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St. Paul's Hospital Millennium Medical College**

**PATTERN OUTCOME OF SHOCK IN PEDIATRIC
INTENSIVE CARE UNIT AT St PAUL HOSPITAL
MILLENNIUM MEDICAL COLLEGE**

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**A THESIS RESULTS SUBMITTED TO St. PAUL
MILLENNIUM MEDICAL COLLEGE AND DEPARTMENT
OF EMERGENCY AND CRITICAL CARE MEDICINE AS
PARTIAL FULFILLMENT OF REQUIREMENTS FOR
SPECIALTY IN EMERGENCY AND CRITICAL CARE
MEDICINE.**

ADDIS ABABA, ETHIOPIA

NOVEMBER 2024

Project Profile

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Full title of the research project	Pattern Outcome of Shock in Pediatric Intensive Care Unit of St Paul Hospital Millennium Medical College
Duration of the project	1-year Cross-Sectional Study
Study Area	St Paul Millennium Medical College Pediatric Intensive Care Unit
Total Cost of the project	42,050 birr
Source(s) of Funding	St Paul Hospital Millennium Medical College
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ABSTRACT

Background: Shock is a common life-threatening condition that is characterized by a state of circulatory insufficiency, that creates an imbalance between tissue oxygen delivery and consumption, resulting in end-organ dysfunction and potentially death. It is classified into four categories based on its underlying pathophysiology: cardiogenic, hypovolemic, obstructive, and distributive. The patterns, outcomes, and associated factors of shock in Ethiopian PICUs have not been well studied. This is particularly concerning given the high burden of shock in Ethiopia, where it accounts for a significant proportion of pediatric mortality. Moreover, Ethiopia has limited preventative and curative healthcare systems and resources, which may further contribute to the poor outcomes of shock.

Objectives: the main objective of the study is to determine the pattern, outcome, and associated factors of shock at the Pediatric Intensive Care Unit of St Paul Millennium Medical College.

Method: A cross-sectional observational study was conducted at St Paul Millennium Medical College Pediatric Intensive Care Unit from October 30, 2022, to November 1, 2023. The study was focus on children aged 1-month post-delivery to 17 years with clinical diagnoses of shock. Patients were selected using a simple random sampling technique with a sample size of 178. Data was collected using a structured questionnaire from chart revision and analyzed using SPSS. Mainly quantitative data analysis was implemented, with additional qualitative analysis on the association between the outcome and management principles, as well as other related factors.

Results: In this study, 97(58.8%): 95%CI [51.5, 66.7] of patients was survived with 70(42.4%) of them were transferred to wards and 68(41.2%) were died.

Conclusion and Recommendations: The study highlights the high burden of septic shock and associated mortality in the PICU at SPHMMC, with septic shock contributing the highest number of admissions into the PICU. The mortality rate of PICU was higher than previous study. Early detection and the transfer of critical patients to the ICU to improve their outcomes, a continuing effort should be made to improve the quality of care through support focusing on hemodynamic support and mechanical ventilator use.

Keywords: Pattern Outcome Pediatric Children Shock, Associated Factors PICU
St Paul Millennium Medical College

Acknowledgments

I would like to express my gratitude to St. Paul Millennium Medical College, Department of Emergency Medicine and Critical Care for giving me an opportunity to to pursue my specialty degree. I also want to extend my sincere appreciation to my advisors, Dr. Etsegenet and Dr. Rediet, for their invaluable feedback, guidance, and unwavering support throughout the development of this study thesis.

