

Intensive Care Units

An Overview

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Definition of ICU

An ICU is an organized system for the provision of care to critically ill patients that provides intensive and specialized medical and nursing care, an enhanced capacity for monitoring, and multiple modalities of physiologic organ support to sustain life during a period of life-threatening organ system insufficiency.

- World Federation of Societies of Intensive and Critical Care Medicine

Objectives:

- Discuss the Different Units
- Workflow, Presentations, Notes
- Ventilators
- Sepsis
- Pressors
- Procedures
- End of Life

- **UH MICU:**

 - 7th floor in Seidman

 - Acutely ill, wide variety of problems

 - ED admits, floor transfers, OSH transfers

- **UHCICU:**

 - 3rd floor in Mather

 - Cardiac- STEMI, ADHF, Cardiogenic Shock, Arrhythmias

- **VA MICU:**

 - 2nd floor in VA

 - Lower threshold for ICU transfer in VA, can have less acuity

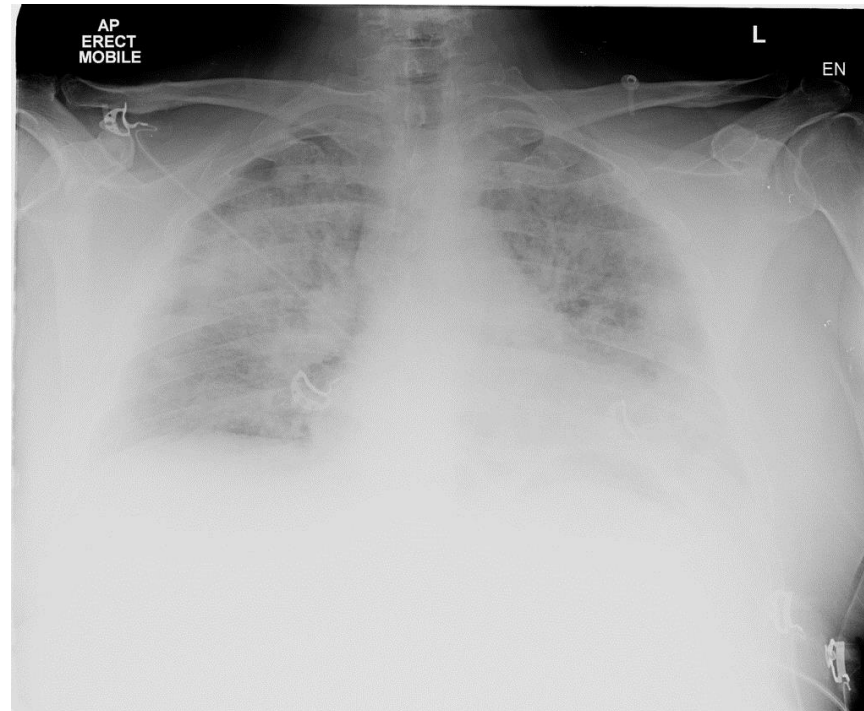
Other unit: NSU, CTICU, SICU

Case

67 year old man with history of COPD (Gold 3), DM, HFrEF (EF 35-40%), HTN, Hypothyroid who was found unresponsive by family

Vitals: Temp 39.2 HR 112 BP 86/43 RR 28 O₂ 82%

- CBC: 18.5>6.2/18.6<41 bands:12%, N:81 L:6%
- RFP: 145/6.7/98/12/64/4.2<184
- LFT: AST/ALT 1024/1405 AlkPhos 154 Bili:2.4/1.1 Alb:3.4
- INR 2.8
- LACTATE: 5.1
- TROPONIN: 1.43
- ABG: 7.18/42/64



Assessment/Plan:

Systems!

- Thinking in terms of systems, instead of individual problems, can simplify your thought process for complicated patients
- You will present a systems-based A&P on rounds
- Notes will have systems-based A&P

Systems Based:

- Neuro
- Respiratory
- Cardiovascular
- GI
- Renal
- Heme
- ID
- Endocrine

- Neuro:
 - AMS:
 - D/Dx metabolic, sepsis, trauma
 - CT head negative
 - Pain
 - Sedation while intubated
 - Fentanyl/Versed, titrate to RAAS -2
 - Sedation holiday in morning
- Resp
 - ARDS
 - On Vent, CMV 18/450/70/12
 - Wean O2 as tolerated
- Cardiovascular
 - Septic Shock
 - Levophed 0.08 mcg/mn
 - Vasopressin
 - Titrate for MAP>65
 - Elevated Troponin
 - No ischemic changes on ECG
 - Likley Type 2 in setting of hypotension
- Etc...

