2025 심장혈관흉부외과 전공의 연수교육

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Diagnosis and Treatment of Septic Shock : An Update for Cardiothoracic Surgery Residents

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01 Introduction & Definitions

What is Sepsis & Septic Shock?

Sepsis:

A life-threatening **organ dysfunction** caused by a dysregulated host **response to infection**.

-SOFA score ≥ 2

- PaO2/FiO2
- Hypotension
- Platelet count
- GCS score
- Bilirubin
- Cr, oliguria

-qSOFA score ≥ 2

- respiratory rate ≥ 22/min
- altered mental status
- systolic blood pressure ≤ 100mmHg

→ **score ≥ 2 suggest a higher risk of a poor outcome**

→ **Does not define sepsis (rapid tool)**

(JAMA.2016;315(8):801-810)

01 Introduction & Definitions

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-SOFA score **≥ 2**

Septic Shock:

A **subset of sepsis** with profound **circulatory, cellular, and metabolic abnormalities**, associated with a greater **risk of mortality** than sepsis alone.

-Clinical Criteria:

1. Persistent hypotension **requiring vasopressors** to maintain a **MAP of ≥ 65 mm Hg.**
2. A serum **lactate level > 2 mmol/L** (18 mg/dL) despite adequate volume resuscitation.

Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock 2021. *Crit Care Med*. 2021;49(11):e1063.

02 Early Recognition & Diagnosis

The Critical First Step: Rapid Screening & Diagnosis

Screening Tools:

-qSOFA (Quick SOFA)

-SIRS, NEWS, or MEWS

MEWS (Modified Early Warning System)

	3	2	1	0	1	2	3
Respiratory Rate per minute		Less than 8		9-14	15-20	21-29	More than 30
Heart Rate per minute		Less than 40	40-50	51-100	101-110	111-129	More than 129
Systolic Blood Pressure	Less than 70	71-80	81-100	101-199		More than 200	
Conscious level (AVPU)	**U**nresponsive	Responds to **P**ain	Responds to **V**oice	**A**lert	New agitation Confusion		
Temperature (°c)		Less than 35.0	35.1-36	36.1-38	38.1-38.5	More than 38.6	
Hourly Urine For 2 hours	Less than 10mls / hr	Less than 30mls / hr	Less than 45mls / hr				

EARLY WARNING SCORING SYSTEM FOR DETECTING ADULT PATIENTS WHO HAVE OR ARE DEVELOPING CRITICAL ILLNESS

IS THE SCORE FOR YOUR PATIENT 1-2? PERFORM 2 HOURLY OBSERVATIONS AND INFORM NURSE IN CHARGE

IS THE SCORE FOR YOUR PATIENT 3? PERFORM 1-2 HOURLY OBSERVATIONS AND INFORM NURSE IN CHARGE

*IF THE MEWS SCORE IS DETERIORATING : THE WARD S.H.O. OR DUTY DOCTOR **MUST** ATTEND*

IS THE SCORE FOR YOUR PATIENT 4 OR MORE? PERFORM OBSERVATIONS AT LEAST 1/2 HOURLY. ENSURE MEDICAL ADVICE IS SOUGHT AND CONTACT OUTREACH TEAM (see below)