ACRONYMS AND ABBREVIATIONS

AGE: Acute Gastroenteritis
AKI: Acute Kidney Injury
AOR/OR: Adjusted Odd Ratio/ Odds Ratio
ARDS: Acute Respiratory Distress Syndrome
CHD: Congenital Heart Disease
CHF: Congestive Heart Failure
CI: Confidence Interval
CO: Cardiac Output
COR: Crude Odd Ratio
CS: Cardiogenic Shock
CT: Computed Tomography
DKA: Diabetic ketoacidosis
Echo: Echocardiogram
ED: Emergency Department
GCS: Glasgow's Coma Scale
HIV/ AIDS: Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
ICU: Intensive Care Unit
IVC: Inferior Vena Cava
LMIC: Low- And Middle-Income Counties
LOC: Level Of Consciousness
LOS: Length Of Stay
MOF/ MODS: Multi-Organ Failure/ Multiple-Organ Dysfunction Syndrome
MV: Mechanical Ventilation
PALS: Pediatric Advanced Life Support
PICU: Pediatric Intensive Care Unit
POCUS: Point of Care Ultrasound
RLS: Resource-Limited Settings
RRT: Renal Replacement Therapy
SBP: Systolic Blood Pressure
SI: Shock Index
SOFA: Sequential Organ Failure Assessment
SPHMMC: Saint Paul Hospital Millennium Medical College
SPSS: Statistical Package for Social Science
SVR: Systemic Vascular Resistance
WHO: World Health Organization

1. INTRODUCTION

1.1. Background

Shock is a circulatory insufficiency that creates an imbalance between tissue oxygen delivery and consumption [1]. Shock is a major health concern for children worldwide, affecting 2% of hospitalized children and causing significant morbidity and mortality [2]. While the initial approach to shock is similar for all patients, managing shock in pediatric populations presents unique challenges due to their developing physiology, complex medical needs, diverse clinical presentations, and often complicated underlying medical conditions. Mortality from shock depends on the underlying cause, clinical circumstances, and severity of the condition. If left unrecognized and untreated, shock progresses along a continuum, leading to irreversible organ injury, multiple organ dysfunction syndrome (MODS), and death. Indeed, most deaths related to shock in children stem from these complications. [3-5].

Shock, resulting from various disorders, is broadly categorized into four primary mechanisms: hypovolemic, distributive, cardiogenic, and obstructive [6,7]. Understanding the underlying mechanism is crucial for identifying causes and guiding treatment decisions. However, a single etiology may manifest features of multiple shock types, and the classification could be mixed at times [8]. Additionally, the etiology and mortality of undifferentiated shock in children remain poorly understood. [10]. The PALS course further categorizes shock into three stages: compensated, decompensated, and irreversible. [11]. The classic differentiation of warm and cold shock based on clinical signs is no longer recommended as it does not accurately reflect the true hemodynamic state. Besides, one type of shock can transition into another over time, as seen with septic shock progressing to cardiogenic shock if the child develops associated myocardial dysfunction [12,13].

Hypovolemic shock develops when there is insufficient intravascular volume for tissue perfusion [14,15]. This type of shock is particularly prevalent in children worldwide and is a leading cause of death among children under the age of five in developing countries [16-18]. Children can rapidly lose significant fluids, up to 10-20% of their circulating volume, within 1-2 hours due to diarrhea [21]. Vomiting is another common source of volume loss; hemorrhagic shock in children often occurs as a result of major trauma [19]. Cardiogenic and obstructive shock are less common but should be quickly recognized as they generally require specific therapies. Cardiogenic shock results from a pump failure and is commonly observed in patients with CHD, arrhythmias, or those with intrinsic cardiac disease such as

cardiomyopathies, including acute myocarditis [20,21]. Obstructive shock stems from any lesion that creates a mechanical barrier that impedes adequate cardiac output. This can be caused by conditions such as pericardial tamponade, tension pneumothorax, massive pulmonary embolism, and infants with ductus-dependent CHD, such as coarctation of the aorta and hypoplastic left ventricle syndrome [22,23].

Distributive shock results from inadequate vasomotor tone, causing fluid leakage and maldistribution in the interstitium. It can be caused by conditions such as sepsis, anaphylaxis, poisoning, or neurologic injury. Although septic shock is primarily distributive, the septic process usually entails a more intricate interplay of distributive, hypovolemic, and cardiogenic shock, and the degree to which a patient exhibits each of these responses varies. This complex condition is among the leading causes of mortality in children worldwide. The mortality rate from septic shock is highly variable, with rates as high as 35% in developing nations and 5% in developed nations [24-26]. However, the mortality rate has recently decreased, likely due to the implementation of guidelines that stress the importance of early administration of fluid and antibiotics [27,28].

