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REVIEW ARTICLE

Cardiogenic shock in resource-limited settings.

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ABSTRACT

Cardiogenic shock (CS) is a critical condition characterized by severe circulatory failure, leading to inadequate perfusion of organs and high mortality rates, especially in resource-limited settings. In these environments, the management of CS faces numerous challenges, including limited access to advanced medical technologies, inadequate healthcare infrastructure, and a lack of trained personnel. These factors contribute to delayed diagnosis and treatment, exacerbating patient outcomes. Global collaboration between well-resourced and under-resourced regions is essential to improve the management of CS. Such partnerships can facilitate knowledge sharing, capacity building through training programs, and the establishment of standardized treatment protocols tailored to local contexts. Additionally, collaborative research initiatives can enhance understanding of CS across diverse populations, while equitable resource allocation can ensure that life-saving technologies reach those in need. By leveraging the strengths of both well-resourced and under-resourced settings, stakeholders can work towards reducing the mortality associated with cardiogenic shock and improving overall healthcare delivery. Ultimately, fostering a global network focused on innovative solutions and shared best practices will be crucial in addressing the persistent challenges of managing cardiogenic shock in resource-limited settings.

Key Words: *cardiogenic shock, collaborations, resource-limited settings.*

INTRODUCTION

Cardiogenic shock (CS) is a critical condition characterized by a significant decrease in cardiac output, leading to systemic hypoperfusion and potential multi-organ failure. It is often a complication of acute myocardial infarction (AMI) and is associated with high mortality rates (30-50%), particularly in resource-limited settings where access to advanced medical care is restricted. This mini-review aims to explore the pathophysiology, challenges, and management strategies including telemedicine approach in these environments, emphasizing the need for timely interventions and a multidisciplinary approach.[1]

EPIDEMIOLOGY AND ECONOMIC IMPACT

CS complicates approximately 5% to 12% of all cases of AMI. The incidence is rising due to an aging population and increasing prevalence of comorbidities such as diabetes, hypertension, and chronic kidney disease.[1] Despite advancements in treatment, the mortality rate for CS remains alarmingly high, often exceeding 40% in hospitalized patients.[2] In cases accompanied by multiorgan failure, the in-hospital mortality can approach 50%. The prognosis for patients with CS is influenced by various factors, including the timing of intervention, the presence of comorbidities, and the availability of specialized care.

The demographic profile of patients experiencing CS is changing, with older adults being more frequently affected due to age-related cardiovascular changes and higher rates of pre-existing conditions (Table 1). Among women, black women had the highest AMI rates among women aged 35 to 74 years, and black and white women aged ≥75 years had similar. In contrast, white men had the highest AMI rates across all age groups among men.[3]

Table 1. Epidemiology of cardiogenic shock in developing and developed countries:

Aspect	Developing Countries	Developed Countries
Incidence of CS	3.7% among admitted patients	53.7 per 100,000 person-years
In-hospital Mortality Rate	69.7% (AMI-CS), 72.3% (non-AMI-CS)	~40% overall
Median Age of Patients	63 years	71 years
Gender Distribution	Predominantly male (70.5%)	Balanced but slight male predominance
Access to mechanical circulatory support devices	Limited availability	Widely available
Common Risk Factors	High prevalence of diabetes and renal dysfunction	Better-managed risk factors

ECONOMIC IMPACT OF CARDIOGENIC SHOCK

The economic burden of CS is substantial. Analysis from the Nationwide Inpatient Sample indicates that the annual cost associated with CS exceeds $65 million in the United States alone. This figure encompasses hospitalization costs, prolonged ICU stays, and resource utilization for complex interventions.[1] The unique challenges for management of CS in resource limited settings, that are linked with cost of healthcare are:

- Limited Access to Advanced Medical Technologies: In resource-limited settings, the high costs associated with advanced medical technologies, such as mechanical circulatory support (MCS) devices, pose a substantial barrier to effective treatment. For example, devices like intra-aortic balloon pumps and veno-arterial extracorporeal membrane oxygenation (VA-ECMO) are often unavailable due to their prohibitive costs. This lack of access means that patients with cardiogenic shock may not receive timely interventions that could significantly improve their survival rates.[4]

- Financial Constraints: Resource-limited settings often face severe financial limitations that restrict healthcare funding. This lack of funding directly affects the availability of essential medical technologies and treatments required for managing cardiogenic shock. For instance, the costs associated with advanced therapies, such as mechanical circulatory support (MCS) devices, are prohibitively high, leading to disparities in care availability. In well-resourced settings, hospitalization costs for CS can exceed $180,000 due to the use of invasive procedures and prolonged intensive care unit (ICU) stays. In contrast, facilities in low-resource environments may not have access to such technologies, resulting in suboptimal management of CS and increased mortality rates.