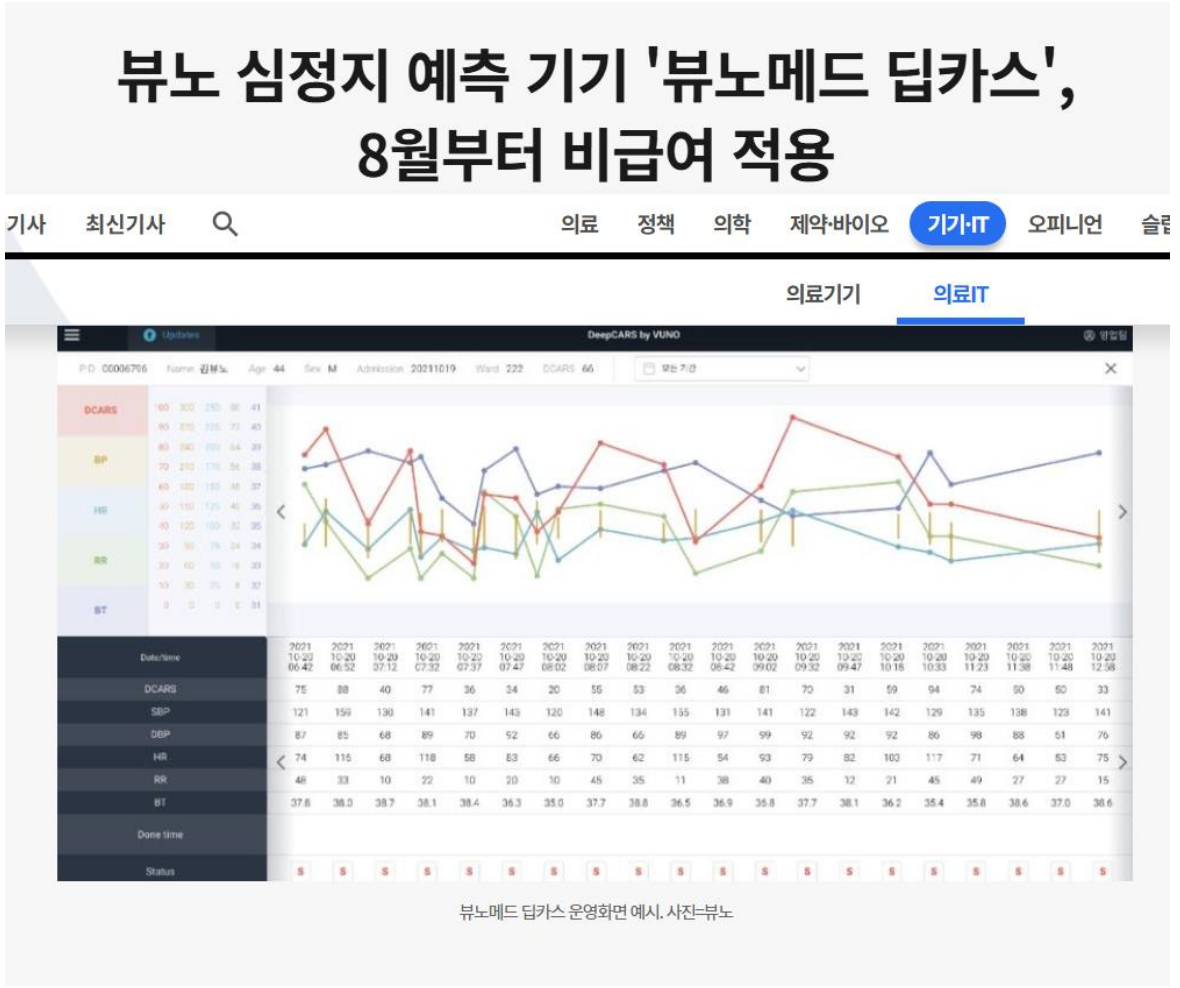
National Early Warning Score (NEWS)*

PHYSIOLOGICAL PARAMETERS	3	2	1	0	1	2	3
Respiration Rate	≤8		9 - 11	12 - 20		21 - 24	≥25
Oxygen Saturations	≤91	92 - 93	94 - 95	≥96			
Any Supplemental Oxygen		Yes		No			
Temperature	≤35.0		35.1 - 36.0	36.1 - 38.0	38.1 - 39.0	≥39.1	
Systolic BP	≤90	91 - 100	101 - 110	111 - 219			≥220
Heart Rate	≤40		41 - 50	51 - 90	91 - 110	111 - 130	≥131
Level of Consciousness				A			V, P, or U

0-2 : low risk, 3-4: low risk with reassessment, **≥5 : moderate risk, ≥7: high risk**

02 Early Recognition & Diagnosis

AI based warning system : DEEPCARS



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03 Initial Resuscitation: The Hour-1 Bundle