Children's substantial physiological reserves and compensating systems can mask overt signs of shock, even when tissue perfusion is severely reduced. This signifies that when symptoms do occur, patients are likely to deteriorate rapidly [9]. It is important to note that hypotension is a late and ominous finding associated with higher morbidity and mortality, and it is not a criterion for the diagnosis of shock in children. [29-31]. Instead, early recognition of shock, before hypotension occurs, is vital for favorable treatment outcomes. Microcirculatory markers such as serum lactate, ScVO₂, and base deficit could be better indicators of tissue perfusion and response to therapy in this regard [32-34].

Hypovolemic shock is primarily characterized by fluid loss and decreased preload. The initial compensatory responses to maintain systemic blood pressure and CO are tachycardia (increased heart rate) and a rise in SVR. Cardiogenic shock patients generally have elevated SVR, compensating for their low cardiac output caused by systolic and/or diastolic myocardial depression. In contrast, abnormal vasodilation and reduced SVR constitute the pathophysiological process underlying distributive shock [16,20-21]. Later stages of all types of shock can negatively affect the myocardium, leading to the development of a cardiogenic component to the initial shock state. This impact on CO occurs through several pathways, affecting heart rate, preload, afterload, and myocardial contractility.

Septic shock should be defined as a subset of sepsis in which particularly profound circulatory, cellular, and metabolic abnormalities are associated with a greater risk of mortality than with sepsis alone. [32,35].

1.2. Statement of the Problem

Shock is a common and life-threatening condition in pediatric intensive care units (PICUs), particularly in developing countries where it remains a major cause of morbidity and mortality despite efforts to reduce its impact [12,36-37]. PICUs play an essential role in saving the lives of critically ill children, such as those suffering from shock [2,38]. Nevertheless, global mortality rates remain high, especially in Sub-Saharan Africa where 53% of under-5 mortality occurs and, in this region, pediatric critical care services are particularly inadequate [39]. The WHO attributes most pediatric deaths in developing countries to preventable and curable diseases if treatment is optimized [40,41]. According to a study by Rudd et al. (2020), which analyzed 109 million individual death records between 1990 and 2017, 85% of sepsis/septic shock-related deaths worldwide occurred in low- and middle-income countries (Global Burden of Disease, 2020) [37]. Furthermore, efforts to enhance outcomes are impeded by the scarcity of data on PICUs in low-income countries, with the majority of existing data originating from high-income countries [42,43].

Ethiopia, with a high U₅MR of 59 deaths per 1000 live births, [40,44] also faces high PICU mortality rates ranging from 8.5% to 88.2% [45-47]. Shock-related mortality rates are also particularly alarming, with studies reporting ranges from 18.6% to 50% [48,50-51]. Despite establishing the first PICU in 2012, the number of these units remains insufficient in Ethiopia. The scarcity of resources and Ethiopia's large child population further exacerbate the issue. Limited data and organizational information regarding shock in pediatric critical care further hinder efforts to improve outcomes [45-47]. Ethiopia's child population comprises 46% of the total population, with approximately 58 million under 18 and 13 million under 5 (UNICEF 2023) [52]. The country also has a per capita gross national income of \$1,020 (World Bank 2023) [53].

The distribution of shock types in PICUs varies based on the patient population. For instance, hemorrhagic shock affects 5-15% of pediatric trauma patients, [54], while cardiogenic shock is more prevalent in those with pre-existing heart conditions. Cardiogenic shock occurs in up to 20% of patients admitted to PICUs [20]. The mortality rate of pediatric shock depends on

the underlying cause and the severity of the shock. Septic shock alone causes over 8% of PICU admissions and results in 4.5 million childhood deaths annually worldwide [27,32,55].

The timely recognition and treatment of shock are paramount in PICUs due to the varied presentations of shock and the potential for severe complications if left untreated. The heterogeneity of shock manifestations, influenced by factors such as age, comorbidities, underlying causes, and the time elapsed since shock onset, can complicate prompt diagnosis and intervention. Failure to identify and address shock promptly can lead to a cascade of adverse consequences, including MOF, prolonged ICU stays, and increased mortality rates. Therefore, early detection and appropriate management of shock are essential to improve patient outcomes and reduce the risk of life-threatening complications [2,5,9,32].