Ventilators:



Case

- 74 year old man with history of COPD (Gold 4), DM, HFpEF (EF 50%), HTN, who was admitted for COPD exacerbation
- Night Float called for increasing somnolence, finds patient to be lethargic and minimally responsive
- ABG: 7.28/72/89

Where is the Problem?

Case

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Where is the Problem?

Case

- 83 year old woman with history HFrEF (EF 30%), CAD (s/p PCI x2), DM, CKD3, who was admitted for HF exacerbation
- Night Float called for dyspnea, O2 sats decreasing to 84% on 4L
- ABG: 7.42/35/52

Where is the Problem?

Case

- 83 year old woman with history HFrEF (EF 30%), CAD (s/p PCI x2), DM, CKD3, who was admitted for HF exacerbation
- Night Float called for dyspnea, O2 sats decreasing to 84% on 4L
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Where is the Problem?

NIPPV

CPAP

- Continuous pressure support
- Provides PEEP, no Ventilation Support
- Benefit in Cardiogenic Pulmonary Edema

BiPAP

- Inspiratory/Expiratory Pressure Gradient
- Assists in Ventilation
- Benefit in COPD

To Intubate or not to Intubate...



Indication for Intubation:

- Increased work of breathing
- Tachypnea (RR>35)
- Severe hypoxemia (PO₂<40 mmHg)
- Acidosis (pH<7.15)
- Somnolence, inability to protect airway
- Respiratory arrest
- Neuromuscular Disease

Ventilator Modes

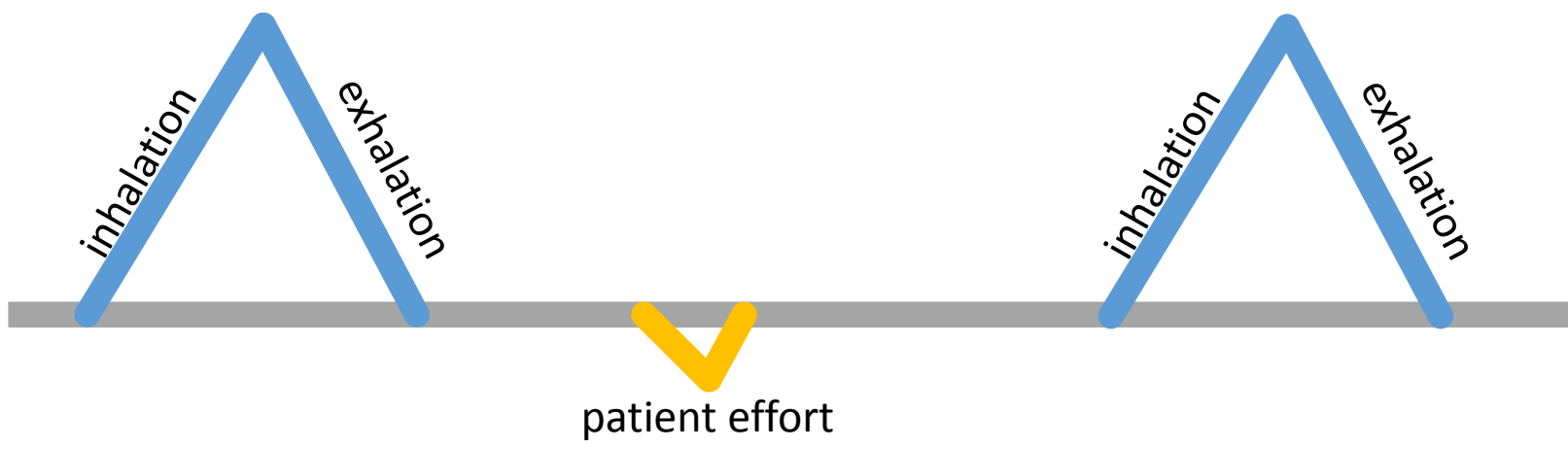
- How Much?
 - Targeting to a set pressure vs. targeting to a set volume
 - Volume Control- set volume, with variable pressure
 - Pressure Control- set pressure, with variable volume
 - No difference in outcomes with respect to ICU length of stay and mortality

