Anesthetic Management of the Patient with Sepsis: The SSC, Guidelines, and Evidence

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'We conclude that goal-directed therapy provided at the earliest stages of severe sepsis and septic shock…… has significant short-term and long-term benefits. These benefits arise from the early identification of patients at high risk for cardiovascular collapse and from early therapeutic intervention to restore a balance between oxygen delivery and oxygen demand….. outcome trials should consider the quality and timing of the resuscitation --- as an important outcome variable.'

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Goal Directed

Utilization of 'monitors/technology' to assess CV performance

Guides interventions based on a predetermined algorithm

Algorithm is based on the evidence…

….that influences our decision to administer fluids, inotropes, vasopressors

Achieving hemodynamic stability during and after surgery to ensure necessary and adequate perfusion and oxygenation

THE GOAL

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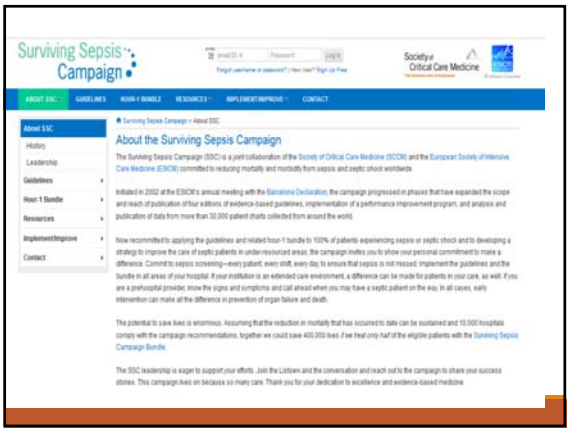

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Surviving Sepsis Campaign

Objectives ~

Reduce mortality from sepsis by 25% via a 7-point agenda including:

- Building awareness of sepsis
- Improving diagnosis
- Increasing the use of appropriate treatment
- Educating healthcare professionals
- Improving post-ICU care
- Developing guidelines of care
- Implementing a performance improvement program

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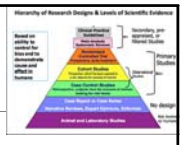
The methodology used to establish the guidelines



Recommendation	Strength	Quality	Description
Recommendation in favor of a therapy	Strong	High Moderate	A recommendation in favor of a therapy is formulated as strong or weak and graded from high to very low based on careful assessment of available evidence.
	Weak	Low Very low	
	Strong	Best practice statement (no grading)	A best practice statement (BPS) is an ungraded strong recommendation, given when the benefit is undisputable, but the evidence is difficult to assess using GRADE methodology.
No recommendation	Neutral	No grading	No recommendation is given when RCTs have been conducted, but the results are not substantial or clear enough to recommend the therapy. Further research is needed to clarify the potential benefit of the therapy.
Recommendation against a therapy	Strong	Best practice statement (no grading)	A best practice statement (BPS) is an ungraded strong recommendation, given when the harm is undisputable, but the evidence is difficult to assess using GRADE methodology.
	Weak	Very low Low	A recommendation against a therapy is formulated as strong or weak and graded from high to very low based on careful assessment of available evidence.
	Strong	Moderate High	

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Case Scenario

60 year old male, ASA II

Past Medical History
- HTN
- Hypercholesterolemia

Past Surgical History
- Stay tuned – becomes significant

Current Medications
- Lisinopril (ACE inhibitor)
- Simvastatin (Statin)

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Initial Presentation

Flu like symptoms:
- Generalized muscle weakness
  - Fall

Severe back pain resulting in:
- ER visit #1
  - Negative diagnostic findings – back, arm, clavicle, other
    - Arm sling
  - Discharge medications:
    - Diazepam
    - Hydrocodone/paracetamol

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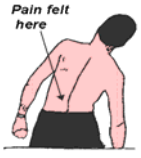
Were the Crucial Signs 'Missed'?