1.3.Rationale of the Study

In Ethiopia, the prevalence of shock in PICUs is high, but limited data exists on the patterns and outcomes of shock in this setting [50,56]. This study aims to address this knowledge gap by investigating the patterns and outcomes of shock in Ethiopian PICUs, while also identifying the associated factors. Understanding the prevalence and characteristics of shock in this setting can help healthcare providers better anticipate and manage these critical conditions. By Unveiling the common patterns or types of shock, providers can tailor their interventions more effectively, leading to improved patient outcomes. Identifying shock-associated factors can provide insights into underlying causes and risk factors, enabling providers to identify children at risk and intervene promptly. Analyzing the impact of treatment timing, comorbidities, underlying diseases, and other concurrent therapies on shock outcomes can yield valuable insights for optimizing patient care. Overall, the study's findings can aid healthcare providers in understanding shock's impact on critically ill children in PICUs and serve as a foundation for future research.

2. LITERATURE REVIEW

In the 2015 SPROUT study, which was an international prospective point-prevalence study conducted at 128 sites in 26 countries, septic shock was found to have a prevalence of 8.2% in 6,925 PICU patients [25]. Similarly, Ruth et al. (2014) discovered that between 2004 and 2012, 7.7% of 43 U.S. children's PICUs had severe sepsis/ septic shock among PICU admissions, with a 14.4% mortality rate [57].

A prospective study involving 75 instances of shock in children was carried out at the Alluri Academy Hospital in India between 2014 and 2016. According to the study, children under 1 year old (38.6%) were most affected, with septic shock (69.3%) being the most prevalent type, followed by hypovolemic shock (25.3%). For septic shock and hypovolemic shock, the most frequent causes were pneumonia (32.6%) and AGE (78.9%), respectively [58].

A retrospective analysis of 136 children with septic shock at a PICU in Yogyakarta, Indonesia found a high mortality rate of 88.2%. The two most common early clinical signs were tachycardia and a reduced peripheral pulse. Mechanical ventilator support was required in 79.4% of cases during the first 24 hours, and a 4-day stay was the median LOS in the PICU. [59].

A 2015 multicentre cohort study found that 2.1% of 97,127 children admitted to PICUs in Australia and New Zealand had septic shock. While the incidence of septic shock rose over time, the authors observed that mortality remained unchanged [60].

According to a 2022 cohort study of 1,523 PICU admissions at a teaching hospital in Jordan, septic shock had a mortality rate of 24%. Patients who died were younger (with a median age of 11 months) and 85% of them had comorbidities.[61]

A 2022 retrospective study found that 79.1% of patients admitted to the PICU with cardiogenic shock had acute myocarditis as the underlying cause. The author noted that the prognosis for these patients has improved in recent years with appropriate fluids, diuretic treatment, inotrope management, and extracorporeal support.[62]

According to a 2012 nationwide survey conducted in Japan, fulminant myocarditis resulted in cardiogenic shock in 28 % of cases. In this study, myocarditis was a rare disease in children

(n=169, 43.5 cases per year), with the most common cause being coxsackie virus (60%). Although fulminant myocarditis had a low survival rate, the author states that the majority (two-thirds) of the survivors recovered without any long-term problems.[63]

A 2010 cohort study of 583 children admitted to an urban pediatric resuscitation room in Malawi found that HIV-infected children with shock had higher mortality rates than HIV-uninfected children, both early and late after resuscitation shock (66%; 162 out of 247). [64]

According to a 2016 retrospective study of 42,937 children admitted to 14 hospitals in Kenya, shock was an uncommon diagnosis (1.45%, n = 622), but with a high case fatality rate (34%). This study, which included children aged 30 days to 5 years old, found hypovolemic shock due to diarrhea to be the most prevalent type (94%). Comorbidity was almost invariably diagnosed with hypovolemic shock (99%), most often pneumonia or malaria and these patients had a higher mortality rate (36%). [65]