Ventilator Modes

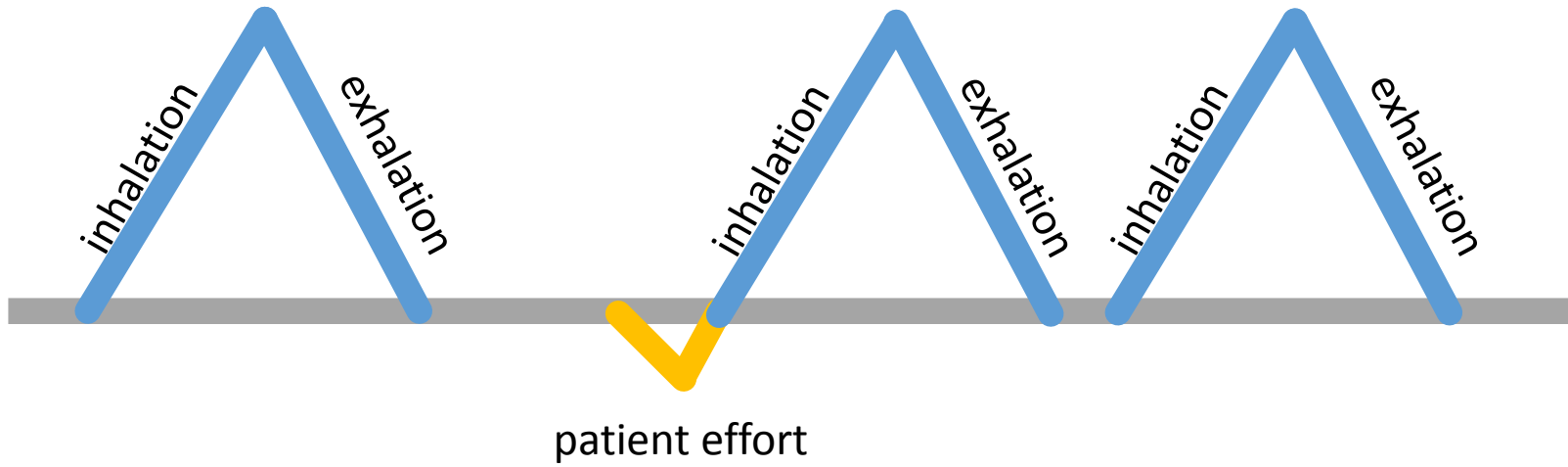
- How Often?
- CMV (controlled mechanical ventilation)
 - Set number of breaths per minute
- AC (assist control)
 - Minimum number of breaths, but patient can trigger more ventilator controlled breaths
- IMV (intermittent mandatory ventilation)
 - Minimum number of breaths, patient can take more patient controlled breaths



