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# Pulmonary Edema and Septic Shock Management in Intensive Care Unit: A Case Report

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**Abstract**

**Background:** Sepsis is the most common complication caused by diabetic foot ulcers (DFU) and the main reason patient admitted to intensive care unit (ICU). Septic shock is characterized by peripheral hypoperfusion and inadequate oxygen delivery to tissues. In septic shock patients with cardiogenic pulmonary edema (CPE), an increased in preload might worsen previously compromised cardiac function. CPE causes respiratory failure due to impaired gas exchange and lung dynamics disturbances, leading to death.

**Case:** Male, 58 years old, admitted to ICU with gangrenous pedis dextra (wagner grade 4), type 2 DM, Acute Decompensated Heart Failure (ADHF), CPE, septic shock, Acute kidney Injury (AKI) dd ACKD, anemia, transaminitis, hypoalbuminemia, hyponatremia, hyperkalemia, atrial fibrilation, and left pleural effusion. Total length of stay was 7 days.

**Discussion:** In this case, patient clinical manifestations are consistent with septic shock and pulmonary edema due to DFU. The imbalance between oxygen delivery and demand results in global tissue hypoxia and septic shock. Microcirculatory changes combined with vasodilation and cardiac dysfunction causes decreased stress volume and cardiac output. Comprehensive fluid status evaluation is important to avoid volume overload in patients with septic shock and pulmonary edema. De-resuscitation involves active fluid removal using diuretics and renal replacement therapy (RRT). Goal of pulmonary edema management are to improve gas exchange and reduce work of breathing, optimize lung functional units as much as possible, reduce alveolar overdistension, hemodynamic stabilization, and improve outcomes. According to guidelines, patient management in this case is in accordance with literatures.

**Conclusion:** Patients with DFU often experience septic shock and pulmonary edema that require ICU admission. Management is complex with high mortality rate. There is no standard regarding the appropriate fluid therapy strategies for patients until recently.

**Keywords**: septic shock, pulmonary edema, diabetes mellitus (DM), resuscitation, fluids.

## INTRODUCTION

Diabetes melitus (DM) is a global, endemic, metabolic dsease due to insulin secretion abnormality or mix-

ed effects of genetics and environmental interaction. The prevalence of DM estimated around 37.5% in West Pasific. Financial burden of DM and its complications are high with annual public cost around £23,7 billions.[1] A study conducted by Diabetes Amputation Research Group of the Chinese Diabetes Society found that hospitalization duration is much longer (33.5 vs. 22.0 days) and cost more ($5.932 vs. $4.101) in DM patients compared to non-DM.[2] These issues highlight the importance of awarenesss in monitoring and management of DM and its complications.

Diabetic foot disease is the most common spectrum of DM complication. This includes lower and upper extremity infection, ulcer formation (diabetic foot ulcer/ DFU), and various degree of vascular disease.[2] Secondary infection worsen the ulcer.[1] Epidemiological studies demonstrated that DFU prevalence range from 5% to 10% (95% confidence interval/CI, 5,4–7,3%) with annual incidence 1–4%; in China (CI 95%, 3.1–5.2%). DFU is the most frequent reason for hospitalization due to DM.[3] Etiologies of DFU includes neuropathy (55%), artery (10%), and neuroischemic (35%). Healing rate of DFU after 12 weeks of treatment is 24–82% and recurrence rate up to 60%.[4] Prognosis of DFU is poor due to reduce patient quality of life, leading to nontraumatic lower extremities amputation, sepsis, even death.[2, 4]

Sepsis, one of the most common complications of DFU, is the leading cause of intensive care unit (ICU) admission.[5] Nearly 75% of ICU patients had sepsis with mortality rate 20% to 50%.[6] According to World Health Organization (WHO), sepsis contributes to more than 30 million cases annually worldwide, with mortality about 6 million.[7] The average age of sepsis patients is 60 years old and more common in men than women. The increasing trend of sepsis is associated with increased number of elderly people, patients with chronic diseases, and immune disorders.[6] In addition, the cost of treatment due to sepsis can reach $50,000 per patient. Study in UK estimates severe sepsis management cost the healthcare system approximately £2.5 billion per year.[5] Severe sepsis and septic shock cases are increasing up to 300,000 cases per year. Mortality risk increases in parallel to sepsis severity, with 16% for sepsis, 20% for severe sepsis, and 46% for septic shock. In Indonesia, sepsis incidence over the past five years remains high, ranging from 8.7% to 30.29%, with mortality 11.56% to 49.9%.[6] Given its impacts, appropriate identification and management within the first hour after sepsis is essential to improved outcomes.[7]

Septic shock is characterized by peripheral hypoperfusion and inadequate oxygen delivery to tissues. The pathophysiology of septic shock is complex and comprises both distributive and cardiogenic components.[8] Fluid therapy and vasopressors are considered the cornerstones of resuscitation for critically ill and hemodynamically unstable patients with hypovolemic and distributive shock. Therefore, it is crucial during the resuscitation phase of all critically ill patients to determine when to stop fluid administration and when to begin pressure reduction.[9,10] However, in patients with septic shock and cardiogenic pulmonary edema (CPE), increased cardiac preload can worsen preexisting compromised cardiac function. Abnormal capillary blood flow distribution, impaired cardiac function, and volume expansion further compromise peripheral and central circulation.[8] Pulmonary edema subsequently leads to respiratory failure due to impaired gas exchange and pulmonary mechanics. In life-threatening cases, mechanical ventilation aims to maintain gas exchange until the edema resolves. However, high airway pressures can lead to ventilator-induced lung injury (VILI). In patients with CPE, air spaces become obstructed due to capillary congestion.[11] Recent studies suggested that fluid overload in septic patients is associated with organ dysfunction, prolonged mechanical ventilation, ICU stay, and higher mortality rates.[8] This case report aimed to discussed a patient with DFU, especially management of CPE and septic shock in ICU.

