day for 4 or 7d based on clinical improvement (then taper, total 8 or 14 days)
- HC: Improved 28d mortality and intermediate endpoints – more insulin in the HC group
- ? Benefits in pt subgroups without a pathogen and elevated CRP (>15 mg/dL)

N Engl J Med. 2023; Mar 21. doi: 10.1056/NEJMoa2215145.

Case 1 conclusion

- Remains intubated for 2 weeks with slow improvement
- Required trach
- Discharged to a ventilator weaning rehab facility

Case 2

- 87 F PMHx type 2 diabetes on metformin
- Brought in with confusion, hypoglycemia
- Given D50W in the field by EMS for glucose 40 mg/dl (2.2 mmol/L)
- Exam: T 92^{o}F (33.3^{o}C), P 90, BP 65/40, RR 20, Sats 97% RA

Case 2

- Laboratory workup:
- WBC 18, Na 124, K 5.2, Bicarb 11, BUN 60 mg/dl, Cr 4.0 mg/dl (354 μmol/L)
- Urinalysis >100 WBC, 4+ bacteria
- Is this sepsis? Next steps?

What is Sepsis (2001-15)?

- Systemic Inflammatory Response Syndrome (SIRS):
  - Temp >38°C or <36°C
  - Heart Rate > 90 bpm
  - Resp Rate > 20/min
  - WBC >10000, <4000, or Bandemia>10%
- Sepsis: SIRS + Infection
- Severe Sepsis: Sepsis+ Organ Dysfunction
- Septic Shock: Sepsis+Refractory Hypotension

Special Communication | CARING FOR THE CRITICALLY ILL PATIENT

The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3)

Mervyn Singer, MD, FRCP; Clifford S. Deutschman, MD, MS; Christopher Warren Seymour, MD, MSc; Manu Shankar-Hari, MSc, MD, FFICM; Djillali Annane, MD, PhD; Michael Bauer, MD; Rinaldo Bellomo, MD; Gordon R. Bernard, MD; Jean-Daniel Chiche, MD, PhD; Craig M. Coopersmith, MD; Richard S. Hotchkiss, MD; Mitchell M. Levy, MD; John C. Marshall, MD; Greg S. Martin, MD, MSc; Steven M. Opal, MD; Gordon D. Rubenfeld, MD, MS; Tom van der Poll, MD, PhD; Jean-Louis Vincent, MD, PhD; Derek C. Angus, MD, MPH

- SEPSIS: (>10% mortality)
  - Life-threatening organ dysfunction
  - Caused by *dysregulated response* to infection
  - Increase SOFA score of ≥2
- SHOCK: (>40% mortality)
  - Vasopressors for MAP≥65 mmg Hg
  - Lactate>2 mmol/L
  - In absence of hypovolemia

JAMA. 2016;315(8):801-810. doi:10.1001/jama.2016.0287

SOFA Score: 6 Organ Systems, 0-4 Points

Points	0	1	2	3	4
PaO2/FiO2	≥400	<400	<300	<200 + mechanical ventilation	<100 + mechanical ventilation
Platelets	≥150	<150	<100	<50	<20
Bilirubin	<1.2	1.2-1.9	2.0-5.9	6.0-11.9	>12.0
Blood Pressure	MAP ≥70	MAP <70	Dopamine <5 or Dobutamine	Dopamine 5.1-15 or Epinephrine <0.1 or Norepinephrine <0.1	Dopamine >15 or Epinephrine >0.1 or Norepinephrine >0.1
Glasgow Coma Scale	15	13-14	10-12	6-9	<6
Creatinine	<1.2	1.2-1.9	2.0-3.4	3.5-4.9 or <500cc urine/d	>5.0 or <200cc urine/d

Vincent et al, Intensive Care Med 1996

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- qSOFA
  - Out of hospital, ED, Ward settings
  - *Worse outcomes* predicted from sepsis with 2 of:
    - Respiratory Rate ≥ 22/min
    - Altered mental status (GCS ≤ 13)
    - SBP ≤ 100 mmHg
  - Ongoing inquiry as to its validation
  - *LESS SENSITIVE* but *MORE SPECIFIC* than SIRS for sepsis screening.