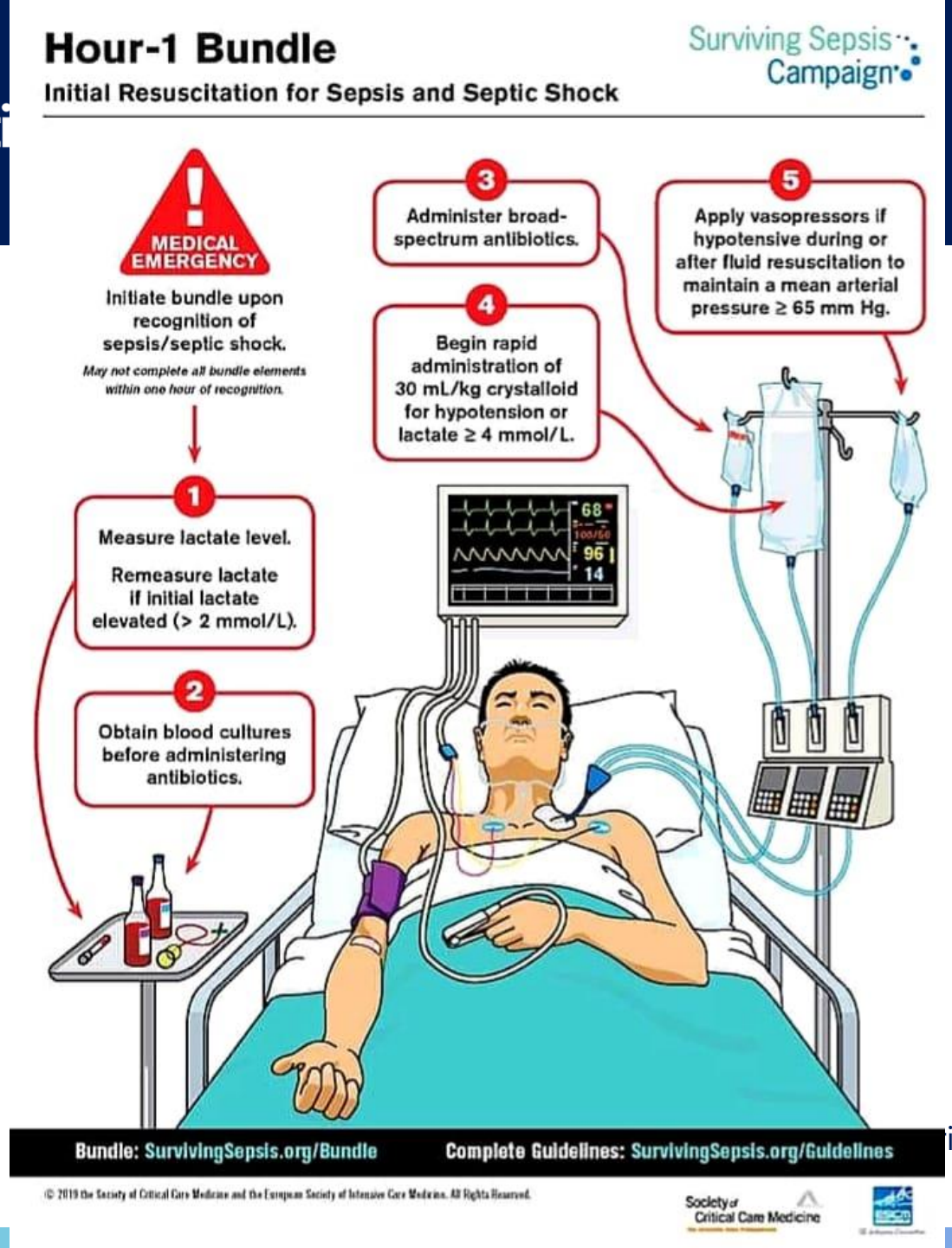
Septic Shock is a Medical Emergency: Act Fast!

The Hour-1 Bundle (Updated 2018): A set of critical interventions that should be initiated within the first hour of recognition of sepsis or septic shock.

1. **Measure lactate level.** Remeasure if initial lactate is elevated (> 2 mmol/L).
2. **Obtain blood cultures** before administering antibiotics**.**
3. **Administer broad-spectrum antibiotics.**
4. **Begin rapid administration of 30 mL/kg crystalloid** for hypotension or lactate ≥ 4 mmol/L.
5. **Apply vasopressors** if hypotensive during or after fluid resuscitation to maintain a mean arterial pressure (MAP) ≥ 65 mm Hg

Crit Care Med. 2018 Jun;46(6):997-1000

03 Initial Resuscitati



it Care Med. 2018 Jun;46(6):997-1000

04 Fluid Therapy Strategy

Initial Fluid Choice & Volume:

1. **Crystalloids** are the first-line fluid for resuscitation (Strong Recommendation, Moderate Evidence).

2. Suggest using balanced crystalloids (e.g., Lactated Ringer's) instead of normal saline (Weak Recommendation, Low Quality of Evidence) to avoid hyperchloremic acidosis.

3. Administer at least 30 mL/kg of IV crystalloid fluid within the first 3 hours of resuscitation for sepsis-induced hypoperfusion (Weak Recommendation, Low Quality of Evidence).