**Case**

Male, 58 years old, admitted on 18th April 2025, then transferred to ICU. Patient had right foot gangren (wagner grade 4), type-2 DM, Acute Decompensated Heart Failure (ADHF), CPE, septic shock, Acute kidney Injury (AKI) dd ACKD, anemia, transaminitis, hypoalbuminemia, hyponatremia, hyperkalemia, atrial fibrillattion, and left pleural effusion. Chief complaint was shortness of breath. Shortness of breath had been worsening since 4 days before admission. It worsened during the day. Patient usually slept in a sitting position, but had difficulty sleeping due to shortness of breath. Cough (+). Previously, patient complained of feeling weak and swollen feet. Wound on patient's right foot is known since 1 month ago due to fishing. Surgery at RSAMP had been performed for it. The wound was bandaged, blackened, and has foul odor. Past medical history is type 2 DM, diagnosed for over a year but uncontrolled. Patient also had undergone three surgeries on his right foot in the past four months. Patient is allergic to penicillin.

General condition patient is moderately ill, GCS E4V5M6; VAS 4 (moderate pain); BW 80 kg, height160 cm, BMI 31 kg/$m^2$ (obese). Vital signs for blood pressure 110/70 mmHg, heart rate (HR) 112 x/minutes, respiratory rate (RR) 24 x/ minutes, temperature 36,5$^0$ C, and SpO2 98%. General status patient look anemic, pulmonary auscultasion found wet, fine, bilateral rhonchi. Shifting dullness (ascites) was positive when abdomen percussion examination, and pitting edema is found in both extremities. Local status for right pedis region found the tendon of the digitorum brevis is visible, digiti 1-3 are missing with surrounding ulcer and dark discoloration.

Random blood glucose (RBG) was 105 mg/dL, O2 NRM 12 lpm dyspnea not improved. Then, HFNC was initiated at FiO2 100% flow 30 lpm. Omeprazole 40 mg iv, ceftriaxone 1gr every 12 hours iv, urine catheter was placed, initial production 50 mL, concentrated. On 19th April 2025, RBG 97 mg/dL HFNC start from FiO2 95% flow 35 lpm. Laboratory result for potassium was 5,8 then planned for correction in 3 times every 1 hour respectively by 1 ampule of Ca gluconas, novorapid 10 IU, bolus D40% 2 – 3 fl if RBG<250 mg/dL then evaluate at second hour. HFNC start from FiO2 95% flow 35 lpm. Contained urine 100 mL per 2 hours, yellow and concentrated. Diuresis 0.62 mL/kgBW/hour. Injection of furosemide 20 mg IV. On 20th April 2025, patient still given HFNC oxygenation with flow 40 lpm, SpO2 98%. BGA: pH 7,404; PCO2 28,1; PO2 90; BE -7; HCO3 17,7 TCO2 19; SO2 98. Suggest respiratory alkalosis with full metabolic compensation. Blood pressure 120/77 mmHg, HR 100 x/minutes, temp 36$^0$ C. Total EWS score for patient is 7.

Therapy administered were loading IVFD NaCl 0.9% 300 mL then 20 dpm, metronidazole 500 mg every 8 hours iv, ceftriaxone 1g every 12 hours iv, metamizole 1 gram every 8 hours iv, furosemide 5 mg/hour iv, omeprazole 40 mg every 24 hours iv, nebulized budesonide 0.5 mg/mL every 8 hours inhalation, ISDN 5 mg every 8 hours PO, spironolactone 25 mg every 12 hours PO, amiodarone 200 mg every 8 hours PO, VIP albumin sachet every 24 hours PO, curcuma tablet every 8 hours PO, Nocid tablet every 8 hours PO, ursodeoxycholic (UDCA) 250 mg every 12 hours PO, digoxin 0.25 mg every 24 hours PO, Acetylcysteine 200 mg every 8 hours PO, iron tablets every 12 hours PO, atorvastatin 20 mg every 24 hours PO, PRBC transfusion, and amputation followed by daily wound care. Blood culture did not detect any pathogenic bacteria. The recommendation was to continue ceftriaxone or change the antibiotic to cefotaxime, pus culture, and repeat CBC. Antibiotic was then replaced with cefotaxime 1 gram every 8 hours IV. Total hospitalization duration was 7 days.

**Table 1. Patient Serial Electrolytes.**

| Test Name | Results | | Units | Normal Value |
|---|---|---|---|---|
| | **21/4/25** | **23/4/25** | | |
| Sodium | 137 | 142 | mmol/L | 135 – 147 |
| Potassium | 4.6 | 4.2 | mmol/L | 3.4 – 5.3 |
| Chloride | 106* | 107* | mmol/L | 95 -105 |

**Table 2. Blood Chemistry Results on 21st April 2025.**

| Test Name | Results | Units | Normal Value |
|---|---|---|---|
| Ureum | 47* | mg/dL | 12 - 43 |
| Creatinine | 1.3 | mg/dL | 0.6 – 1.3 |
| SGPT | 208* | U/L | <45 |
| SGOT | 111* | U/L | L: 0 – 50 |