- High cost medical of Advance Medical Technologies: The treatment of cardiogenic shock often involves costly interventions like percutaneous ventricular assist devices or veno-arterial extracorporeal membrane oxygenation (VA-ECMO). These technologies are not only expensive to acquire but also require specialized training for healthcare providers. In resource-constrained settings, the inability to afford these technologies means that patients may miss critical therapeutic windows, leading to worse outcomes. Moreover, the financial burden extends beyond initial treatment; patients frequently require ongoing care and rehabilitation, which further strains limited resources.

- Systemic Health care Limitation: The combination of high costs and limited resources often leads to systemic healthcare challenges in managing cardiogenic shock. Many healthcare systems in low-resource settings lack the infrastructure needed for effective emergency care, including trained personnel and adequate facilities. This

inadequacy results in delayed treatment and increased mortality from conditions like CS, where timely intervention is crucial. Furthermore, the regionalization of specialized care—where complex cases are referred to distant centers—can delay access for patients who need immediate attention.

PATHOPHYSIOLOGY

The pathophysiology of cardiogenic shock is complex and not fully understood. Ischemia to the myocardium causes derangement to both systolic and diastolic left ventricular function, resulting in a profound depression of myocardial contractility.[4] This, in turn, leads to a potentially catastrophic and vicious spiral of reduced cardiac output and low blood pressure, perpetuating further coronary ischemia and impairment of contractility. Several physiologic compensatory processes ensue. Activation of the sympathetic system leading to peripheral vasoconstriction may improve coronary perfusion at the cost of increased afterload, and tachycardia increases myocardial oxygen demand and subsequently worsens myocardial ischemia.

These compensatory mechanisms are subsequently counteracted by pathologic vasodilation that occurs from the release of potent systemic inflammatory markers such as interleukin-1, tumor necrosis factor-α, and interleukin-6. Additionally, higher levels of nitric oxide and peroxy nitrite are released, which also contribute to pathologic vasodilation and are known to be cardiotoxic. Unless interrupted by adequate treatment measures, this self-perpetuating cycle leads to global hypoperfusion and the inability to effectively meet the metabolic demands of the tissues, progressing to multiorgan failure and eventually death.

CHALLENGES IN RESOURCE-LIMITED SETTINGS

Managing CS in resource-limited settings presents numerous challenges:

Limited Diagnostic Capabilities

Access to advanced diagnostic tools such as echocardiography or cardiac biomarkers may be restricted. This limitation complicates the rapid identification of CS and its underlying causes. In resource-limited settings, the availability of essential diagnostic tools is often inadequate. Key challenges include:

i. **Echocardiography:** Transthoracic echocardiography (TTE) is a vital tool for assessing cardiac function and identifying the underlying cause of CS. However, many facilities lack access to echocardiographic equipment or trained personnel to perform and interpret the studies effectively.[5] This limitation can delay diagnosis and appropriate management.

ii. **Laboratory Facilities:** The ability to perform timely laboratory tests, including cardiac biomarkers (e.g., troponins) and lactate levels, is crucial for diagnosing CS and assessing its severity. In many low-resource settings, these tests may not be available or may take an extended time to process, leading to delays in treatment

Inadequate Therapeutic Resources

Essential medications such as inotropes, vasopressors, and anticoagulants may not be readily available. Furthermore, advanced interventions like percutaneous coronary intervention (PCI) or intra-aortic balloon pumps (IABP) are often lacking in these settings. The management of CS often requires a range of medications and interventions that may not be available in resource-limited settings:

i. **Inotropes and Vasopressors:** Medications such as dobutamine or norepinephrine are critical for supporting cardiac output and blood pressure. However, these agents may be unavailable or prohibitively expensive in some regions, limiting their use.[6]

ii. **Mechanical Support Devices:** Advanced therapies such as intra-aortic balloon pumps (IABP) or ventricular assist devices (VADs) are essential for managing severe cases of CS but are rarely available in low-resource environments due to high costs and lack of trained personnel

Delayed Revascularization

Timely revascularization is crucial for patients with AMI-related CS. However, logistical challenges such as transportation issues or limited access to specialized care can delay necessary interventions. Challenges include:

i. **Limited Access to PCI Facilities:** Many resource-limited settings lack facilities capable of performing percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG). Patients may need to be transferred to specialized centers, which can lead to delays in treatment that adversely affect outcomes

ii. **Logistical Barriers:** Transportation issues, including poor infrastructure and lack of emergency medical services, can significantly delay patient transfer to appropriate care facilities

Lack of Trained Personnel

There may be a shortage of healthcare professionals trained in managing complex cases of CS, leading to suboptimal care delivery. The effective management of CS requires a multidisciplinary team approach that includes cardiologists, intensivists, and emergency physicians. Challenges related to personnel include:

i. **Shortage of Specialists:** There may be a lack of trained healthcare professionals capable of managing complex cases of CS. This shortage can lead to suboptimal care delivery and increased mortality rates

ii. **Training Opportunities:** In many low-resource settings, opportunities for continuing education and training in advanced cardiac care are limited, further exacerbating the skills gap among healthcare providers.