04 Fluid T

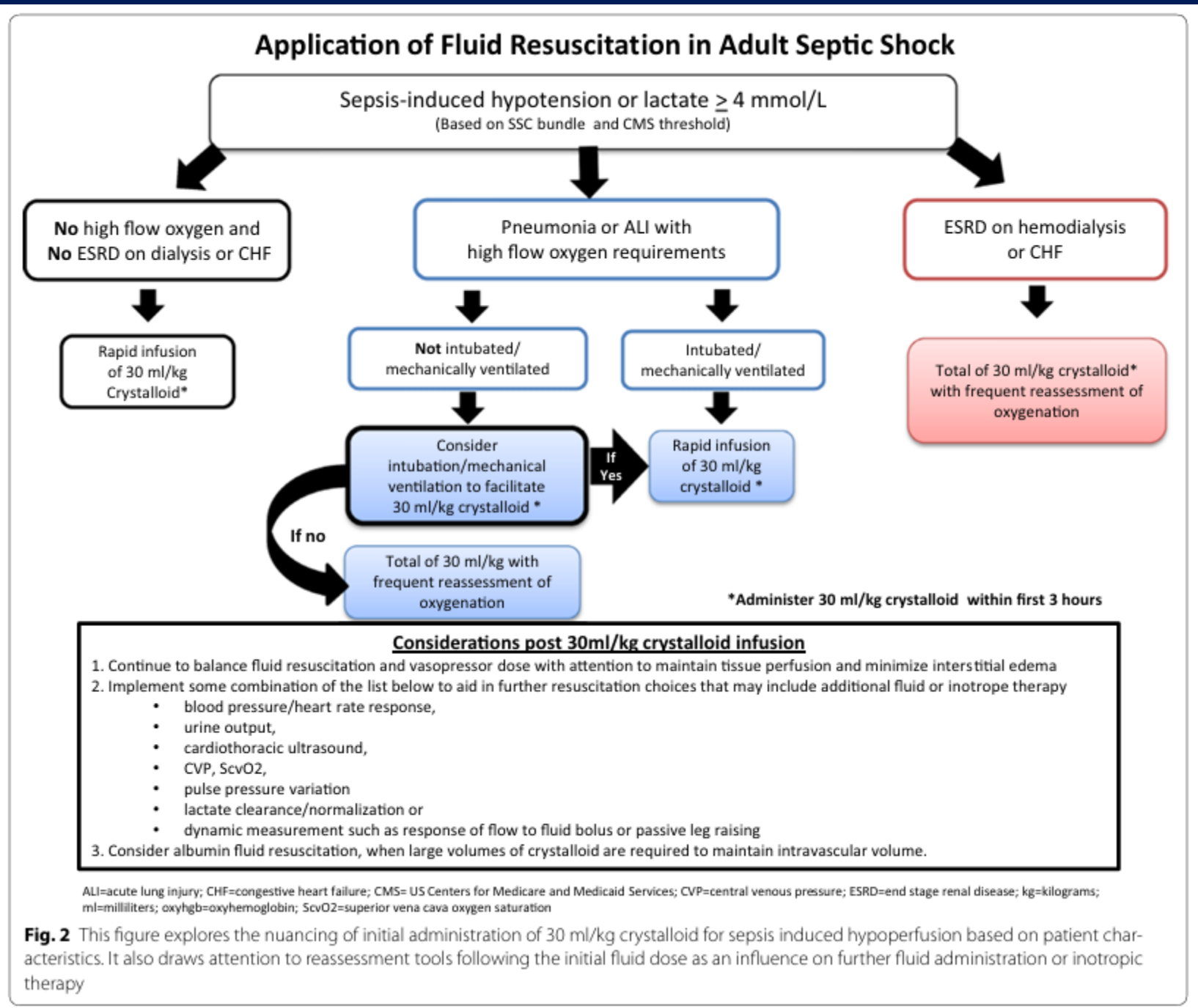


Fig. 2 This figure explores the nuancing of initial administration of 30 ml/kg crystalloid for sepsis induced hypoperfusion based on patient characteristics. It also draws attention to reassessment tools following the initial fluid dose as an influence on further fluid administration or inotropic therapy

04 Fluid Therapy Strategy

Beyond the Initial Bolus: Assessing Fluid Responsiveness:

-Suggest using dynamic measures to guide fluid resuscitation over static parameters (e.g., CVP) alone (Weak Recommendation, Very Low-Quality Evidence).

Dynamic Measures Include:

1. **Passive Leg Raise** (PLR) with measurement of cardiac output (CO) or stroke volume (SV).
2. Pulse Pressure Variation (PPV) in mechanically ventilated patients with no spontaneous respiratory effort.
3. Response to a mini-fluid challenge.

05 Vasoactive & Inotropic Agents

Vasopressors

1. **First-line Agent: Norepinephrine** (Strong Recommendation, High Quality of Evidence).

   It is more potent and has a lower risk of arrhythmia than dopamine.

2. **Second-line Agent**: **Add Vasopressin** when MAP is inadequate despite norepinephrine.

   Consider starting vasopressin when norepinephrine dose is 0.25-0.5 μg/kg/min.