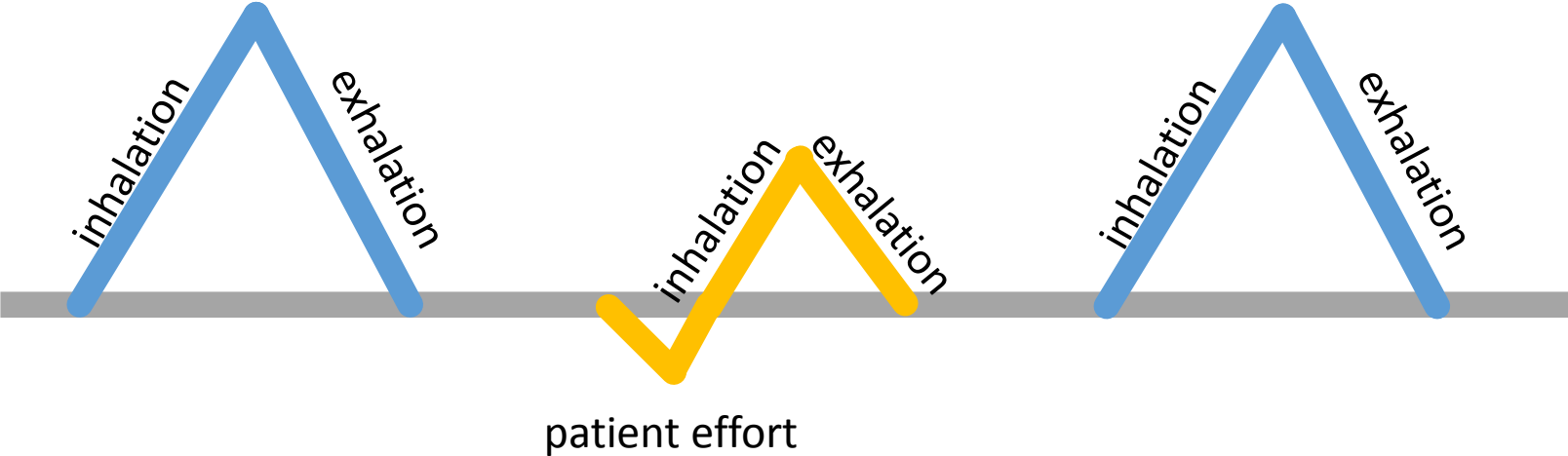
CMV



A/C



IMV



Settings

- Rate
 - Tidal Volume
 - FiO₂
 - PEEP
-
- Ventilation = Rate and Tidal Volume
 - Oxygenation = FiO₂ and PEEP

Ventilator Cases

- 81 year old woman with A Fib, HTN, DM, Hypothyroid, presented with cough, fever, dyspnea. Intubated in ED for acute hypoxic respiratory failure.
- Initial Vent settings: AC 12/450/70/5
- ABG 1 hour later: 7.37/38/205

WHAT NEXT?

Ventilator Cases

- 36 year old man with Hx of IVDU, found down, intubated in the field for respiratory arrest.
- Initial Vent settings: AC 12/450/35/5
- ABG 1 hour later: 7.28/68/120

WHAT NEXT?

Ventilator Cases

- 81 year old woman with A Fib, HTN, DM, Hypothyroid, presented with cough, fever, dyspnea. Intubated in ED for acute hypoxic respiratory failure.
- Initial Vent settings: AC 12/450/100/5
- ABG 1 hour later: 7.37/38/48

WHAT NEXT?

ARDS

- Acute inflammatory process, due to an inciting event (sepsis, aspiration, trauma, pancreatitis, etc.)
- Reported Mortality 34-46%
- Definition (Berlin Criteria, 2012):
 - Within 1 week of inciting event
 - bilateral opacities consistent with pulmonary edema that are not fully explained by effusions, lobar/lung collapse, or nodules/masses
 - Respiratory failure not fully explained by cardiac failure or fluid overload (but no longer any need to document PAWP)
- Categories:
 - Mild: $\text{PaO}_2/\text{FIO}_2$ 200-300
 - Moderate: $\text{PaO}_2/\text{FIO}_2$ 100-200
 - Severe: $\text{PaO}_2/\text{FIO}_2$ <100

Acute respiratory distress syndrome



Chest radiograph showing diffuse, bilateral, alveolar infiltrates without cardiomegaly in a patient with ARDS.

ARDS: acute respiratory distress syndrome.

Courtesy of Steven E Weinberger, MD.

UpToDate®

ARDS Mechanical Ventilation

- Low Tidal Volume Ventilation (4 to 8 mL/kg predicted body weight), protect from Ventilator Associated Lung Injury
- High PEEP strategy, if oxygenation not improving



NIH NHLBI ARDS Clinical Network
Mechanical Ventilation Protocol Summary

Lower PEEP/higher FiO₂

FiO ₂	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO ₂	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

Higher PEEP/lower FiO₂

FiO ₂	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5
PEEP	5	8	10	12	14	14	16	16

FiO ₂	0.5	0.5-0.8	0.8	0.9	1.0	1.0
PEEP	18	20	22	22	22	24

- Neuromuscular Blockade for <48 Hours may be beneficial (PaO₂/FIO₂<150)
- Prone Positioning for 2-6 hours/day may improve survival (PaO₂/FIO₂<150)

All Intubated Patients Need...