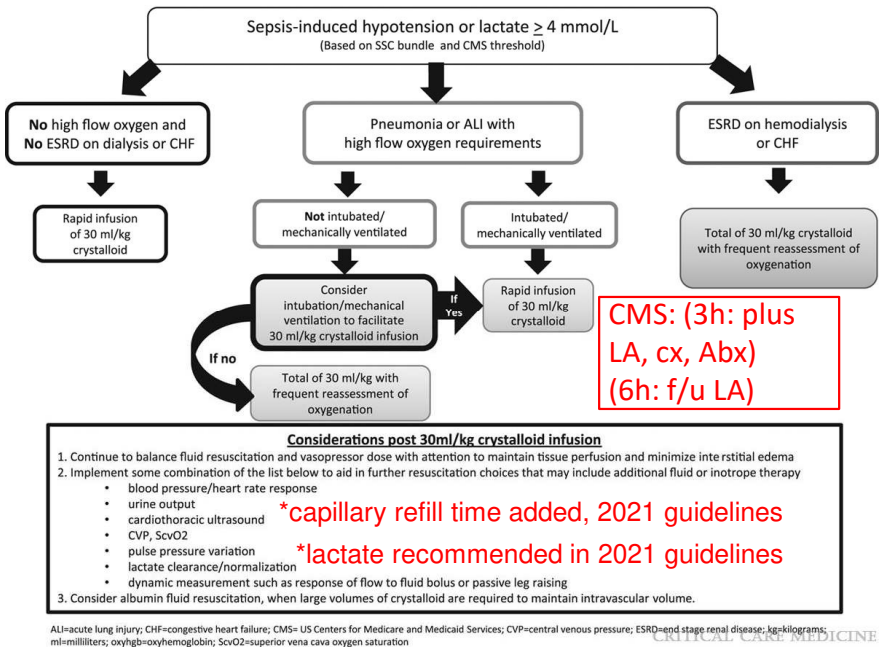
JAMA. 2016;315(8):801-810. doi:10.1001/jama.2016.0287

Case 2 continued

- After initial bedside evaluation the team received a "Sepsis Alert" from the EMR…
  - What is the evidence for sepsis alerts?

Sepsis alerts in EMR: Helpful?

- Rationale: We don't want to miss sepsis
- Reality: Mixed data on efficacy (variable effects in different systems and using different metrics, etc)...increased case detection on the good end and alert fatigue on the less good end
- Future: Better data analysis and tool creation (NIH RFA)



Surviving Sepsis Guidelines 2016, ICM 2017, 2021: "uncertain fluid goals"

The JAMA Network

From: Will This Hemodynamically Unstable Patient Respond to a Bolus of Intravenous Fluids?

JAMA. 2016;316(12):1298-1309. doi:10.1001/jama.2016.12310

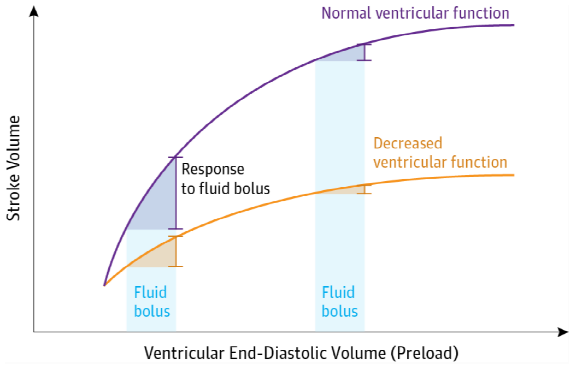


Figure Legend:

Effect of Increase in Preload on Stroke Volume of Ventricles With Normal and Decreased Contractility. Frank-Starling curves illustrate that the effect of a given increase in preload on stroke volume is dependent both on ventricular contractility and on baseline preload.