A retrospective single-center cohort study of 797 AHF hospitalizations in children aged 0-18 years at Texas/Houston University, USA from 2004 to 2018 found that 26% of children developed cardiogenic shock (CS). CS patients were younger (median age 4 years vs 8 years) and had more severe symptoms and higher BNP levels at admission. They also required more mechanical support (mechanical ventilation, RRT, MCS) and CPR during their hospitalization. CS patients had a higher mortality rate (24% vs 8%) and longer hospital stays (median 30 days vs 17 days) compared to those without CS. The most common etiologies of AHF were cardiomyopathy (53%), followed by HTx graft failure (15%), CHD (15%), and myocarditis (11%). The study concludes that risk stratification of pediatric CS should be considered to improve outcomes and survival.[66]

A 2021 retrospective cross-sectional study of 406 children admitted to the PICU of Tikur Anbessa Specialized Hospital (TASH) in Ethiopia found that septic shock was the most common reason for admission (27.14%) [51].

A 2022 prospective cross-sectional study found that 1.9% of pediatric patients at SPHMMC were diagnosed with shock, with hypovolemic shock being the most common type (64.2%) and had a mortality rate of 15%. The study enrolled 1605 children and septic shock was the most common cause of death (50%). Only 1 patient was diagnosed with cardiogenic shock.

Over half of the study participants (54.8%) had comorbid conditions, and the majority of Children (74.2%) were under the age of 2. [48].

A 2019, 3-month prospective study of 23 children with shock TASH found that septic shock was the most common cause of death in ED, with a mortality rate of 88.2%. Septic shock mortality was highest within the first 24 hours of admission, and fever, vomiting, and tachypnea was the most common initial presentation. Notably, Children with hypovolemic shock, which was often caused by AGE or DKA, had no recorded deaths [49].

A systematic review of observational studies from 2015 to 2022 found that pediatric mortality in Ethiopia's PICUs is higher than in middle- and high-income countries with an overall mortality rate of 28.5%. The reported mortality rate ranged from 8.5% to 43.8% in the included 8 studies from 4 distinct regions of Ethiopia, with a total of 2,345 children. According to the studies, severe sepsis/septic shock was one of the top 3 common causes of death in these studies [50].

All of the aforementioned papers' authors reported that children with shock who have comorbidities, require mechanical ventilation or inotropes, have a severe GCS score, or develop admission hypoglycemia or MOD were at increased risk of death [48-51]. In addition, Molla et al. (2023) stated that studies of shock in Ethiopian children are limited in number, sample size, and duration, and do not always observe culture-proven sepsis and underlines the paucity of research conducted in Ethiopia [50,56].

Pediatric shock death rates are probably underestimated, with global impact exceeding the reported. According to Balamuth et al. (2014), the more often reported pediatric septic shock death rate of 2-8% [24,67] is likely diluted by the inclusion of children with mild sepsis [68]. Similarly, Kissoon et al. (2016) highlighted that global pediatric deaths owing to sepsis/septic shock are probably overlooked as sepsis is the common denominator of almost all childhood deaths due to infections outside [69].

In addition to the significant mortality observed in PICUs, shock-related deaths prior to PICU or hospital admission are also a major concern. A study by Cvetkovic et al. (2015) studied 627 children with septic shock in, England between 2005 and 2011, and found that 55% of the 130 children who died did so within 24 hours, and half of those died before reaching the

PICU ^[70]. “Most of these early deaths were due to ineffective shock resuscitation attempts, often involving delayed or insufficient resuscitation” [37,71].

A 9-year study of 91 children found that early shock reversal was linked to improved survival. Successful reversal resulted in a 96% survival rate, while the risk of mortality doubled for each hour of untreated shock. Patients who died received more inotropic treatments but not more fluid therapy [72].

The lack of "gold-standard" criteria for defining sepsis and shock hinders early shock recognition and contributes to high child mortality [7,55,73]. Weiss et al. (2015) noted that 31% of PICU patients diagnosed with septic shock by the treating physician did not meet consensus criteria ^[9], yet had high mortality (17%) and disability (17%) rates [74].

In 2016, a scientific article (sepsis-3) was published with an updated set of criteria for diagnosing and treating sepsis/septic shock [35]. The Sepsis-3 definitions are more specific than the SIRS, but they are less sensitive, removed the term "severe sepsis" and do not include a concept of sepsis without organ dysfunction [75,76].