Sepsis symptom: pain or discomfort

Symptoms
- Bone pain
- Fever
- General discomfort, uneasiness, or ill-feeling (malaise)
- Local swelling, redness, and warmth
- Other symptoms that may occur with this disease:
- Chills
- Excessive sweating
- Low back pain
- Swelling of the ankles, feet, and legs



The pain from fighting off a sepsis infection can be felt 'all over or localized'.

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Progression of disease

4 days later
- Medications- minimal relief
- Acute chills and alteration in level of consciousness
- Swollen/sore wrist L

ER visit #2
- Triage
- Hand/wrist inflammation
- ↑ WBC, lactate, fever, flu like symptoms, tachycardia, normotensive
- Radiographic diagnostics
  - = hospital admission

Sepsis protocol set in motion –SEPSIS BUNDLES

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SEPSIS

Defined
- Life threatening
- Organ dysfunction
  - Caused by dys-regulated host response to infection
- SEPTIC SHOCK
  - Subset of sepsis w higher risk of mortality
    - Circulatory dysfunction
    - Cellular dysfunction
    - Metabolic dysfunction

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SEPSIS BUNDLES

Cornerstone of sepsis quality improvement
- Designed to be updated – new evidence

Sepsis considered medical emergency:

Analogy-
- Poly-trauma
- MI
- Stroke

EARLY identification and evidence-based management:
- IMPROVES OUTCOMES

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What is a 'bundle'?

A selected set of elements of care that, when implemented as a group, have an effect on outcomes beyond implementing the individual elements alone

Sepsis protocols may be customized, but must meet the standards created by the bundle

The aim is to create a reliable system reducing odds for both death and morbidity

Examples of Bundles of Care

- Foley Catheter Nursing Care Bundle
- Central Vascular Catheter Maintenance Care Bundle
- Peripheral Vascular Catheter Maintenance Care Bundle
- Surgical Site Infection Prevention Care Bundle
- Catheter Associated UTI Care Bundle

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Select the incorrect answer

What is the significance of lactate?

A. No significance; another way to charge for diagnostics

B. Lactate is overproduced by increased anaerobic glycolysis {when tissue hypoxia is present; typically occurring with sepsis}

C. Lactate clearance at a discrete time point is an important prognostic factor compared to initial lactate level in severe sepsis

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Select the correct answer

What is a 'normal' lactate level?

A. in unstressed patients - 0.5-1 mmol/L

B. lactic acidosis is characterized by persistently increased blood lactate levels (usually >4-5 mmol/L) in association with metabolic acidosis

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The 411 - LACTATE

Acute hospital mortality according to serum lactate level in septic patients requiring vasopressors

Hospital mortality	Initial serum lactate level (mmol/L)			P value
	<4	4-8	>8	
24-hour mortality, n (%)	1 (10.0)	14 (35.0)	19 (52.8)	0.011
48-hour mortality, n (%)	3 (30.0)	26 (65.0)	26 (72.2)	0.033

Decreasing or normalized lactate levels are important signs of recovery from septic shock

'This clinical finding supports that serum lactate level is a more sensitive vital sign reflecting anaerobic metabolism and acidosis than BP ~ further clinical studies are necessary to support this'

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1) Lactate is important source of energy

2) When not produced, humans cannot survive

3) It also contributes to acidic environment by converting to lactic acid

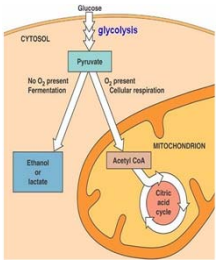
4) It also is converted to bicarbonate and becomes a main source of alkalemia under normal conditions

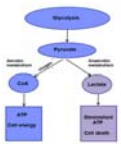
5) 1,400–1,500 mmol/L per day formed, from reduction of pyruvate largely generated by anaerobic glycolysis

6) In tissue hypoxia, lactate is overproduced by increased anaerobic glycolysis

7) Lactate clearance - in the liver (60%), the kidney (30%), and to a lesser extent by other organs (heart and skeletal muscle)

8) Lactate clearance cannot overcome lactate production and may be worsened during critically ill status





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Lactic acidosis ~ caused by increasing lactate levels.