Methods for Assessing Fluid Responsiveness

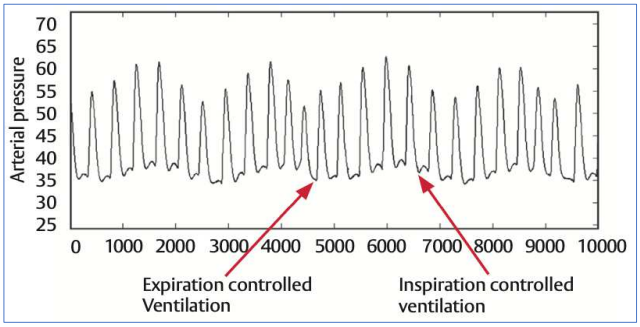
Passive leg raise (PLR) maneuver

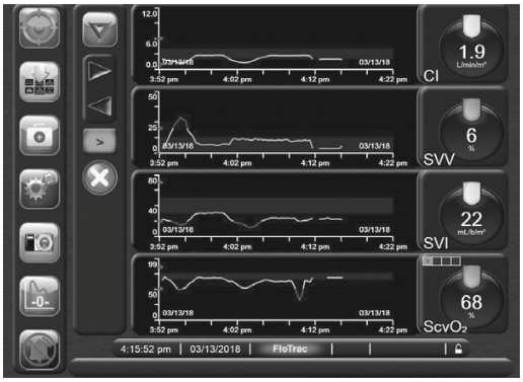
Patients who are preload responsive will:

- Usually show a maximal effect within 120 seconds

Noninvasive measures of volume responsiveness and CO (e.g., Vigileo)?

- Many use pulse pressure variability (from arterial line tracings) to estimate stroke volume variability (SVV) to predict an increase in cardiac output in response to a volume challenge.





Noninvasive measures of volume responsiveness and CO?

- As above, data suggests no optimal metric of volume responsiveness, especially in spontaneously breathing patients and those with rapidly changing pressor requirements (and patients can't be in AF, etc). Would use in conjunction with best bedside judgement.

Fluid Response Evaluation in Sepsis Hypotension and Shock

A Randomized Clinical Trial

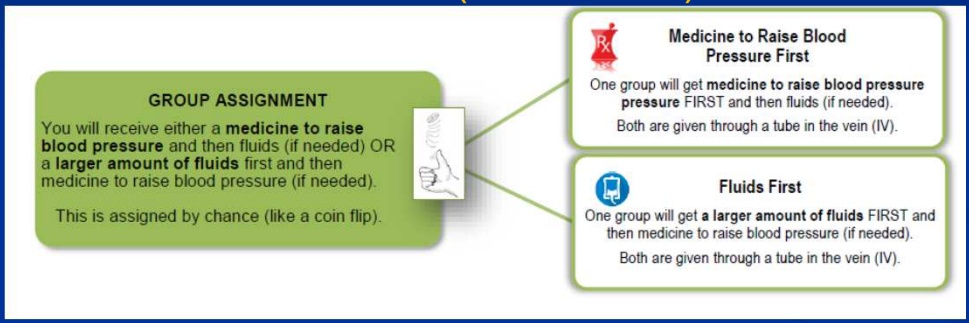
Ivor S. Douglas, MD; Philip M. Alapat, MD; Keith A. Corl, MD; Matthew C. Exline, MD, MPH; Lui G. Forni, PhD; Andre L. Holder, MD; David A. Kaufman, MD; Akram Khan, MD; Mitchell M. Levy, MD; Gregory S. Martin, MD; Jennifer A. Sahatjian, PsyD; Eric Seeley, MD; Wesley H. Self, MD; Jeremy A. Weingarten, MD; Mark Williams, MD; and Douglas M. Hansell, MD

Fluid responsiveness assessed by Passive Leg Raise to guide fluid resuscitation (n=83) vs. Usual Care (n=41). With intervention:

- Lower net positive fluid balance
- Lower risk of renal replacement and mechanical ventilation

Chest 2020

Recently completed:
CLOVER trial design (PETAL Network)
NEJM (Feb, 2023)



No difference in 90-day mortality with a restrictive vs. a liberal fluid strategy. Similar findings from an Denmark study (NEJM June, 2022).

What 'flavor' of fluid should we be using in sepsis?

