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REVIEW ARTICLE

Advances in Shock Management and Fluid Resuscitation in Children

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Abstract
Shock in children is associated with significant mortality and morbidity, particularly in resource-limited settings. The principles of management include early recognition, fluid resuscitation, appropriate inotropes, antibiotic therapy in sepsis, supportive therapy for organ dysfunction, and regular hemodynamic monitoring. During the past decade, each step has undergone several changes and evolved as evidence that has been translated into recommendations and practice. There is a paradigm shift from protocolized-based care to personalized management, from liberal strategies to restrictive strategies in terms of fluids, blood transfusion, ventilation, and antibiotics, and from clinical monitoring to multimodal monitoring using bedside technologies. However, uncertainties are still prevailing in terms of the volume of fluids, use of steroids, and use of extracorporeal and newer therapies while managing shock. These changes have been summarized along with evidence in this article with the aim of adopting an evidence-based approach while managing children with shock.

Keywords Septic shock · Fluid resuscitation · Protocolized care · Multimodal monitoring · Surviving sepsis campaign guidelines · Dynamic indices

Introduction

Shock is a state of tissue hypoperfusion either due to inadequate oxygen delivery that fails to meet metabolic demands, increased oxygen consumption, inadequate oxygen utilization, or a combination of these factors. In the recent past, there have been several advances in the diagnosis and management of pediatric shock, particularly septic and cardiogenic shock. The latest recommendations are in the Surviving Sepsis Campaign (SSC) guidelines 2020 [1]. These advances have been summarized with evidence in this article.

Methodology

To identify the literature on advances in the management of shock in children, PubMed/Medline and Google Scholar were searched for the relevant articles from 2001 to June 2022 by using the following keywords: 'shock,' 'sepsis,' 'septic shock,' 'cardiogenic shock,' 'children,' 'hemodynamic monitoring,' 'fluid resuscitation,' 'bolus fluid,' 'inotropes,' 'antimicrobials,' 'steroids' as well as combinations of these. As it is not a systematic review, relevant articles were identified for inclusion in this review.

Diagnosis of Shock—Recent Advances

It is important to recognize shock and initiate treatment promptly to prevent irreversible damage to the vital organs. Based on the etiology, shock has been categorized into hypovolemic, cardiogenic, distributive, obstructive, and septic shock (Table 1). Manifestations of shock consist of abnormalities in hemodynamic parameters and features of impaired end-organ perfusion. The classical differentiation of warm and cold shock based on clinical signs is currently no longer recommended as it does not reflect the true hemodynamic state. Besides, one type of shock can change over into another in due course of time [1, 2].

There have been several recent advancements in diagnosis and monitoring of shock in children, particularly septic shock. Many of these are applicable to all types of shock.

1. *New definition*: A new approach for the diagnosis of sepsis and septic shock (sepsis-3) has been developed,

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Table 1 Etiology of various types of shock in children

Type of Shock	Causes
Hypovolemic	1. Fluid and electrolyte losses a. Acute gastroenteritis b. Excessive sweating c. Renal diseases 2. Plasma loss a. Burns b. Third space losses 3. Hemorrhage a. External: Trauma, bleeding disorder, gastrointestinal bleeding b. Internal: Visceral injury, vascular injury, fractures 4. Endocrinal disorders a. Adrenal insufficiency b. Diabetes mellitus c. Diabetes insipidus
Cardiogenic	a. Myocarditis b. Cardiomyopathy c. Dysrhythmias d. Metabolic: Hypoxia, hypoglycemia, acidosis, hypothermia, uremia e. Drug intoxication: Anthracyclines, β-blockers, tricyclic antidepressants f. Congenital heart disease g. Cardiac surgery
Obstructive	a. Pericardial tamponade, pneumopericardium b. Pulmonary embolism c. Congenital heart disease: Aortic stenosis, coarctation of aorta, critical pulmonary stenosis, interrupted aortic arch d. Tension pneumothorax
Distributive	a. Anaphylaxis b. Drug toxicity c. Neurogenic