Again, typically derived from tissue hypoxia in clinical situations

→ septic shock

Acidotic conditions caused by lactic acidosis do bad things:
- depress cardiac function
- decrease the response of vasopressors

In contrast, sodium bicarbonate, which is (incorrectly used) to correct metabolic acidosis, may aggravate lactic acidosis and increase mortality

Early detection of septic shock based on a new definition is very important because early management of infection can reverse lactic acidosis and shock status

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Why not sodium bicarbonate?

One thing is clear, sodium bicarbonate is not the hero we have been searching for. Unfortunately, the buffer we all know and want to love is ineffective in producing any significant change that will alter outcomes in the setting of the acutely acidemic patient. Why? Well to understand this, we'll have to do a brief dive (a "wade") into the relevant human biochemistry.

$$HCO_3^- + H^+ \rightleftharpoons H_2CO_3 \rightleftharpoons CO_2 + H_2O$$

Bicarb — Hydrogen ion (your acid) — Carbonic Acid — Carbon Dioxide — Water

The patient can blow it out OR The whole pathway reverses and you get more acid

So if you give sodium bicarbonate in an attempt to scavenge your troublemaking protons, you'll get carbonic acid which dissociates into carbon dioxide and water, which can freely diffuse across the cell membrane creating an intracellular acidosis. If you can get rid of carbon dioxide (blow it off), you will force the equation to the "right" and get rid of your protons. However, patients in extremis may not be able to compensate for the increased carbon dioxide with increased respiratory drive further exacerbating intracellular acidemia.

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Another component in the 1-hour bundle

Blood is injected in to the bottles with culture media

So what about our patient? He did have BC drawn in 2nd ER visit; broad spectrum antibiotics given

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True or False?

Sterilization of cultures can occur within minutes of the first dose of an appropriate antimicrobial, so cultures must be obtained before antibiotic administration to optimize the identification of pathogens and improve outcomes

Absolutely TRUE

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BACTEREMIA

However best practice – don't delay antibiotics in order to obtain cultures! HOW LONG OF A DELAY IS APPROPRIATE ??

Empiric broad spectrum therapy with ≥ 1 antimicrobial should be started immediately if presenting with sepsis or shock.

Empiric therapy should be narrowed once pathogen identified and sensitivities established!

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Challenging the process, and, the health of our patients -Two Types of Anaerobes we have to deal with

Facultative	Obligate
- can live with or without O_2	- must live without O_2
- when present use aerobic cellular respiration to produce energy in the form of ATP	- are only equipped to undergo anaerobic respiration or fermentation, and the presence of oxygen kills
- if oxygen becomes depleted, they can switch to anaerobic respiration or fermentation	

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- Cell Respiration
  - Produces massive amounts of ATP (~38 ATP)
  - Needs O_2
  - Thought to have evolved after fermentation.
  - Final e^- acceptor is O_2

- Fermentation
  - Produces little ATP (only 2 ATP through glycolysis)
  - Does not need O_2
  - Thought to have evolved first.
  - Final e^- acceptor is pyurvate

Fermentation is a metabolic process that consumes sugar in the absence of oxygen. The products are organic acids, gases, or alcohol. It occurs in yeast and bacteria, and also in oxygen-starved muscle cells, as in the case of lactic acid fermentation. The science of fermentation is known as zymology.

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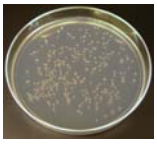
Facultative anaerobes

Escherichia coli

Staphylococcus aureus



Obligate Anaerobes

Clostridium tetani: Causes tetanus

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Aerobic Bacteria – Grow in the presence of oxygen

Bacillus

Mycobacterium tuberculosis

Nocardia

Lactobacillus

Pseudomonas Aeruginosa

Pa Th O Ge N

O H C Ra P

You can say anything with chemistry. ANYTHING

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The case scenario – diagnosis - septic arthritis

Septic arthritis, AKA infectious arthritis -direct invasion of joint space by various microorganisms, most commonly caused by bacteria.