**Table 3. Laboratory Examination on 24th April 2025.**

| Test Name | Results | Unit | Normal Value |
|---|---|---|---|
| Albumin | 2.9* | g/dL | 3.5 – 5.0 |
| **Complete Blood Count** | | | |
| Hemoglobin | 10.5* | g/dL | L: 13.2 – 17.3 |
| Erythrocytes | 3.9* | /uL | L: 4.4 – 5.9 |
| Hematocrit | 31* | % | L: 40 – 52 |
| MCV | 79.4* | fl | 80 – 100 |
| MCH | 26.8 | pg | 26 – 34 |
| MCHC | 33.8 | g/dL | 32 – 36 |
| Leucocytes | 17970* | /uL | L: 3800 – 10600 |
| Eosinophils | 0.0* | % | 2 – 4 |
| Neutrophils | 84.6* | % | 50 – 70 |
| Lymphocytes | 9.4* | % | 25 – 40 |
| Monocytes | 5.8 | % | 2 – 8 |
| Platelets | 495000* | /uL | 150000 – 440000 |

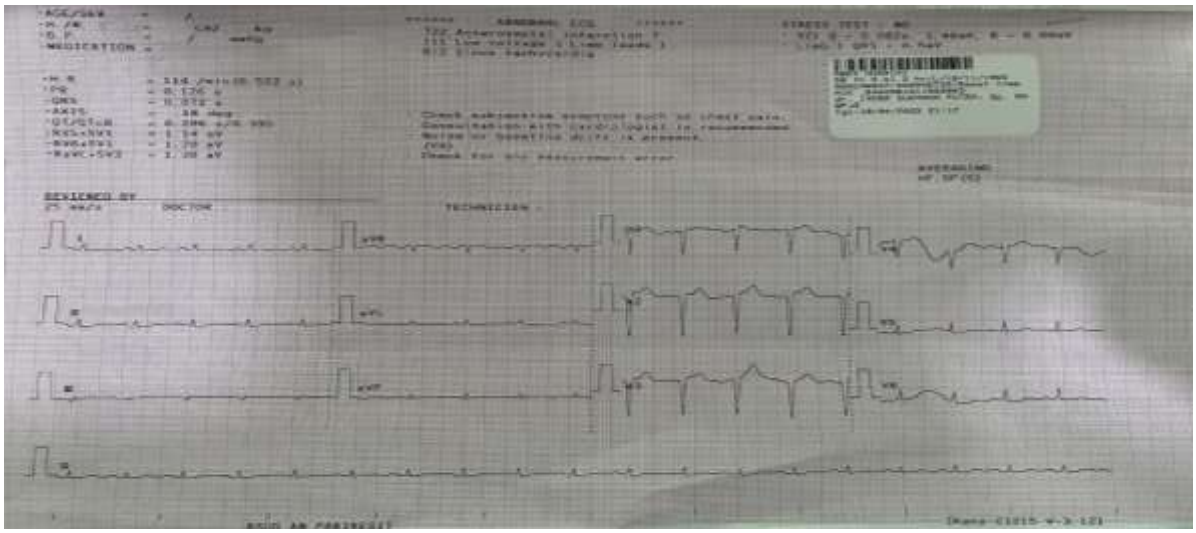

**Figure 1. Patient ECG on admission (18th April 2025).**

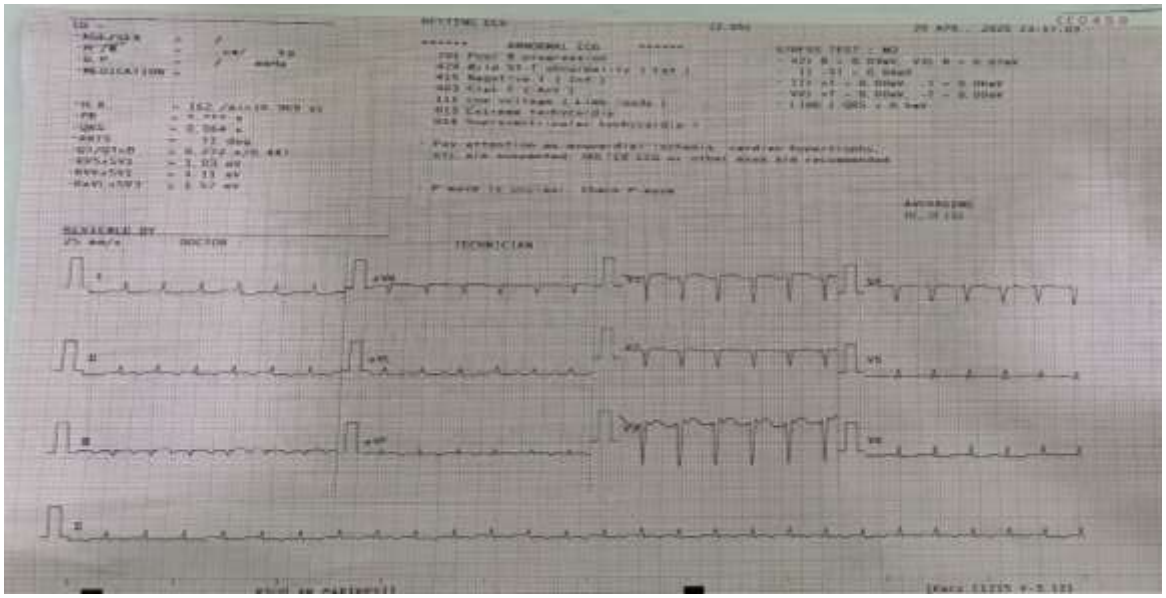

**Figure 2. Patient ECG in ICU (20thApril 2025).**

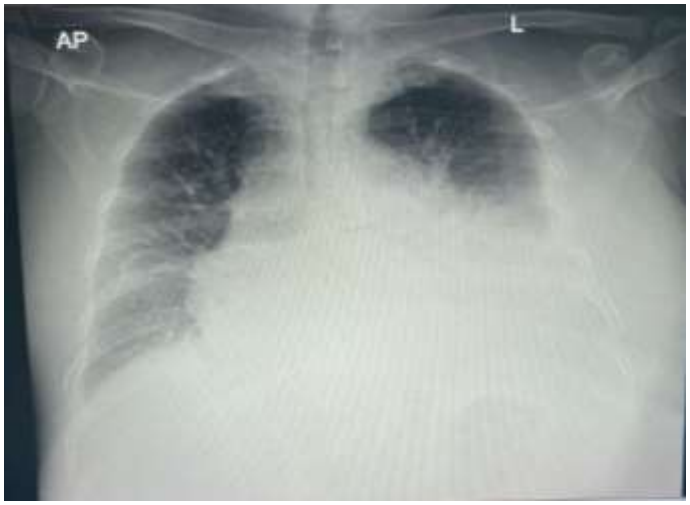


**Figure 3. Thorax x ray of patient when first admitted to emergency room (18th April 2025).**

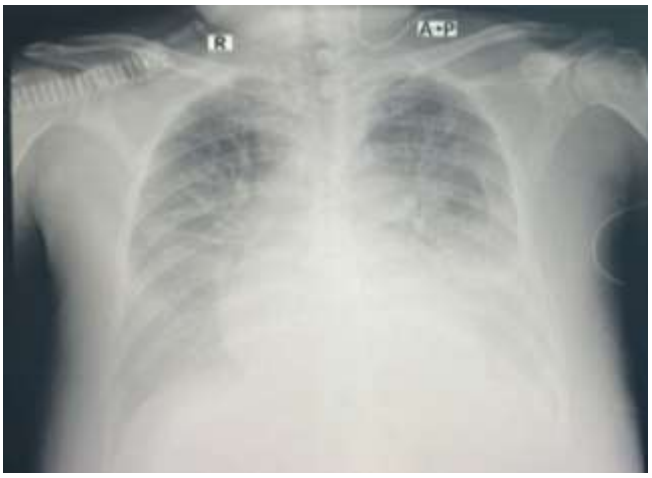

**Figure 4. Thorax x ray of patient when admitted to ICU (20th April 2025).**

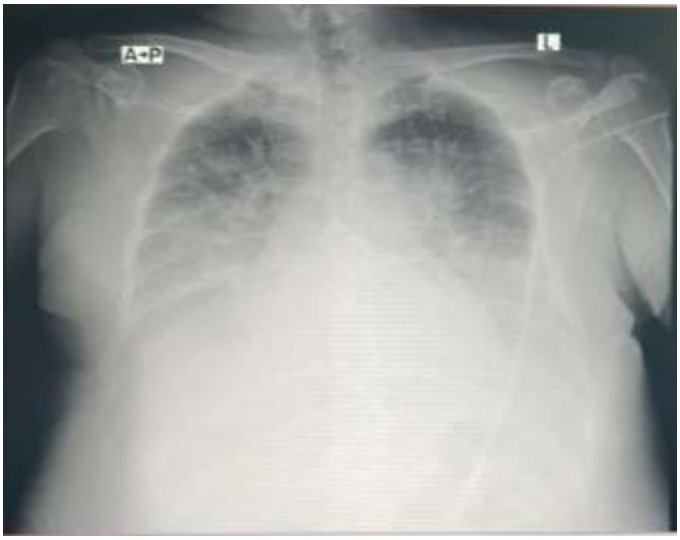

**Figure 5. Thorax x ray of patient before discharge from hospital (24th April 2025).**

**Discussion**

Septic shock has a wide variety of clinical manifestations. A comprehensive evaluation should identify shock, which can be used to develop management strategy.[10] Most important sign of septic shock is sepsis (suspected or confirmed infection) with persistent systolic hypotension <90 mmHg or mean arterial pressure (MAP) <65 mmHg, despite adequate fluid resuscitation and in the absence of other causes and/or evidence of tissue hypoperfusion. However, these signs are not required definitively according to the European Society of Intensive Care Medicine (ESICM) consensus statement.