Adapted from [2, 3]

where sepsis is defined as "a life-threatening organ dysfunction caused by a dysregulated host response to an infection." Septic shock is the more severe variety of sepsis with risk of increased mortality as per the new definition. This approach has the potential for better associating the pathophysiology and clinical symptoms of sepsis and septic shock. In the new Sepsis-3 definitions, the traditional systemic inflammatory response syndrome (SIRS) criteria has been replaced with Sequential Organ Function Assessment (qSOFA) score due to lack of specificity of former; the term 'severe sepsis' has been removed; and the clinical criteria for sepsis and septic shock have been redefined [3]. However, even these new definitions have various shortcomings which include: a) elimination of concept of sepsis without organ dysfunction, which may hinder the early diagnosis and prompt treatment of sepsis; b) lack of sensitivity and prognostic accuracy of qSOFA; c) need of lactate levels for defining septic shock, which may be difficult in resource-limited settings; d) lack of representativeness from lower and middle-income countries. Also, these newer definitions need more studies for validation of their use in the pediatric population.

2. *Markers of shock identification*: Rapid recognition of shock is vital for timely interventions and improving outcomes. A combination of various clinical signs and hemodynamic parameters help in shock identification in the absence of an optimal marker. The clinical parameters have moderate sensitivity and poor specificity for shock recognition. Besides, hemodynamic compromise leads to age-dependent changes in macrocirculatory parameters in children, making them inappropriate diagnostic markers of shock. Hypotension is a late sign in children due to their ability to increase heart rate (HR) and systemic vascular resistance (SVR) to maintain cardiac output (CO). Hence, microcirculatory markers like serum lactate, mixed venous saturation ($ScVO_2$), and base deficit provide better information regarding tissue perfusion as well as response to treatment [4, 5].

All sick children at presentation should be screened using appropriate screening tools for early recognition of sepsis and shock. An example of such a screening tool is given in (Table 2) [6]. As the screening parameters may vary depending on the available resources, every institution should develop its own sepsis and shock screening tools and protocols for shock management [1, 4].

Table 2 Example of sepsis screening tool [6]

Vital sign	Criteria
Temperature	• ≥100.4°F/38°C or ≤96°F/35.5°C
High risk patient (any of the conditions listed)	• Malignancy • Immunodeficiency • Central venous catheter • Organ transplant • Referred from another hospital on inotropes
And any three of the following findings	• Feeble pulses/abnormal capillary refill/hypotension • Altered sensorium • Decreased urine output • Jaundice • Thrombocytopenia/bleeding from any site • Low pH or HCO_3 values if available

3. *Biomarkers in sepsis and septic shock*: Various biomarkers have been identified and studied that have diagnostic and prognostic role in patients with shock. The most studied biomarkers in sepsis are C-reactive protein, procalcitonin, and various cytokines, with cutoff values of 13.3 mg/L and 1.0 ng/mL for the former two, respectively [7]. Other less commonly used but emerging ones include lipopolysaccharide binding proteins, angiopoietin-1 and angiopoetin-2 [8, 9]. However, most of these are nonspecific and a few are not freely available. They are most commonly used in clinical practice for precluding infection and to step down the treatment. Monitoring the serial values of these biomarkers provides more information than a single-time measurement. Based on transcriptomic approach, a panel of serum protein biomarkers in pediatric sepsis has been identified, and the pediatric sepsis biomarker risk model (PERSEVERE) was developed with considerable sensitivity for risk stratification in pediatric sepsis [10]. Such a model will help in assessing the efficacy of newer therapies in sepsis.
4. *Hemodynamic monitoring*: The management of shock requires continuous monitoring of hemodynamic variables as well as regional and global tissue perfusion. Frequent clinical assessment along with the use of technology and certain laboratory parameters help in bedside hemodynamic monitoring [2]. The SSC 2020 guidelines recommend multimodal monitoring with bedside assessment for CO and cardiac index by echocardiography and monitoring of the stroke index and SVR index (SVRI) as it has been shown to characterize the hemodynamic phenotypes in pediatric septic shock [1, 2].

   Assessment of volume status and fluid responsiveness (FR) in a patient with septic shock is important for appropriate fluid resuscitation. Several hemodynamic static and dynamic parameters are used for the assessment of FR. Static parameters (HR, BP, central venous pressure, pulmonary capillary wedge pressure, CO, $ScVO_2$, or lactate) have been found to be less reliable for predicting FR and hence not recommended. On the other hand, dynamic indicators help to determine the need for fluids while measuring the change in stroke volume in response to a change in preload. These techniques include the passive leg raising test (PLR) and variations in inferior vena cava dimensions, stroke volume, pulse pressure, and systolic pressure during mechanical ventilation (MV) [11]. Though these are well studied in the adult population, evidence in children is still evolving. Out of all these variables, respiratory variation in aortic blood flow peak velocity has shown to be the best performing predictor of FR in children with a sensitivity of 92% and specificity of 85% [12].