Approximately 20,000 cases - United States each year (7.8 cases per 100,000 person-years)

Because of the increasing use of prosthetic joints, infection associated with these devices has become the most common and challenging type of septic arthritis

Septic arthritis is also becoming increasingly common among people who are immunosuppressed and elderly persons.

45% are older than 65 years; these groups are more likely to have various comorbid disease states. 56% of patients with septic arthritis are male.

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Pneumococcal Infections (Streptococcus pneumoniae)

Pneumococcal infections are caused by Streptococcus pneumoniae, a gram-positive, catalase-negative organism commonly referred to as pneumococcus.

S pneumoniae is the most common cause of community-acquired pneumonia (CAP), bacterial meningitis, bacteremia, and otitis media, as well as an important cause of sinusitis, septic arthritis, osteomyelitis, peritonitis, and endocarditis.

Complications of each of these diagnoses are common.

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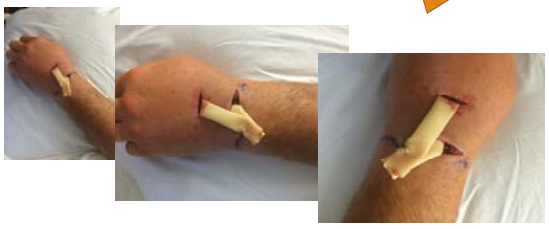
Surgery and Anesthesia 1

Source control surgery when? 6-12 hours after diagnosis

Surgery 1/Anesthesia 1 – General LMA



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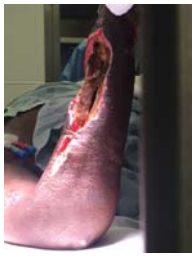
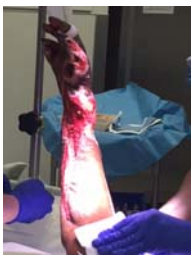
Trying to prevent….THIS





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Urgent / emergent case SOURCE CONTROL SURGERY

The principles
- SC in the management of sepsis and septic shock – rapid diagnosis of specific site of infection
  - Determination whether infection is amendable to source control measures
- Drainage of an abscess
- Debridement of infected necrotic tissue
- Removal of a potentially infected device
- Definitive control of a source of ongoing microbial contamination
  - Prevent the travel of the bug!

Readily amenable to SC
- Intra-abdominal abscesses
- GI perforation
- Ischemic bowel or volvulus
- Cholangitis
- Cholecystitis
- Pyelonephritis w obstruction or abscess
- Necrotizing soft tissue infection
- Deep space infection
  - Septic arthritis empyema
- Implanted device infections

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1st I and D – Preoperative Glucose > 300 m/dL

Give insulin –
- 2 consecutive levels ≥180 mg/dL

Target ≤ 180 mg/dL

Monitor every 1-2 hours

Point of care versus laboratory *

perioperative hypoglycemia is found to be an independent risk factor for mortality

Another Goal – prevent hypoglycemia masked by anesthesia

Neuroglycopenic symptoms and symptoms of the adrenergic response to hypoglycemia are the two main manifestations of hypoglycemia. Neuroglycopenic manifestations generally begin with confusion, irritability, fatigue, headache, and somnolence. Prolonged, severe hypoglycemia may cause seizures and even focal neurological deficits,coma, and death.

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Current Aspects in the Pathophysiology and Treatment of Chronic Wounds in Diabetes Mellitus

BioMed Research International Volume 2013, Article ID 535641

…….exposure to high glucose is associated with changes in cellular morphology, decreased proliferation, and abnormal differentiation of keratinocytes……

HOW LONG HAS THIS PATIENT HAD UNDIAGNOSED DIABETES?

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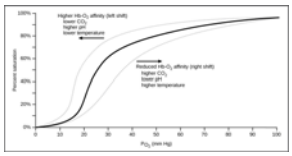
POD 2 – 3

Progressing to Septic Shock?
Hypoxemia
Febrile
Not responding to antimicrobials
NOT IMPROVING

RAPID RESPONSE- Emergent CT – Transfer to the ICU

At this stage arterial blood gas analysis may reveal a primary metabolic acidosis as well as hypoxemia. … The blood lactate level is elevated.