- Analgesia
- Sedation
- HOB at 30°
- PPI
- Nutrition
- Sedation Holiday (if deeply sedated)

Richmond agitation-sedation scale (RASS)

Score	Term	Description
4	Combative	Overtly combative or violent, immediate danger to staff
3	Very agitated	Pulls on or removes tubes or catheters, aggressive behavior toward staff
2	Agitated	Frequent nonpurposeful movement or patient-ventilator dyssynchrony
1	Restless	Anxious or apprehensive but movements not aggressive or vigorous
0	Alert and calm	
-1	Drowsy	Not fully alert, sustained (>10 seconds) awakening, eye contact to voice
-2	Light sedation	Briefly (<10 seconds) awakens with eye contact to voice
-3	Moderate sedation	Any movement (but no eye contact) to voice
-4	Deep sedation	No response to voice, any movement to physical stimulation
-5	Unarousable	No response to voice or physical stimulation

Weaning/Extubation

- Minimal Vent Settings
- Ability to protect airway, low secretions
- Good cough, cuff leak
- Predictors:
 - RSBI: respiratory rate/tidal volume
 - RSBI <105 breaths/min/L associated with successful extubation
 - NIF (Negative Inspiratory Force), or MIP (Maximal Inspiratory Pressure), patient takes deep breath against occluded airway
 - NIF < -30 associated with successful extubation (but not so sensitive/specific)
- SBT: 30-120 minutes without hypoxemia, tachypnea, tachycardia, hypotension

SEPSIS

- Life threatening organ dysfunction caused by the body's response to infection
- Septic shock is sepsis leading to tissue hypoperfusion, with vasopressor-requiring hypotension and elevated lactate levels
- High mortality associated with sepsis, as high as 52%

SIRS vs qSOFA

SIRS

- Temp > 38°C or <36°C
- HR >90
- RR >20 or PaCO₂ <32 mmHg
- WBC >12 or <4
 - Bands > 10%
- ≥ 2 Criteria = SIRS
- SIRS + infection = sepsis

qSOFA

- Hypotension (SBP ≤ 100)
- AMS (GCS <15)
- Tachypnea (RR ≥22)
- 2 criteria is positive score
- qSOFA is a predictor of mortality, it is not a diagnostic tool for sepsis

SOFA

Table 1. Sequential [Sepsis-Related] Organ Failure Assessment Score^a

System	Score				
	0	1	2	3	4
Respiration					
Pao ₂ /Fio ₂ , mm Hg (kPa)	≥400 (53.3)	<400 (53.3)	<300 (40)	<200 (26.7) with respiratory support	<100 (13.3) with respiratory support
Coagulation					
Platelets, ×10 ³ /μL	≥150	<150	<100	<50	<20
Liver					
Bilirubin, mg/dL (μmol/L)	<1.2 (20)	1.2-1.9 (20-32)	2.0-5.9 (33-101)	6.0-11.9 (102-204)	>12.0 (204)
Cardiovascular					
	MAP ≥70 mm Hg	MAP <70 mm Hg	Dopamine <5 or dobutamine (any dose) ^b	Dopamine 5.1-15 or epinephrine ≤0.1 or norepinephrine ≤0.1 ^b	Dopamine >15 or epinephrine >0.1 or norepinephrine >0.1 ^b
Central nervous system					
Glasgow Coma Scale score ^c	15	13-14	10-12	6-9	<6
Renal					
Creatinine, mg/dL (μmol/L)	<1.2 (110)	1.2-1.9 (110-170)	2.0-3.4 (171-299)	3.5-4.9 (300-440)	>5.0 (440)
Urine output, mL/d				<500	<200

Abbreviations: Fio₂, fraction of inspired oxygen; MAP, mean arterial pressure;

Pao₂, partial pressure of oxygen.

^a Adapted from Vincent et al.²⁷

^b Catecholamine doses are given as μg/kg/min for at least 1 hour.

^c Glasgow Coma Scale scores range from 3-15; higher score indicates better neurological function.