Management of Shock in Children—Recent Advances

In any form of shock, the aim is to initially optimize the vital organ perfusion and thereafter prevent or reverse the metabolic abnormalities and defects in cellular metabolism. Several advancements have been made in the management of specific varieties of shock particularly septic and cardiogenic shock in recent years. More evidence is now available and is still evolving regarding various aspects of shock management, which has been translated into recommendations and practice.

1. **Septic Shock**

   The management of pediatric septic shock has undergone several changes over the last two decades, though the basic principles remain the same. Management is also shifting away from goal-directed therapy and toward an individualized approach based on adult RCTs, though it needs more evidence in children [13, 14].

   a) **Fluid Resuscitation in Septic Shock**

   Although fluid resuscitation is the cornerstone in the management of septic shock, various aspects of

fluid therapy, viz., type of fluid, optimal volume, and duration of fluid bolus, are still debatable.

Ideal fluid: Crystalloids are the recommended fluids for initial resuscitation in septic shock [15]. Recent evidence indicates that use of balanced crystalloids like Ringer lactate or PlasmaLyte during resuscitation is associated with a lower risk of hyperchloremic acidosis, acute kidney injury (AKI), and overall mortality compared to crystalloids with higher chloride concentrations like 0.9% normal saline (NS) [16, 17]. Current SSC 2020 guidelines have also recommended the use of balanced salt solution over NS as bolus fluid therapy [1]. However, NS continues to be the most commonly used resuscitation fluid because of issues with cost and availability.

Synthetic colloids, particularly hydroxyethyl starch solutions, have been associated with increased risk of acute kidney injury, coagulopathy, and death in patients with septic shock. Use of albumin is associated with better outcomes and is recommended in conditions with large fluid losses in third spaces, like dengue [15]. The latest guidelines recommend against the use of colloids in the management of sepsis and septic shock [1].

Volume of fluid bolus: Aggressive fluid resuscitation using fluid boluses of 40–60 mL/kg during the initial phase of septic shock has been advocated by various guidelines, including the latest ACCM guidelines [4], and has been consistently shown to be associated with reduced mortality. The concept behind using such large volumes is to mitigate the hypovolemia due to the massive capillary leak associated with sepsis. However, the use of this approach has been questioned lately by the Fluid Expansion as Supportive Therapy (FEAST) trial, which has reported poor outcomes with bolus fluid administration, particularly in those with severe anemia, malnutrition, and malaria [18]. The SSC 2020 guidelines have recommended that, based on the availability of intensive care resources, 40–60 mL/kg of bolus fluid (10–20 mL/kg per bolus) in 1 h can be given in the presence of intensive care facilities, while only 40 mL/kg of bolus fluid in 1 h is recommended if hypotension is present, and no fluid bolus, if hypotension is not present where these facilities are not available [1].

Method of fluid administration: The rapidity with which a fluid bolus can be administered is still unknown, with the recommendations for pushing fluids as fast as possible in the presence of hypotension. In two pediatric RCTs, greater rates of intubation, mechanical ventilation, and hepatomegaly were observed in the group where bolus fluid was administered over 5–10 min compared to when administered over 15–20 min. However, there was no difference in mortality in both groups [19, 20]. The current recommendations advocate a slower rate of fluid bolus administration, particularly in resource-limited settings.

Assessing fluid overload: While early fluid resuscitation in septic shock improves organ perfusion, it leads to fluid accumulation in later stages, causing fluid overload. Studies have revealed that cumulative fluid overload > 10% is associated with increased mortality [21]. Apart from usual clinical signs, point-of-care ultrasound, and echocardiography are being increasingly used for assessment of fluid status, cardiac function, and fluid overload. The concept of dividing fluid resuscitation during shock management in four phases, i.e., resuscitation, optimization, stabilization, and evacuation (ROSE) aids in the rational use of fluids in each phase and prevents fluid overload [22]. De-resuscitation strategies, including fluid restriction after achieving hemodynamic stability and the use of diuretics or renal replacement therapy (RRT) as indicated along with strict monitoring of the fluid balance, have been associated with better outcomes [23].