Some patients in septic shock may be clinically indistinguishable from those with shock of any cause.



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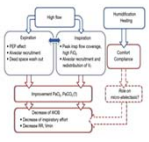
CT - ICU – NUMEROUS CONSULTATIONS - AND - High Flow Nasal Cannula Oxygen Therapy

High-flow nasal cannula oxygen therapy in adults



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Wound debridement #2

Tachycardic

High flow nasal oxygen

Antimicrobial therapy appropriate to cultures

'riding the fence'

Anesthesia consultation -

THEY consulted infectious disease

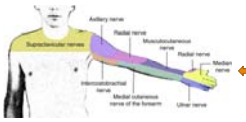
Who consulted intensivist

And consulted hand surgeon (performing the 2nd I and D)

AND now cardiology involved !

NOW THAT IS WHAT I CALL COORDINATION OF CARE –

- And the anesthesia? Axillary block,
- No sedation
- Head phones and music therapy!



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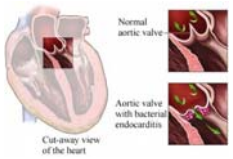
AND THEN: The bedside TEE – Anesthesia #3
Diagnosis – Infectious endocarditis, Aortic regurgitation



COMPLICATIONS OF ENDOCARDITIS

- **Cardiac**
  - congestive cardiac failure valvular damage,
  - more common with aortic valve endocarditis,
  - infection beyond valve→ CCF,
  - higher mortality,
  - need for surgery,
  - A-V, fascicular or bundle branch block,
  - pericarditis, tamponade or fistulae
- **Systemic emboli**
  - Risk depends on valve (mitral>aortic), size of vegetation, (high risk if >10 mm)
  - 20-40% of patients with endocarditis,
  - risk decreases once appropriate antimicrobial therapy started.

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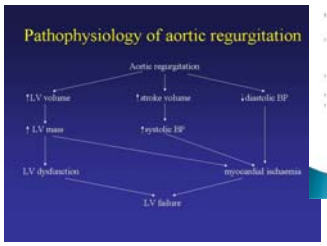
Infectious Endocarditis



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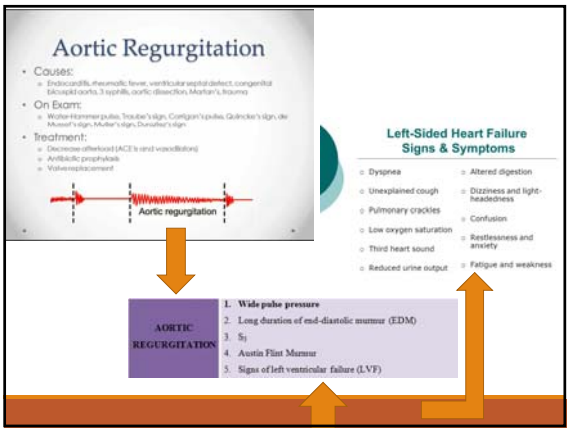

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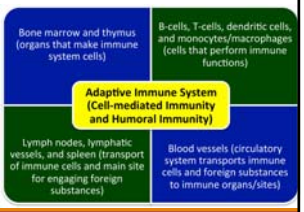
What were those 2 previous surgeries?

1st one – Minimally invasive laminectomy

BUT the 2nd one?

Splenectomy – as a young adult



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s/p splenectomy

If the spleen stops working normally or is surgically removed, the body's immune system can usually compensate. However, there is a small but significant risk of sepsis.

The risk of sepsis is highest in the following groups:

- Children whose spleens are removed during infancy
- People with lymphoma who are treated with splenectomy, radiation, and chemotherapy

Sepsis can also develop in otherwise healthy adults who have had their spleen removed, particularly in the first few years following splenectomy. The lifetime risk of sepsis after splenectomy is about 1 to 2 percent.