[12] They stated that septic shock has various signs and symptoms, depends on which system is affected, and associated with many conditions.[5, 12] Septic shock can be accompanied by other condition such as pulmonary edema. Physical examination of patients with shock may demonstrated altered mental status, increased capillary refill time, or mottled skin. Meanwhile, signs of central venous congestion (jugular venous distension, pulmonary edema, and rhonchi) generally indicate intravascular volume overload; pallor, decreased skin turgor, and sinus tachycardia that indicate the need for intravascular volume expansion.[10] In our case report, the patient signs and symptoms were consistent with septic shock patients due to DFU accompanied by pulmonary edema although no bacterial growth was found in blood culture examination in this case.

Sepsis screening tools were established to promote early detection and timely intervention. These modalities are used in conjunction with clinical manifestations, including systemic inflammatory response syndrome (SIRS) criteria, Sequential Organ Failure Assessment (SOFA), quick Sequential Organ Failure Score (qSOFA), National Early Warning Score (NEWS), or Modified Early Warning Score (MEWS).[5, 12] qSOFA exclusively includes criteria that can be rapidly evaluated in a clinical setting, such as level of consciousness, respiratory rate, and systolic blood pressure ≥100 mmHg.[12] However, the low specificity of qSOFA makes laboratory testing necessary to distinguish it from other conditions, assess organs function, and evaluates acid-base balance.[13] This is because, in most cases, tissue hypoperfusion occurs before the development of hypotension.[5] In our patient, the EWS score was 7, consistent with sepsis. Although most screening tools have weak predictive value and a wide range of diagnostic accuracy, they are still associated with better care practices.[12]