NO: Hetastarch
Mostly NO: Albumin
Yes: Crystalloid…moving toward favoring LR over saline


The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Balanced Crystalloids versus Saline in Critically Ill Adults

Matthew W. Semler, M.D., Wesley H. Self, M.D., M.P.H., Jonathan P. Wanderer, M.D., Jesse M. Ehrenfeld, M.D., M.P.H., Li Wang, M.S., Daniel W. Byrne, M.S., Joanna L. Stollings, Pharm.D., Avinash B. Kumar, M.D., Christopher G. Hughes, M.D., Antonio Hernandez, M.D., Oscar D. Guillamondegui, M.D., M.P.H., Addison K. May, M.D., Liza Weavind, M.B., B.Ch., Jonathan D. Casey, M.D., Edward D. Siew, M.D., Andrew D. Shaw, M.B., Gordon R. Bernard, M.D., and Todd W. Rice, M.D., for the SMART Investigators and the Pragmatic Critical Care Research Group*


The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Balanced Crystalloids versus Saline in Noncritically Ill Adults

Wesley H. Self, M.D., M.P.H., Matthew W. Semler, M.D., Jonathan P. Wanderer, M.D., Li Wang, M.S., Daniel W. Byrne, M.S., Sean P. Collins, M.D., Corey M. Slovis, M.D., Christopher J. Lindsell, Ph.D., Jesse M. Ehrenfeld, M.D., M.P.H., Edward D. Siew, M.D., Andrew D. Shaw, M.B., Gordon R. Bernard, M.D., and Todd W. Rice, M.D., for the SALT-ED Investigators*

NEJM March 1, 2018

FLUIDS in SEPSIS BOTTOM LINE:

Bolus crystalloid, but don't overdo it.

Find your favorite way(s) to target resuscitation. Still no clear answers.*

*Monnet et al. Annals of Intensive Care (2022) 12:46

Other issues related to sepsis, including other 2021 guidelines points

- Optimal antibiotics dosing, as an example...

Original Investigation | Caring for the Critically Ill Patient

June 12, 2024

Prolonged vs Intermittent Infusions of β-Lactam Antibiotics in Adults With Sepsis or Septic Shock

A Systematic Review and Meta-Analysis

Mohd H. Abdul-Aziz, BPharm, PhD[1]; Naomi E. Hammond, RN, PhD[2,3]; Stephen J. Brett, MD[4]; et al

» Author Affiliations

JAMA. Published online June 12, 2024. doi:10.1001/jama.2024.9803

- Prolonged β-lactam infusions were associated with lower 90d mortality in ICU sepsis and septic shock patients, vs. intermittent infusions
- Extended infusions (3-4 hours) have been considered similarly in analysis to continuous infusions
- Pharmacy consultation in our ICU has been incredibly helpful

Other issues related to sepsis, including other 2021 guidelines points

- Optimal antibiotics dosing
- Acknowledges reasonable to dose pressors peripherally while awaiting central access
- Long term follow-up needs in critical illness survivors
- Accumulating data is not supporting a role for Vitamin C in sepsis (NEJM June 2022)

Case 2 continued

- Ongoing hypotension despite adequate fluid resuscitation
- Started on norepinephrine through peripheral IV
- Transferred to ICU for further management

Case 2 continued

- Continued instability led to urgent imaging
- Emphysematous pyelonephritis
- Necrotizing soft tissue infection
- Often underlying DM
- May be associated with obstruction
- Treatment: antibiotics and/or drainage; surgery in severe cases where feasible

Case 2 continued

- Cultures grew E. coli; slowly responded to antibiotics – no obstruction on imaging and poor surgical candidate, regardless.
- Course complicated by AKI requiring HD, delirium
- Hemodynamically stable but still requiring a lot of care:
  - Delirious
  - Extremely weak
  - End of life and goals of care discussions with family have been challenging
- Transfer to floor!

Take Home Messages

- Wide spectrum of illness from floor to ICU and back
- Multiple options exist for O2 delivery and respiratory support
- Data supports effective CPR, administration of epinephrine when indicated, and targeted temperature control post-arrest as important features of resuscitation efforts
- Early recognition and treatment of sepsis is key
- Early appropriate antibiotics (broad spectrum, optimally dosed) and judicious fluid resuscitation (avoiding volume overload) are important
- Close communication between floor and ICU is critical for optimal management