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Back to antibiotics and timing…

IV antimicrobials ASAP after recognition and within 1 hour!

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3rd component in First HOUR Bundle - Initial Resuscitation

Begin rapid administration of 30ml/kg crystalloid for hypotension or lactate ≥4 mmol/L.

Presence of sepsis induced hypoperfusion

- At least 30 ml/kg of IV crystalloid within 1st 3 hours
- Additional fluids guided by frequent reassessment of hemodynamic status
- Crystalloids – fluid of choice

'Due to the importance of fluids in the resuscitation of sepsis patient, it is imperative that …. decision making in this regard be guided by a strong evidence base. We contend that there is a need for further research on the use of crystalloids to develop evidence-based guidelines for future clinical decision making'.

- Cureus. 2016 Mar; 8(3): e528. The Use of Fluids in Sepsis

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Hypoperfusion

SIGNS OF DECREASED PERFUSION

Organ dysfunction	↓ Perfusion	↓↓ Perfusion	↓↓↓ Perfusion
CNS	—	Restless, apathetic, anxious	Agitated/confused, coma
Respiration	—	↑ Ventilation	↑↑ Ventilation
Metabolism	—	Compensated metabolic acidemia	Uncompensated metabolic acidemia
Gut	—	↑ Motility	Ileus
Kidney	Decreased urine volume Increased specific gravity	Oliguria < 0.5 mL/kg/hr	Oliguria/anuria
Skin	Delayed capillary refill	Cold extremities	Mottled, cyanotic, cold extremities
CVS	Increase heart rate	2° increase HR	2° increase HR

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True or False – Albumin?

SSC guidelines state:

Use albumin in addition to crystalloids when a requirement for substantial amounts of crystalloids exists?

…we suggest using albumin in addition to crystalloids for initial resuscitation and subsequent intravascular volume replacement in patients with sepsis and shock ….

(Weak recommendation, low quality of evidence)

I call this: the studies are inconclusive

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Albumin

n engl j med 370;15 nejm.org april 10, 2014

ORIGINAL ARTICLE

Albumin Replacement in Patients with Severe Sepsis or Septic Shock

CONCLUSIONS

In patients with severe sepsis, albumin replacement in addition to crystalloids, as compared with crystalloids alone, did not improve the rate of survival at 28 and 90 days. Our results confirm that administration of albumin produces small but significant hemodynamic advantages. A significantly greater proportion of patients in the albumin group than in the crystalloid group reached the targeted mean arterial pressure within 6 hours after randomization. During the first 7 days, the mean arterial pressure was higher, whereas the heart rate and net fluid balance were lower, in the albumin group than in the crystalloid group. Moreover, the average cardiovascular SOFA subscore over the course of the study period was lower in the albumin group, and the time to the suspension of inotropic or vasopressor agents was shorter, indicating a decreased use of vasopressors.

These findings confirm a physiological advantage of albumin administration during severe sepsis, including a larger fluid distribution within the intravascular compartment and, in addition, possible effects of albumin as a scavenger of nitric oxide,mediating peripheral vasodilatation during sepsis.

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Albumin

Albumin -- normal range is 3.5 to 5.5 g/dL or 35-55 g/liter

Adverse Reactions

The most serious events = anaphylactic shock, circulatory failure, cardiac failure, and pulmonary edema.

The most common adverse events are anaphylactoid type of reactions.

Adverse reactions for Albumin (Human) 20% normally resolve when the infusion rate is slowed down or the infusion is stopped. In case of severe reactions, the infusion should be stopped and appropriate treatment should be initiated.

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Target Blood Pressure?

What is the recommended initial target MAP in patients with septic shock requiring vasopressors?

> 65 mmHg

$$\text{MAP} = \text{diastolic P} + \frac{1}{3}(\text{systolic P} - \text{diastolic P})$$

For the given values, the formula is:

$$\text{MAP} = 73 + \frac{1}{3}(115 - 73)$$

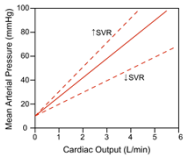
$$= 73 + \frac{1}{3}(42)$$

$$= 73 + 14$$

$$= 87$$

Hence,

MAP = 87 mm Hg



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What is the driving pressure of tissue perfusion?