b) **Vasoactive Medications**

Patients with septic shock should be started on vasoactive medications in the presence of signs of poor perfusion, even after 40–60 mL/kg of fluid boluses and earlier on development of signs of fluid overload or other concerns for fluid administration. The choice of the first line vasoactive agent remains debatable. Epinephrine use has been associated with lower mortality compared to dopamine in 2 RCTs [24, 25]. There is no RCT comparing epinephrine and norepinephrine. The safety of administration of vasopressors through peripheral lines till the central access is achieved has been established [26].

c) **Early Initiation of Appropriate Antimicrobial Therapy and Source Control**

Delayed administration of antimicrobials has been shown to be associated with increased morbidity and mortality [27]. It is recommended to administer antimicrobials within 1 h of presentation in children with septic shock and up to 3 h in sepsis without septic shock [1]. The local antibiotic susceptibility patterns and the immune status of the child determine the choice of antibiotics. Daily assessment (clinical, microbiological) for de-escalation of antimicrobials should be part of management. Source control measures after a thorough evaluation should be undertaken within 6 h in patients presenting with sepsis [1].

d) **Steroids**

Relative adrenal insufficiency and increased inflammation associated with septic shock provide rationale for the use of steroids, but the evidence has not supported their role. The RESOLVE study and meta-analysis have failed to demonstrate the benefit of steroids in septic shock for the reduction of shock duration and mortality [28, 29]. Though the adult RCTs have shown the beneficial role of steroids (hydrocortisone plus fludrocortisone) in the reduction of mortality [30], there are lack of RCTs in children for solving this much debatable question. Currently, there are strict recommendations for not using steroids in cases where fluid and vasoactive medications are able to restore hemodynamic stability. However, if the latter fail to achieve hemodynamic stability, steroids may or may not be used [1].

e) **Supportive Management for Organ Dysfunction**

Invasive MV should be considered in fluid refractory shock besides its usual indications, like acute respiratory distress syndrome (ARDS) and other causes of respiratory failure [1]. However, a trial of noninvasive ventilation (NIV) can be given in children who respond to initial management [31]. Early use of NIV has been shown to improve outcomes, particularly in patients with decreased myocardial function and cardiogenic shock [32].

Restrictive blood transfusion strategies should be used in children with shock due to the associated risks and limited clinical benefit of their liberal use [33]. It is recommended not to transfuse packed red blood cells (PRBC) in hemodynamically stable patients with hemoglobin > 7 g%. However, the cutoff for hemodynamically unstable patients is not clear [1, 33].

Metabolic abnormalities in blood glucose, calcium, and other electrolytes should be prevented and corrected [1]. Early use of enteral feeding in children with shock and inotropic support has been associated with lower mortality, while use of total parenteral nutrition in the first week leads to poor outcomes and hence should be avoided [1, 34, 35]. Use of RRT, particularly continuous renal replacement therapy (CRRT), for treating refractory fluid overload, addressing acute kidney injury, and to remove certain metabolites in children with shock is associated with improved outcomes [1, 36].

Use of extracorporeal membrane oxygenation (ECMO) is considered as the last option for refractory septic shock as it is associated with significant risks. Venovenous ECMO is recommended for severe ARDS and refractory hypoxemia, while venoarterial ECMO is considered for refractory septic shock [1, 37]. Other therapies like plasma exchange and IVIg are experimental therapies and should be used on a case-to-case basis, like the former in thrombocytopenia-associated multiorgan failure (TAMOF) [38] and the latter in multisystem inflammatory syndrome in children temporally associated with SARS Coronavirus 2 infection (MIS-C) [39] or toxic shock syndrome.

Refractory Septic Shock

Refractory septic shock in children is defined as high blood lactate of > 8 mmol/L with high vasoinotrope doses (vasoactive inotrope score - VIS > 200 mcg/kg/min) and associated myocardial dysfunction [40]. Potentially reversible causes should be looked for and treated first in these children before going for extracorporeal support like ECMO. Pediatric cardiology consultation and echocardiography should be sought for suspected myocarditis, myocardial infarction, heart failure or congenital heart diseases (CHDs), especially in neonates and young infants as a cause of refractory septic shock [4].