Apart from clinical assessment, biomarkers are used for diagnosis and outcome prediction. It can also be used to monitor infectious processes or to rule out infection. Tissue hypoperfusion determined by measuring blood lactate concentrations.[5,12,13] Therefore, elevated serum lactate levels indicate organ failure. Furthermore, hyperlactatemia is a marker of severe sepsis and used as prognostic indicator because it is associated with a 35% to 70% increase in mortality.[5] Measurement of serum perfusion biomarkers, such as lactate and renin, may be helpful in patients with circulatory shock.[14, 15] Renal dysfunction is common in patients with circulatory shock. The kidneys are highly sensitive to inadequate perfusion. Low urine output and diminished renal function are markers of hypoperfusion. Adequate resuscitation can improve urine output and renal function. Urine output-guided fluid therapy is associated with significantly lower rates of AKI in some clinical setting.[16] Renal dysfunction and its complications affect circulatory shock management, including acid-base imbalances that leads to altered respiratory drive and response to vasoactive agents; electrolyte disturbances resulting in arrhythmias, myocardial dysfunction, muscle weakness and rhabdomyolysis; vascular tonicity; coagulation disorders (e.g., hypercoagulability and platelet dysfunction); reduced elimination of toxins/drugs (e.g., digoxin and vancomycin); and fluid retention.[10] In our patient, AKI was found with a suspected prerenal source due to sepsis. In addition, the patient's initial urine output was quite low with concentrated urine before the urinary catheter was inserted for monitoring. Based on surviving sepsis campaign,[12] septic shock patients must be managed as belows:

- **Source Control**

Empiric broad spectrum antibiotic must be administered within the first hour after diagnosis. It should be initiated for all patients suspected of sepsis to aid in source control. If necessary, removal of infected tissue can be performed to reduce the spread and control the source of sepsis.[5, 12]

- **Antimicrobial Therapy**

An antimicrobial that covers majority of pathogens with a multidrug regimen is essential to ensure adequate protection. The initial choice should be based on individual factors that influence antibiotic effectiveness, such as patient age, infection source, prior antibiotic history, comorbidities, multidrug-resistant organisms, severity of septic shock, patient immunity, and medication dose. Drug effectiveness depends on peak plasma levels and minimum inhibitory concentrations of the pathogen. Therefore, a higher initial dose is recommended to maintain therapeutic drug levels in the blood.[5, 12, 17]

- **Enhancing Host Response**

Corticosteroid and vasopressin administration is indicated in refractory vasoactive cases or patients with unstimulated basal cortisol levels. Although central venous access is not indicated in all cases, it can provide accurate monitoring of mixed venous oxygen (MVO2) and central venous pressure (CVP). Central

lines within the right atrium are more accurate than lower extremity lines.[18] Dopamine, norepinephrine, and phenylephrine is safe if administered at high doses. Early goal-directed therapy (EGDT) is standard practice in the management of severe sepsis. Survival also influenced by blood pressure stabilization.[5, 12]

- **Shock Management**

Early management is crucial for survival. There are three main goals of interventions: return venous pressure to 8-18 mmHg, MAP greater than 65, and superior vena cava saturation >70%. This is achieved by fluid resuscitation with crystalloids or colloids. Patients may require mechanical ventilation and the use of vasoactive agents such as epinephrine in fluid-refractory cases. Dopamine is not recommended as a first-line agent because it can induce immunologic dysfunction through decreased prolactin and growth hormone via its inhibitory effect on hypothalamic-pituitary-adrenal (HPA) axis.[5, 12]

In sepsis and septic shock, a series of circulatory events such as peripheral vasodilation, myocardial depression, and increased metabolism leads to imbalance between systemic oxygen delivery and oxygen demand. This results in global tissue hypoxia or shock. Sepsis and septic shock are not the same with a state of volume depletion, but rather microcirculatory changes combined with vasodilation and possible cardiac dysfunction that lead to a decrease in volume stress and cardiac output.[19] Therefore, fluid resuscitation in patients with sepsis is to increase volume stress and mean systemic filling pressure (Pmsf), thereby increasing cardiac preload by increasing the gradient for venous return [the difference between Pmsf and CVP. In an observational study, about 50% of ICU patients response-well to fluid boluses. While the ANDROMEDA-Shock study demonstrated that altough more than 50% subjects were fluid responsive at initial, the number decreased substantially during intervention period.[20] However, in clinical practice, a large multicenter cohort study found that a significant percentage of fluid-unresponsive patients received IV fluids in ICU (approximately 50%).[19-21]

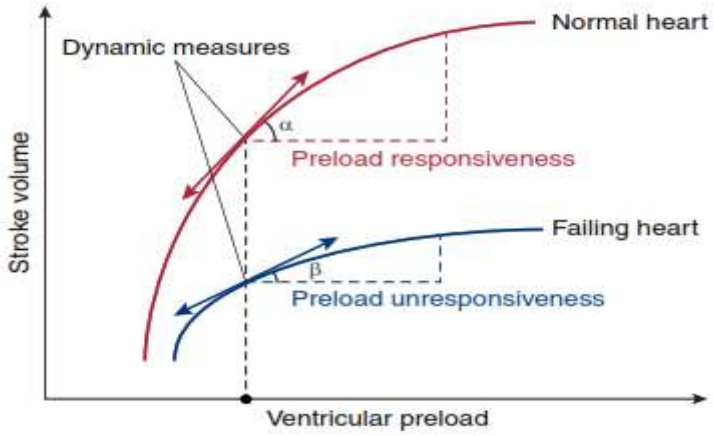


**Figure 6. Fluid responsiveness based on myocardial contractility. The Frank–Starling curve. Normal heart can increase stroke volume (SV) with preload expansion, whereas patients with heart failure cannot. Using static measurements of fluid status by assessing ventricular preload (estimated by CVP), patients may have same preload but different response to fluid administration. Dynamic measurements can assess the steepness of curve (i.e., α and β angles) and identify whether patient is fluid responsive.[10]**