MAP

While perfusion of critical organs such as the brain or kidney may be protected from systemic hypotension by autoregulation of regional perfusion, below a threshold MAP, tissue perfusion becomes linearly dependent on arterial pressure

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What is the FIRST choice vasopressor?

Select the correct answer

1 phenylephrine?

2 epinephrine?

3 norepinephrine?

4 dopamine?

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5th component of first hour bundle

Apply vasopressors if patient is hypotensive during or after fluid resuscitation to maintain MAP ≥ 65 mmHg

Vasopressors

Norepinephrine as the first choice vasopressor (strong recommendation, moderate quality of evidence).

Adding either **vasopressin** (up to 0.03 U/min) (weak recommendation, moderate quality of evidence) or **epinephrine** (weak recommendation, low quality of evidence) to norepinephrine with the intent of raising MAP to target, or adding vasopressin (up to 0.03 U/min) (weak recommendation, moderate quality of evidence) to decrease norepinephrine dosage.

Surviving Sepsis Campaign

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Norepinephrine functions as a peripheral vasoconstrictor by acting on alpha-adrenergic receptors. It is also an inotropic stimulator of the heart and dilator of coronary arteries as a result of it's activity at the beta-adrenergic receptors.

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Curr Opin Crit Care. 2017 Aug;23(4):342-347. doi: 10.1097/MCC.0000000000000418.
Norepinephrine in septic shock: when and how much?
Hamzaoui O1, Scheeren TWL, Teboul JL.

Abstract

PURPOSE OF REVIEW:

Norepinephrine is the first-line agent recommended during resuscitation of septic shock to correct hypotension due to depressed vascular tone. Important clinical issues are the best timing to start norepinephrine, the optimal blood pressure target, and the best therapeutic options to face refractory hypotension when high doses of norepinephrine are required to reach the target.

RECENT FINDINGS:

Recent literature has reported benefits of early administration of norepinephrine because of the following reasons: profound and durable hypotension is an independent factor of increased mortality, early administration of norepinephrine increases cardiac output, improves microcirculation and avoids fluid overload. Recent data are in favor of targeting a mean arterial pressure of at least 65 mmHg and higher values in case of chronic hypertension. When hypotension is refractory to norepinephrine, it is recommended adding vasopressin, which is relatively deficient during sepsis and acts on other vascular receptors than α1-adernergic receptors. However, increasing the dose of norepinephrine further cannot be discouraged.

SUMMARY:

Early administration of norepinephrine is beneficial for septic shock patients to restore organ perfusion. The mean arterial pressure target should be individualized. Adding vasopressin is recommended in case of shock refractory to norepinephrine.

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SVO2

Perfusion monitoring

- After several recent negative trials testing the use of central venous oxygen saturation (ScvO2) as a target for early resuscitation of septic shock –
  - the SSC has abandoned its initial recommendation to include ScvO2 as part of standard monitoring

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Rationale

The use of CVP alone to guide fluid resuscitation can no longer be justified:

because the ability to predict a response to a fluid challenge when the CVP is within a relatively normal range (8–12 mm Hg) is limited

The same holds true for other static measurements of right or left heart pressures or volumes. Dynamic measures of assessing whether a patient requires additional fluid have been proposed in an effort to improve fluid management and have demonstrated better diagnostic accuracy at predicting those patients who are likely to respond to a fluid challenge by increasing stroke volume.

These techniques encompass passive leg raises, fluid challenges against stroke volume measurements, or the variations in systolic pressure, pulse pressure, or stroke volume to changes in intrathoracic pressure induced by mechanical ventilation

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What is 'time zero' for initiating bundle?

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So what happened to our patient?