2. **Cardiogenic Shock**

Cardiogenic shock is a state in which oxygen delivery to the tissues is insufficient relative to body needs, secondary to poor cardiac function. The principles in the management of cardiogenic shock include optimizing the carriage of oxygen to the tissues, reducing their utilization of oxygen, and treatment of the underlying cause. The initial principles of shock resuscitation also apply to cardiogenic shock, which include stabilization of airways and breathing, fluid resuscitation, and inotropic support, and supportive management. However, in cardiogenic shock, fluid bolus volume and rate need to be reduced to 5–10 mL/kg over 20–30 min to prevent the burden on already failing heart with early use of inotropes. The fluid bolus should be altogether avoided in conditions with evidence of increased right ventricular filling pressures, like congestive heart failure [41, 42].

Tissue oxygen delivery can be increased by maximizing the myocardial performance (preload, myocardial contractility, and afterload) as well as by increasing the arterial oxygen content (CaO_2). Depending upon the volume status of an individual patient, preload can be optimized by using fluids, diuretics with fluid restriction, or inotropes. Myocardial contractility can be enhanced by optimizing serum calcium and potassium levels and providing inotropic support. Dobutamine with noradrenaline are currently recommended as the first choice of inotropes in cardiogenic shock with adrenaline to be used in inotrope resistant shock. Ameliorating the anxiety, pain, and fever control and positive pressure ventilation help in reducing the afterload as well as myo-

Table 3 Summary of recent advances in the management of shock in children

Components of shock management	Advances/Recommendations
Definition, recognition, and diagnosis of pediatric shock	1. Newer sepsis-3 definitions for defining sepsis and septic shock with elimination of terms like SIRS and severe sepsis 2. Septic shock in adults is identified by either MAP < 65 mm Hg and arterial lactate > 2 mmol/L 3. Use of microcirculation-based parameters like lactate and $ScVO_2$ for identification of early and persistent shock 4. Systematic screening using appropriate screening tools for early recognition 5. Biomarkers for diagnosis and prognosis in sepsis and septic shock 6. PERSEVERE model—Biomarker-based model for classification of types of pediatric septic shock
Hemodynamic monitoring	1. Multimodal monitoring with use of clinical parameters and invasive and noninvasive techniques, especially bedside echocardiography for identification of physiological type of shock as well as therapeutic intervention 2. Dynamic variables (passive leg raise test, IVC distensibility and collapsability indices, stroke volume variation, systolic or pulse pressure variation indices) preferred over static variables for determining fluid responsiveness
Management of pediatric shock	1. Protocol-based management of septic shock 2. Early goal-directed therapy (EGDT) is no longer recommended
Fluid resuscitation	**Pediatric septic shock:** 1. Crystalloids preferred over colloids 2. Balanced fluids recommended over 0.9% saline 3. Restrictive fluid approach than aggressive fluid resuscitation 4. Bolus fluid volume of 40–60 mL/kg (10–20 mL/kg per bolus) in 1 h can be given in presence of intensive care facilities while only 40 mL/kg of bolus fluid in 1 h is recommended if hypotension is present and no fluid bolus if hypotension is not present where these facilities are not available 5. Fluid bolus to be given slowly over 15–20 min 6. After stabilization following initial fluid resuscitation, optimization and de-resuscitation strategies (ROSE approach) to avoid fluid overload **Cardiogenic shock:** 1. Fluid bolus of 5–10 mL/kg over 20–30 min can be administered; should be avoided in cases of congestive heart failure 2. Optimization of preload with use of diuretics and fluid restriction is required in most of the cases
Vasoactive medications	1. Epinephrine preferred over Dopamine as a first line vasoactive in pediatric septic shock 2. Dobutamine with nor-adrenaline are currently recommended as first choice of inotropes in cardiogenic shock with adrenaline to be used in inotrope resistant shock. 3. Milrinone and Levosimendan can be used in non-responding cases
Anti-microbial therapy and source control	1. Antimicrobials to be administered within 1 h of presentation in children with septic shock and upto 3 h in sepsis without septic shock 2. Source control to be achieved within 6 h of presentation
Steroids	1. Steroids are not recommended in cases where fluid and vasoactive medications are able to restore hemodynamic stability. However, if latter fail to achieve hemodynamic stability, steroids may or may not be used.
Supportive management	1. Invasive mechanical ventilation in fluid refractory shock, a trial of NIV in early pediatric shock and cardiogenic shock 2. PRBC transfusion not to be done if Hb >7 g/dl and hemodynamically stable; may keep Hb to 10 g/dl in children with shock 3. Early enteral feeding in children with shock; early parenteral nutrition to be avoided in first week 4. CRRT in case of AKI and fluid overload 5. Extracorporeal therapies like ECMO in refractory pediatric shock **Specific to Cardiogenic shock:** 1. Strategies for reducing anxiety, pain and controlling fever 2. Normalizing the electrolyte (calcium and potassium) abnormalities 3. ECMO and ventricular assist devices as a bridge to cardiac transplantation 4. E-CPR in cases like myocarditis