3. Third-line Agent: Add Epinephrine if MAP remains inadequate despite norepinephrine and vasopressin.

   Initiation: Suggest starting vasopressors peripherally rather than delaying initiation until central venous access is secured (Weak Recommendation).

*심장수술환자에서는 low cardiac output syndrome 을 항상 염두!

05 Vasoactive & Inotropic Agents

Restoring Perfusion Pressure and Myocardial Function

Target MAP:

An initial target **MAP of 65 mm Hg** is recommended over higher targets (Strong Recommendation, Moderate Quality of Evidence).

Inotropes:

Suggest adding Dobutamine to norepinephrine (or using Epinephrine alone) for patients with persistent hypoperfusion despite adequate volume status and arterial pressure, especially with evidence of cardiac dysfunction (Weak Recommendation).

Controlling the Source and Modulating the Response

Timing of Antimicrobials:

-**Shock Present** or Sepsis is Definite/Probable

: Administer antimicrobials immediately, ideally **within 1 hour** of recognition (Strong Recommendation).

-Shock Absent & **Sepsis is Possible**

: Recommend a time-limited course of rapid investigation. If infection concern persists, administer antimicrobials **within 3 hours** from recognition (Weak Recommendation).

Antimicrobial Selection:

Initiate with empiric broad-spectrum therapy with one or more antimicrobials to cover all likely pathogens. Daily assessment for de-escalation of antimicrobial therapy is suggested once pathogen and susceptibilities are known.

Controlling the Source and Modulating the Response

Corticosteroids:
Suggest using IV corticosteroids for adults with septic shock and an ongoing requirement for vasopressor therapy (Weak Recommendation, Moderate Quality of Evidence).

Typical Regimen: IV hydrocortisone 200 mg per day, given as 50 mg every 6 hours or as a continuous infusion.

Initiation: Suggested to commence when norepinephrine or epinephrine dose is ≥ 0.25 mcg/kg/min for at least 4 hours.

07 Personalized Hemodynamic Management

Beyond 'One-Size-Fits-All': A Phased Approach

Hemodynamic monitoring and intervention should be personalized according to the phase of shock.

1. Salvage Phase:

Goal: Restore life-saving tissue perfusion.
Interventions: Liberal fluids, early vasopressors.
Targets: Achieve minimal MAP (≥ 65 mmHg) and DAP (≥ 45 mmHg).

2. Optimization Phase:

Goal: Optimize cardiac output and tissue perfusion.
Interventions: Fluid challenges guided by dynamic measures, titrate vasopressors, consider inotropes.
Monitoring: CRT, Lactate, $ScvO_2$, $Pv\text{-}aCO_2$.

07 Personalized Hemodynamic Management

Beyond 'One-Size-Fits-All': A Phased Approach

3. Stabilization Phase:

Goal: Provide organ support and prevent complications.
Interventions: Minimize fluid infusion, avoid fluid overload.
Monitoring: Assess for venous congestion (e.g., lung ultrasound).

4. De-escalation Phase:

Goal: Liberate from supportive therapies.
Interventions: Achieve a negative fluid balance (fluid removal), wean vasopressors and inotropes while ensuring tissue perfusion is preserved.

08 Key Principles & Adjunctive Therapies

A Comprehensive Approach for the CTS Patient

1. Source Control:

-Rapidly identify and control the anatomical source of infection as soon as medically

2. Ventilation Strategy:

-For sepsis-induced ARDS, use a low tidal volume ventilation strategy (6 mL/kg predicted body weight) (Strong Recommend, High Quality of Evidence).

-Maintain plateau pressures < 30 cm H_2O (Strong Recommend, Moderate of Evidence).

-For severe ARDS, consider prone ventilation for > 12 hours daily (Strong Recommend).

3. Goals of Care:

Discuss goals of care and prognosis with patients and **their families** (Best Practice Statement).This is critical for aligning intensive and potentially invasive treatments with patient values.

09 Conclusion & Key Takeaways

1. **Recognize Early:** Septic shock is a time-critical emergency.

2. **Act Fast:** Initiate the **Hour-1 Bundle** immediately upon recognition.

3. **Personalize Treatment: dynamic measures** to guide fluid therapy & avoid fluid overload.

4. **Adhere to Guidelines:**
   Use **Norepinephrine** as the first-line vasopressor to a target **MAP of 65 mmHg**.
   Implement **lung-protective ventilation** for ARDS.
   Ensure timely **source control**.

5. **Continuously Re-evaluate:** Sepsis is a dynamic process. Continuously reassess. Be prepared to de-escalate care as the patient stabilizes.

감사합니다.

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