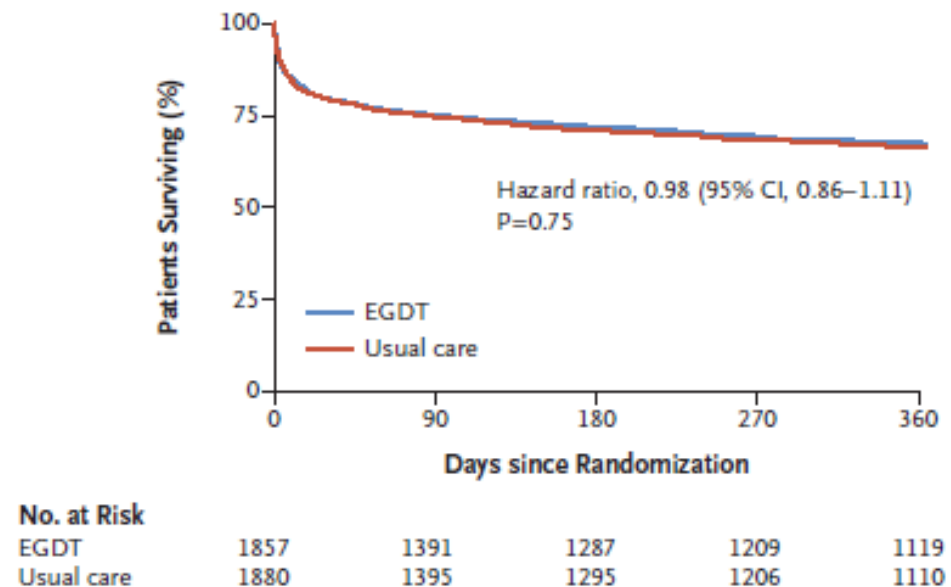
A SOFA score ≥2 reflects an overall mortality risk of approximately 10%

Early Goal Directed Therapy

- Dr. Emanuel Rivers, in 2001
- Standardized Protocol for first 6 hours
- Target of CVP 8-12 mmHg
- Target of MAP 65-90 mmHg
- Central $VO_2 > 70\%$, if less then transfuse RBC for HCT >30
- Initial study of 263 patient (130 assigned to intervention group)
- In-hospital mortality was 30.5 % vs. 46.5 %, RR 0.58 (0.38–0.87)
- Initially incorporated into 2012 Surviving Sepsis Guidelines

Early Goal Directed Therapy, Revisited

- ProCESS (2014), ARISE (2014), ProMISe (2015)
- PRISM meta analysis in NEJM in 2017
- No difference between EGDT and standard care, but increased costs



The Surviving Sepsis Campaign Bundle: 2018 Update

Mitchell M. Levy, MD, MCCM¹; Laura E. Evans, MD, MSG, FCCM²;
Andrew Rhodes, MBBS, FRCA, FRCP, FFICM, MD (res)³

INTRODUCTION

The "sepsis bundle" has been central to the implementation of the Surviving Sepsis Campaign (SSC) from the first publication of its evidence-based guidelines in 2004 through subsequent editions (1–6). Developed separately from the guidelines publication by the SSC, the bundles have been the cornerstone of sepsis quality improvement since 2005 (7–11). As noted when they were introduced, the bundle elements were designed to be updated as indicated by new evidence and have evolved accordingly. In response to the publication of "Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016" (12,13), a revised "hour-1 bundle" has been developed and is presented below (Fig 1).

The compelling nature of the evidence in the literature, which has demonstrated an association between compliance with bundles and improved survival in patients with sepsis and septic shock, led to the adoption of the SSC measures by the National Quality Forum (NQF) and subsequently both by the New York State (NYS) Department of Health (14) and the Centers for Medicare and Medicaid Services (CMS) (15) in the USA for mandated public reporting. The important relationship between the bundles and survival was confirmed in a publication from this NYS initiative (16). Paramount in the management of patients with sepsis is the concept that sepsis is a medical emergency. As with

polytrauma, acute myocardial infarction, and stroke, early identification and appropriate immediate management in the initial hours after development of sepsis improves outcomes (7–11,14,16–21). The guidelines state that these patients need urgent assessment and treatment, including initial fluid resuscitation while pursuing source control, obtaining further laboratory results, and attaining more precise measurements of hemodynamic status. A guiding principle is that these complex patients need a detailed initial assessment and then ongoing re-evaluation of their response to treatment. The elements of the 2018 bundle, intended to be initiated within the first hour, are listed in **Table 1** and presented in the following. Consistent with previous iterations of the SSC sepsis bundles, "time zero" or "time of presentation" is defined as the time of triage in the emergency department or, if referred from another care location, from the earliest chart annotation consistent with all elements of sepsis (formerly severe sepsis) or septic shock ascertained through chart review. Because this new bundle is based on the 2016 Guidelines publication, the guidelines themselves should be referred to for further discussion and evidence related to each element and to sepsis management as a whole.