AKI Acute kidney injury, *CRRT* Continuous renal replacement therapy, *ECMO* Extracorporeal membrane oxygenation, *E-CPR* ECMO cardio-pulmonary resuscitation, *IVC* Inferior vena cava, *MAP* Mean arterial pressure, *NIV* Noninvasive ventilation, *PRBC* Packed red blood cells, *SIRS* Systemic inflammatory response syndrome

cardial oxygen demand. Drugs which act as veno- or vasodilators like sodium nitroprusside and inodilators like milrinone decrease the afterload. In refractory cases, levosimendan can also be tried; however, there is insufficient evidence for its use in children. In children with duct-dependent left-sided obstructive cardiac conditions, prostaglandin is used for medical management till the time definitive surgical treatment is available [43, 44].

Regular use of digoxin in children with cardiogenic shock is not suggested due to the lack of clear benefit in anatomically normal heart. The usefulness of beta-blocker agents in pediatric patients with acute heart failure is not clear [44]. Other strategies include increasing CaO_2 by PRBC transfusion whenever indicated, appropriate respiratory support, and correction of metabolic acidosis or other electrolyte abnormalities [43, 44].

A worsening of cardiac function despite medical management warrants the use of invasive cardiac support. Such treatment options include ECMO and ventricular assist devices (VAD) as bridge therapies with cardiac transplantation as the ultimate treatment goal. ECMO-cardiopulmonary resuscitation (ECPR) in cases of myocarditis or myocardial dysfunction should be considered as early as possible, provided the necessary facilities are readily available at the center [44, 45].

The underlying causes of cardiogenic shock should also be addressed after initial resuscitation and stabilization like cardiac arrhythmias and myocarditis. Other causes, like CHDs and cardiomyopathies may require long-term management and surgical treatment [41, 44].

3. **Hypovolemic Shock**

This type of shock includes shock due to fluid losses and hemorrhagic shock. The management requires adequate fluid replacement in the former and blood transfusion with appropriate components in the latter with initial steps of resuscitation [42, 46].

4. **Obstructive Shock**

This type includes shock due to the presence of pneumothorax, pericardial tamponade, or acute pulmonary thrombosis, which affect the left or right heart output. The treatment is mainly directed toward managing the underlying cause, apart from the basic steps of shock resuscitation [42, 46]. For example, pericardiocentesis in cardiac tamponade; immediate needle thoracotomy followed by intercostal chest tube drainage in tension pneumothorax; fibrinolysis or thrombectomy and inotropic support in cases of pulmonary thrombosis [46].

5. **Distributive Shock**

Anaphylactic shock requires airway and breathing management, fluid resuscitation, immediate administration of I/M or I/V adrenaline, and removal of the inciting agent. The dose of epinephrine is 0.1 mL/kg of 1:10,000 solution every 3–5 min (the maximum dose is 1 mg). If hypotension is refractory to epinephrine boluses, start epinephrine infusion at 0.1 mcg/kg/min and increase up to 1 mcg/kg/min depending on the response [46]. Neurogenic shock is managed with the initial steps of shock resuscitation with fluid boluses and norepinephrine administration [42, 46]. Table 3 summarises the various advancements in the management of shock in children.

Conclusion

Early recognition, timely intervention, and close monitoring are central to improving the outcomes in children with shock. A lot of advances have been made in the management of shock in children. Newer definitions for septic shock are in place but their applicability in children requires validation. Biomarkers, both for diagnosis and monitoring, are evolving. Multimodal monitoring with the use of bedside echocardiography is now becoming the standard of care in pediatric shock. Restrictive fluid and transfusion strategies are being followed in shock. Assessment of FR using dynamic variables is far more accurate than static parameters. Epinephrine is now the first choice of inotropic agent over dopamine. More clarity is still required regarding the type of fluids and use of steroids in pediatric septic shock. Extracorporeal therapies are being increasingly used in refractory and cardiogenic shock and are associated with improved outcomes.

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Declarations

Conflict of Interest None.

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