Assessment of volume responsiveness in patients with septic shock must consider afterload and cardiac systolic contraction, which will determine the effects of fluid bolus on cardiac output. This will help determine the best approach for managing septic shock with pulmonary edema. The optimal resuscitation strategy aimed to restore adequate SV and improve tissue perfusion while avoiding hypervolemia, which leads to unfavorable outcomes related to venous congestion and interstitial edema. In acute setting, intravascular fluid expansion can be lifesaving. But, it is important to note that not every fluid-responsive patient is hypovolemic and require volume expansion. As mentioned above, volume responsiveness is not the same as volume deficiency.[10]

The Frank–Starling curve describes cardiac ability to alter its contractile force in response to changes in myocyte length (preload). Stroke volume will change in response to any change in venous return. Increased venous return in a normal heart function and a stable afterload will increase SV by increasing the stretch of cardiac myocytes (sarcomere length). This will increases systolic force and allows heart to eject additional blood, thereby increasing SV. Patients on the flat side of the curve are less sensitive to changes in preload and intravenous fluid boluses, indicating a lack of fluid responsiveness. In this situation, extravascular fluid in lungs increases, clinically manifesting as pulmonary edema.[10]

Organ perfusion is influenced by systemic arterial blood pressure, intravascular volume status, cardiac output, and venous pressure. At tissue level, pressure gradient across capillary bed is crucial for optimal perfusion. Volume overload, congestive heart failure (CHF), and renal failure are three most common causes of venous congestion. Effects on respiratory system are pulmonary edema, chest wall edema, and prolonged ventilation.[10] The clinical impacts of venous congestion in sepsis/septic shock patients are well described in renal system. Under physiological conditions, our kidneys receive approximately one-quarter of cardiac output, whereas in shock states, such as the first phase of sepsis/ septic shock, this can decrease to 10% or less to divert blood flow away from renal bed. Consequently, urine output and renal function decrease. In stabilization and deresuscitation phases of sepsis/septic shock, urine output may remain low even after the initial shock has resolved. In this stage, renal venous congestion can lead to impaired urine output and renal function due to fluid accumulation, intra-abdominal hypertension, and/or right heart failure. Impaired renal venous outflow leads to kidney injury, which is associated with mortality in critically ill patients. Unfortunately, persistent low urine output/impaired kidney function may incorrectly lead physicians to administer additional IV fluids to increase urine output, thus creating a vicious cycle.[21]

Growing evidence suggests that volume overload/ edema, renal hyperemia, or increased pressure within renal capsule contribute to AKI. They can occur either as a direct consequence of septic shock or as a consequence of treatment. [10, 22]

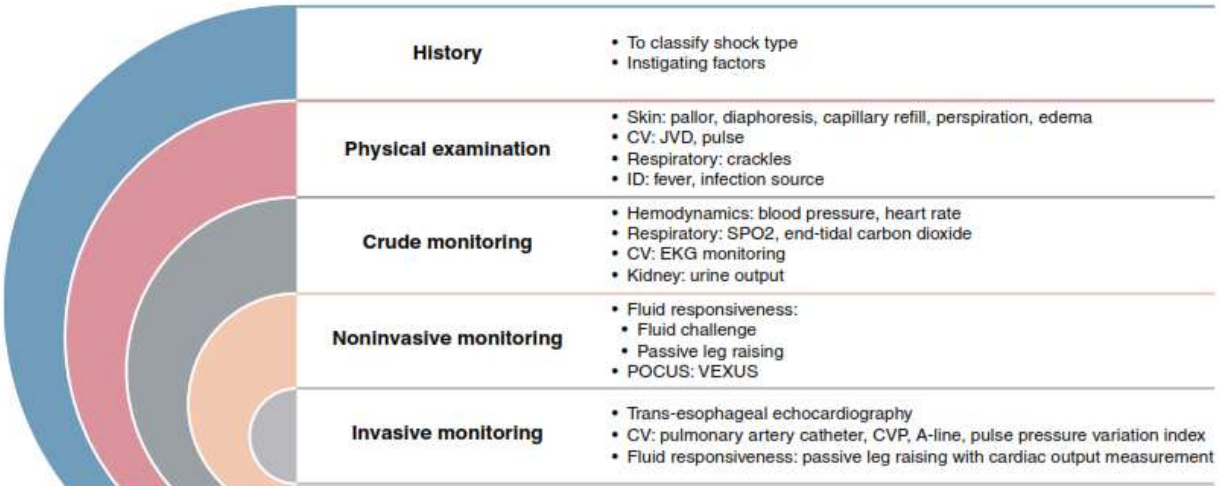


**Figure 7. Main components in shock evaluation. CV, cardiovascular; CVP, central venous pressure; EKG, electrocardiogram; ID, infectious diseases; JVD, jugular venous distention; POCUS, point-of-care ultrasound; SPO2, saturation of peripheral oxygen; VEXUS, venous excess ultrasound grading system.[10]**

Comprehensive fluid status assessment is essential to optimize effective blood volume and cardiac output while avoiding volume overload in patients with septic shock and pulmonary edema. Evaluation requires information regarding the macrocirculation (effective blood volume; Pmsf and mean arterial pressure; cardiac contractility; liver, kidney, and intestines compartment pressures; and intra-abdominal and intrathoracic pressures) and microcirculation (capillary permeability and perfusion, glycocalyx integrity, and tissue edema). Mean systemic filling pressure (Pmsf) is defined as the average pressure present in the circulatory system when there is no blood flow. The difference between Pmsf and right atrial pressure determines blood return to the right atrium.[10]