1. Successful AVR, open
2. Home w MIDLINE catheter and 6 weeks ceftriaxone
3. PCN for…….ever
4. Extensive physical and occupational therapy – 9 months
5. Confirmed adult onset diabetes; metformin (biguanide)

TAKE HOME POINT – EARLY INTERVENTION AND GOAL DIRECTED THERAPY SAVED HIS LIFE.

AND OF COURSE – THE HIGHEST QUALITY CRNA CARE

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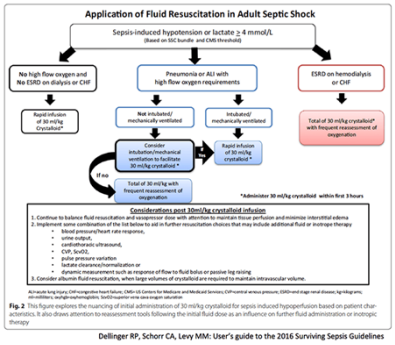

Fig. 2 This figure explores the nuancing of initial administration of 30 ml/kg crystalloid for sepsis induced hypoperfusion based on patient characteristics. It also draws attention to reassessment tools following the initial fluid dose as an influence on further fluid administration or inotropic therapy

Dellinger RP, Schorr CA, Levy MM: User's guide to the 2016 Surviving Sepsis Guidelines

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Use low tidal volumes of 6 mL/kg of predicted body weight for people with sepsis-induced ARDS (or from any cause). (Strength: Grade 1A, as compared against 12 mL/kg).

The plateau pressure in people with ARDS should be measured and ideally maintained ≤ 30 cm H2O with passive inflation of the lungs during mechanical ventilation (Grade 1B).

If plateau pressures ≤ 30 cm H2O can't be achieved with 6 mL/kg tidal volumes, try reducing them even lower, to 5 or 4 mL/kg (as low as 280 mL for a 5' 9" man).

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Why?
The landmark ARDSNet trial demonstrated a 9% absolute reduction in mortality in people with ARDS treated with tidal volumes 6 mL/kg compared to 12 mL/kg predicted body weight. They also targeted a plateau pressure ≤ 30 cm H2O. Subsequent meta-analyses supported these findings of benefit from low tidal volume ventilation for ARDS.

But: Individual patient factors should be considered when choosing the tidal volume in sepsis-induced ARDS, such as:

1. Reduced chest wall / abdominal compliance (most often due to obesity), which may necessitate higher plateau pressures to achieve minimal gas exchange parameters;
2. Amount of PEEP being applied (adds to plateau pressure);
3. Patients' breathing efforts (which increase transalveolar pressure for any given plateau pressure) and ventilatory demand, such as from metabolic acidosis.

FYI ~ High frequency oscillatory ventilation (HFOV) was not been shown to be beneficial as first-line therapy for ARDS in two large randomized trials.

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Positive End-Expiratory Pressure (PEEP) for ARDS due to Sepsis

Should be used during mechanical ventilation for ARDS, to prevent atelectotrauma (shear stress as alveoli expand and collapse during mechanical ventilation) (Grade 1B)

With moderate-to-severe ARDS due to sepsis, higher PEEP is suggested (Grade 2C). Higher PEEP can be titrated according to measurements of respiratory compliance, or more simply according to oxygenation

Why?

Animal experiments show PEEP prevents ventilator-induced lung injury when high plateau pressures are present. In a 2010 meta-analysis, people with moderate or severe ARDS (PaO2/FiO2 ≤ 200 mm Hg) appeared to benefit from a higher PEEP strategy (but those with less severe ARDS did not).

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Summary

Fluids

Ventilation

Vasopressors

Glycemic Control

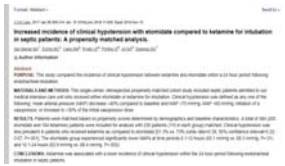
Antibiotics

Cultures

Anesthesia

Steroids – ADRENAL Trial = ADjunctive corticosteroid tREatment IN criticAlly ill patients with septic shock

We still don't have a conclusive answer to the use of Etomidate


Increased incidence of clinical hypotension with etomidate compared to ketamine for intubation in septic patients: A propensity matched analysis.

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