HOURLY-1 BUNDLE

The most important change in the revision of the SSC bundles is that the 3-h and 6-h bundles have been combined into a single "hour-1 bundle" with the explicit intention of beginning

Thompson, MD, PhD⁴;
FCCM⁵;

ons, listed by cat-
ation of the septic
(1C); blood cultures

Surviving Sepsis, 2018

- “Hour-1 Bundle”
- Obtain Lactate
- Obtain cultures prior to initiation of antibiotics
- Start broad-spectrum antibiotics
- Fluids!!! 30ml/kg for hypotension or lactate >4
- Pressors if still hypotensive despite adequate fluid resuscitation, titrate for MAP>65

Pressors:

- Use MAP of 65 as goal
- Higher MAPs (80-85) not shown to have mortality benefit at 28 and 90 days, and is associated with higher rates of Afib
- In patients with baseline hypertension, higher MAPs (80-85) associated with less AKI and less RRT
- A-line more accurate than non-invasive BP, but using Mean BPs reduces difference between invasive and non-invasive

Vasoactive medication receptor activity and clinical effects

Drug	Receptor activity				Predominant clinical effects
	Alpha-1	Beta-1	Beta-2	Dopaminergic	
Phenylephrine	+++	0	0	0	SVR ↑↑, CO ↔/↑
Norepinephrine	+++	++	0	0	SVR ↑↑, CO ↔/↑
Epinephrine	+++	+++	++	0	CO ↑↑, SVR ↓ (low dose) SVR/↑ (higher dose)
Dopamine (mcg/kg/min)*					
0.5 to 2.	0	+	0	++	CO
5. to 10.	+	++	0	++	CO ↑, SVR ↑
10. to 20.	++	++	0	++	SVR ↑↑
Dobutamine	0/+	+++	++	0	CO ↑, SVR ↓
Isoproterenol	0	+++	+++	0	CO ↑, SVR ↓

+++ : Very strong effect; ++ : Moderate effect; + : Weak effect; 0 : No effect.

* Doses between 2. and 5. mcg/kg/min have variable effects.

Which Pressor?

- Norepinephrine (Levophed) 1st line for septic shock
 - Starting dose 0.01-0.05mcg/kg/min
- Add Vasopressin to decrease Levophed requirement
 - Vasopressin deficiency in septic shock
 - add when Levophed dose is 0.2-0.4 mcg/kg/min
- Dobutamine for cardiogenic shock
- Epinephrine for anaphylactic shock, 2nd line in septic shock
- Dopamine for cardiogenic or septic shock, but associated with more arrhythmias compared to Levophed
- “Renal Dose” Dopamine not shown to improve renal function

Adverse Effects

- Arrhythmias
- Myocardial Ischemia
- Limb Ischemia
- Kidney Injury
- Extravasation
 - Can only be given in central line
 - Exception is Phenylephrine (low concentration formulation 10mg/250mL)

Coming soon to an ICU near you...

- Angiotensin II for septic shock refractory to pressors
- ATHOS-3 trial, industry sponsored clinical trial of 321 patients
- Primary endpoint was MAP>75 or increase in MAP by 10 after 3 hours, with Angiotensin showing benefit
- Mortality difference at day 7 and 28 not statistically significant
- Selepressin, a vasopressin V_{1A} agonist, studied as replacement for norepinephrine
- Small Phase II trial (52 patients)
- Those receiving Selepressin required less norepinephrine, had less days on ventilator, with no difference in 28 day mortality.

PROCEDURES:

- Central Line
- A-line
- Paracentesis
- Thoracentesis
- LP

For all Procedures...

- Consent (unless emergent)
- Will need supervision until signed off
- Become familiar with the ultrasound
- Use full sterile technique
- Send off any diagnostics (for LP, thora, para)
- Don't forget the procedure note
- Log your procedure in MyEvaluations

Procedure Resources

- NEJM procedure videos
- EMCrit podcasts
- Touch Surgery App

END OF LIFE

- You will have critically ill patients, some of them will die
- GOC discussion early, can re-assess with changes in clinical status
- Can involve palliative care if needed
- Use End-of-Life order sets
- Emotionally trying time for family, they may react in different ways

ASK FOR HELP!