The '4D' fluid therapy strategy (drug, duration, dosage, de-escalation) is a crucial concept throughout various stages of septic shock management. Selecting the most appropriate fluid type and amount is fundamental. Fluid strategies vary from strict protocol approach to individualized care plans and range from conservative (dry) to liberal (wet) strategies. The average CVP target is 4–8 cmH2O in a conservative approach versus 8–12 cmH2O in a liberal strategy. A key question that remains unanswered is which strategy produces best clinical outcomes. In a study comparing two fluid management strategies for acute lung injury (ALI), patients randomized to a conservative fluid strategy had significantly more ventilator-free days and a shorter length of stay than those in the liberal fluid strategy group. However, no difference in mortality was found.[23] Conservative fluid management strategy is reported to be associated with lower costs, shorter ICU stays, and more ventilator-free days without affecting mortality.[10,23]

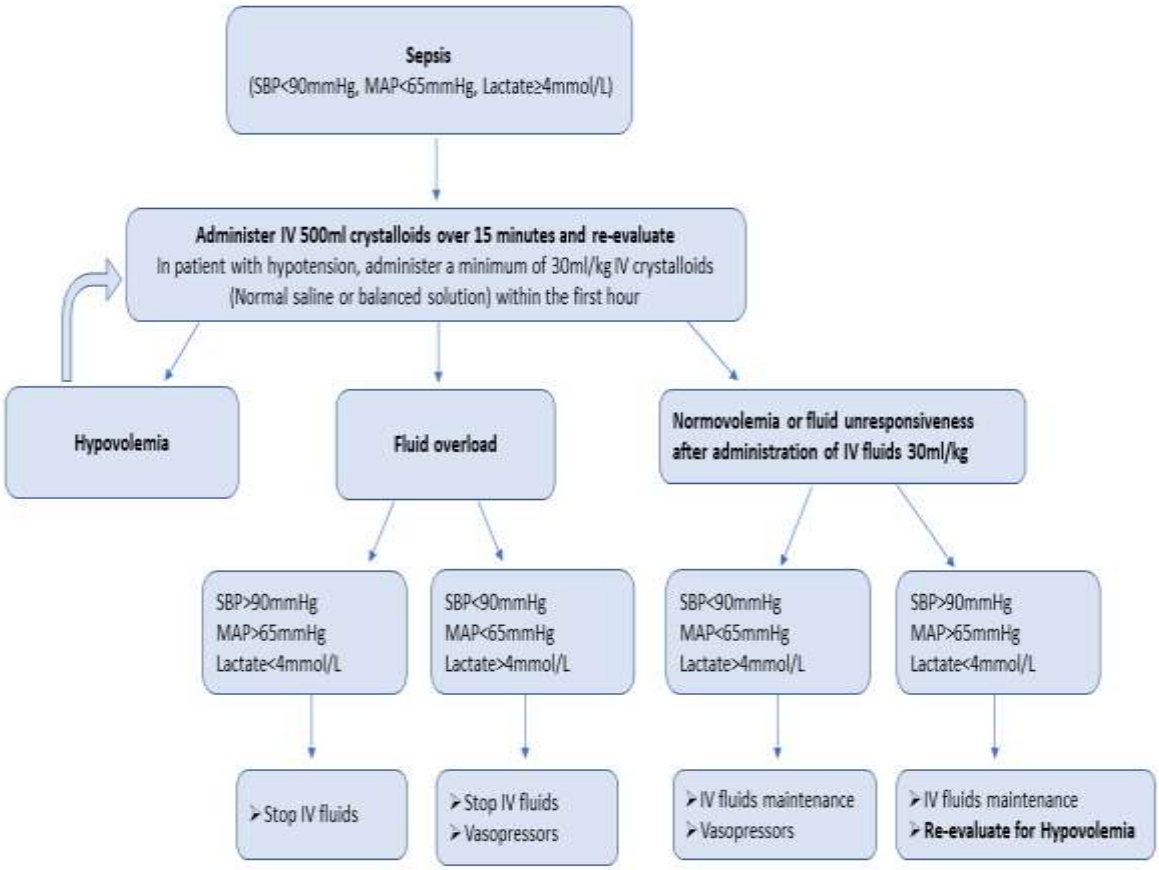


**Figure 8. Proposed Algorithm for fluid resuscitation of sepsis patients.[26]**

Deresuscitation refers to targeted fluid removal alongside delayed conservative fluid management strategies, involving active fluid removal using diuretics and renal replacement therapy (RRT). The goal is to increase diuresis and/or fluid removal. Several studies have reported that progressive use of loop diuretics to achieve greater fluid removal volumes in fluid-overloaded patients is associated with better outcomes. This also applies to critically ill patients on vasopressor support. Therefore, the authors suggest that furosemide can be initiated independently of the actual vasopressor dose once the criteria for deresuscitation are met. The dosing regimen for diuretic therapy should consider the pharmacodynamic and pharmacokinetic properties, with the dose dependent on patient's renal function, prior drug exposure, and drug tolerance. The dose can be titrated to achieve etter outcome. If the response to furosemide is limited, evidence from heart failure population suggests that combination diuretic therapy using spironolactone, acetazolamide, or indapamide may be considered, but this needs further studies.[24] Other studies have shown a beneficial effect on fluid removal by using 20% hyperoncotic albumin before furosemide, or a combination of PEEP levels adjusted to counteract IAP, followed by 20% albumin and furosemide (PAL combination). However, data are conflicting regarding the effect of PEEP levels on pulmonary edema. On the one hand, alveolar recruitment caused by PEEP may have an effect on alveolar vessels. On the other hand, high PEEP may also be responsible for an increase in CVP, which represents pressure downstream of lymphatic drainage and promote fluid accumulation. Mechanical ventilation with high PEEP further reduces lymphatic drainage, which, together with increased IAP, decreases the lymphatic pressure gradient in the splanchnic area, thus promoting fluid accumulation.[21, 25]