Socioeconomic Factors

Socioeconomic factors also make management of CS challenging in the places with limited resources:

i. **Access to Healthcare:** Patients from lower socioeconomic backgrounds may face barriers to accessing healthcare services, including transportation costs and the ability to pay for necessary treatments.

ii. **Public Health Infrastructure:** Weak public health systems can hinder the implementation of standardized protocols for managing CS, leading to inconsistent care delivery across different facilities.

MANAGEMENT STRATEGIES

Effective management of cardiogenic shock requires a structured approach that includes early recognition, stabilization, and definitive treatment:[7]

Early Recognition

Rapid identification of CS is critical for improving outcomes. Key clinical indicators include:

- Hypotension (systolic blood pressure <90 mmHg)
- Signs of end-organ hypoperfusion (altered mental status, cool extremities, oliguria)
- Elevated serum lactate levels

Utilizing simple clinical assessments combined with basic monitoring techniques can aid in early diagnosis even in low-resource environments.

Stabilization

Initial stabilization involves supportive measures aimed at restoring hemodynamic stability:

- **Fluid Resuscitation:** Administering intravenous fluids judiciously helps improve preload but must be balanced against the risk of fluid overload.
- **Oxygenation:** Providing supplemental oxygen is essential for improving tissue oxygenation.
- **Vasopressor Support:** In cases where hypotension persists despite fluid resuscitation, vasopressors such as norepinephrine may be utilized to maintain adequate perfusion pressure.

Pharmacological Interventions

The use of medications plays a vital role in managing CS:

- **Inotropes:** Agents like dobutamine or dopamine can enhance myocardial contractility but should be used cautiously due to potential side effects.
- **Antithrombotic Therapy:** Early administration of aspirin and heparin is crucial for patients with AMI-related CS to prevent further thrombus formation.

Revascularization

For patients with AMI-induced cardiogenic shock, early revascularization remains a cornerstone of treatment:

- **Percutaneous Coronary Intervention (PCI):** If available, PCI should be performed as soon as possible to restore blood flow to the affected myocardium.
- **Coronary Artery Bypass Grafting (CABG):** In cases where PCI is not feasible or effective, CABG may be considered if resources permit.

Despite logistical challenges in resource-limited settings, efforts should be made to facilitate timely transfer to facilities capable of performing these interventions.

Multidisciplinary Approach

The management of CS requires collaboration among various healthcare professionals:

- **Cardiologists and Intensivists:** Close collaboration between specialists ensures comprehensive care tailored to the patient's needs.
- **Emergency Medical Services (EMS):** Efficient EMS protocols can facilitate rapid transport and treatment initiation before reaching the hospital.[7]

To conclude, managing cardiogenic shock in resource-limited settings presents numerous challenges that significantly impact patient outcomes. Limited access to diagnostic tools, inadequate therapeutic resources, delayed revascularization, lack of trained personnel, high mortality rates, and socioeconomic factors all contribute to the complexity of care in these environments. Addressing these challenges requires a multifaceted approach that includes improving healthcare infrastructure, enhancing training opportunities for healthcare providers, and developing protocols tailored to the specific needs of resource-limited settings. By focusing on these areas, it may be possible to improve outcomes for patients suffering from cardiogenic shock in these challenging contexts.

Global collaboration between well-resourced and resource-limited settings is essential for improving the management of cardiogenic shock (CS), a condition characterized by severe circulatory failure and high mortality rates. Such partnerships can leverage the strengths of both types of healthcare environments to enhance patient care and outcomes.

Addressing cardiogenic shock in resource-limited settings through global collaboration presents a powerful opportunity to improve patient outcomes and reduce mortality rates associated with this critical condition. By fostering knowledge sharing, building capacity through training, engaging in collaborative research, ensuring equitable resource allocation, and promoting innovative solutions, stakeholders from well-resourced and under-resourced regions can work together effectively. This collaborative approach not only

enhances the management of cardiogenic shock but also strengthens healthcare systems globally, ultimately leading to better health outcomes for patients worldwide.

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