Whether fluid deresuscitation will improved outcomes or not is currently uncertain. A recent meta-analysis of deresuscitation in patients with septic shock found no difference in survival with the use of deresuscitation. This study reccomend usual care over fluid deresuscitation.[27] Fluid deresuscitation should only be initiated when the patient is unresponsive to fluids, no signs of tissue hypoperfusion, and there are signs of fluid accumulation. Primary concerns with premature or rapid fluid removal are hypovolemia, subsequent hemodynamic instability, and tissue hypoperfusion. There is currently no gold standard for the safety of fluid deresuscitation.[21]

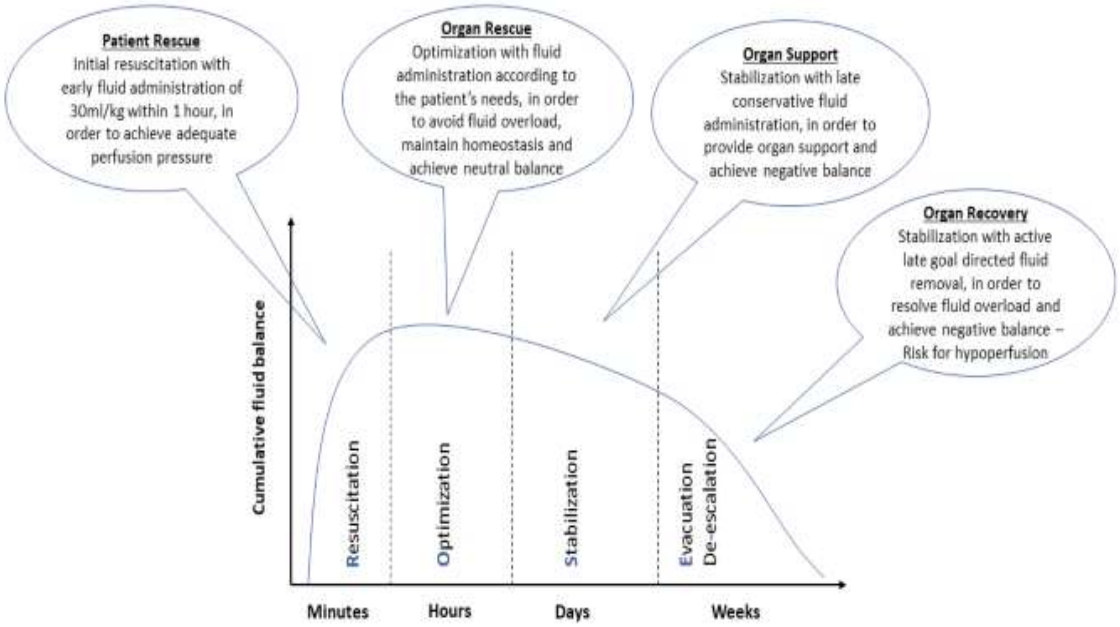


**Figure 9. Characteristics of the four separate phases in intravenous fluid therapy: resuscitation, optimization, stabilization, and evacuation. (ROSE).[26]**

Aside from fluid therapy, essential interventions in the management of pulmonary edema aim to improve gas exchange and reduce work of breathing, optimize lung functional units as much as possible, reduce alveolar overdistension,[7] stabilize hemodynamics, and improve outcomes. It is recommended to administer oxygen as early as possible to hypoxemic patients to achieve an arterial oxygen saturation of 95% (90% in COPD patients). Caution should be exercised in patients with severe airway obstruction to avoid hypercapnia. Continuous positive alveolar pressure (CPAP) is also helpful in CPE patients. Intubation and mechanical ventilation with PEEP are required in severe cases. In patients with fluid overload-related pulmonary edema, PEEP and fluid evacuation with diuretics have shown good outcomes.[7] In recent years, high-flow nasal cannula (HFNC) therapy has been used as an effective approach to provide adequate oxygen to patients with acute respiratory failure, as this modality has the potential to generate positive airway pressure, reduce ambient air intake, and decrease the work of breathing. HFNC systems can improve patient comfort and tolerability by integrating additional functions for humidification and heating of high-flow oxygen. [28] Appropriate use of HFNC can reduce the need for mechanical ventilation, as observed in our patient. However, studies have found that although HFNC therapy improved respiratory rate and oxygen saturation in patients, these effects were not significant on ventilation and final outcomes. Further studies using objective parameters such as blood gas analysis are recommended to clarify the benefits and generalize the validity of HFNC in patients with CPE.[28]

Based on guidelines, patient management in this case was in accordance with the literatures. Septic shock management was adapted to surviving sepsis campaign, including source control with daily wound care after amputation, antimicrobial therapy according to culture results, and shock management that took into account other comorbidities, particularly pulmonary edema. Oxygen therapy with a target saturation of 95% as per guidelines was also achieved. Supportive and symptomatic management were also provided to help improve patient outcomes in this case.

**Conclusion**

Management of patients with septic shock and pulmonary edema is complex. Various management components require attention given the high mortality rates in both conditions. The primary focus is on fluid therapy. There is no standard for appropriate fluid therapy strategies. Fluid deresuscitation should only be initiated when the patient is unresponsive to fluids, no signs of tissue hypoperfusion, and there are signs of fluid accumulation. The primary concern with premature or rapid fluid removal is hypovolemia, hemodynamic instability, and subsequent tissue hypoperfusion.

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