A systematic review by Assies et al. (2022) found that 5 different shock definitions were used in LMICs, with no single definition consistently applied. The most common definition was from sepsis guidelines (30.5% of studies) followed by self-adapted definitions (27.1% of studies), and the WHO ETAT definition (10.2% of studies). The highest pooled mortality was observed in studies using sepsis guidelines definitions (33.3%) [36].

Tamburlini et al. (1999) indicated that the WHO's definition of shock is based on bedside clinical parameters, making it advantageous in resource-limited settings [77]. However, studies by Ahmad et al. (2010) and Mbevi et al. (2016) have questioned its validity. Their studies have demonstrated that the definition represents an advanced or potentially irreversible stage of shock, with a mortality rate of up to 100%. [64,65].

Hypotension is a hallmark of shock in adults, however, a 2018 observational study of 10,698 children in the Netherlands found that it is a late and ominous sign in pediatric patients. The study indicated that hypotension had a high specificity (0.94–0.98) and modest sensitivity (0.02–0.08) for critical illness or PICU admission [29]. Despite this, Gilhotra et al. (2006) and

Thompson et al. (2010) noted that the frequency of BP measurement varies widely (23%–87%), and, no consensus exists on a standard BP monitoring way for all children [78,79].

A large-scale study conducted in Pennsylvania Trauma Bay involving 64,344 children found a mortality rate of 2.0%, with higher rates for those with admission hypotension (4.4%) or transfusion (1.6%). Hypotension and transfusion independently increased the odds of death, and survival rates were worse for transfused patients [30]

Another measure of hemodynamic status is the Shock Index (SI). Studies conducted on a cohort of children have shown that SI is linked to the severity of injuries sustained in trauma as well as mortality rates in cases of septic shock [80,81].

For example, in a cohort of 559 children with moderate to severe injuries in 2017, an age-adjusted SI was found to be a better predictor (3 times) of the need for emergency operation, endotracheal intubation, or early blood transfusion than age-adjusted hypotension [80]. Similarly, a 2013 cohort study of 544 children admitted to PICU with septic shock found that hourly SI was associated with mortality, and a reduction in ICU mortality was linked to an improvement in SI during the first 6 hours [81].

A 2017 prospective study found that lactate levels and clearance are associated with mortality in 148 children with septic shock admitted to a PICU in India. The study's author noted that admission lactate levels ≥ 4 mmol/L demonstrated a high predictive value (OR 5.4) for mortality and a Lactate clearance $< 10\%$ at 24 h had high sensitivity (78.7%) and specificity (72.2%) for death [82].

Concerning many facets of shock care, numerous developments have been made, especially in septic and cardiogenic shock, though the basic principles remain the same. Importantly, there had been a paradigm shift from protocolized-based care to personalized management [83,84], from liberal strategies to restrictive strategies [85-87], and from clinical monitoring to multimodal monitoring using bedside technologies [88,89].

A 2019 study implemented process changes in phases to improve antibiotic administration and recognition of septic shock conducted in 41 children at tertiary care hospitals in India. The median time to antibiotic administration decreased from 50 to 20 minutes, while the median time to recognition of severe sepsis decreased from 10 to 5 minutes. [90].

The tenet of EGDT is that patients with septic shock can benefit from early, vigorous fluid resuscitation and vasopressor treatment. However, the efficacy of bundle care has been the subject of several studies, with varying results. A 2016 single-institution study of 1380 children with septic shock found that bundle-compliant care was associated with a fivefold decrease in mortality rate (OR, 0.20; 95% CI, 0.07–0.53) [91].

In a 2018 prospective multicentre trial in Thailand, the use of SSC care bundles [3] to treat children with septic shock significantly reduced mortality from 37% to 19.4%. The study enrolled 519 children aged 1 month to 15 years in 7 large academic centers. Children in the intervention group received earlier and more aggressive fluid and vasopressor therapy, with a significantly higher fluid bolus (28.3 ± 17.2 cc/kg vs. 17.7 ± 10.6 cc/kg; $P = 0.02$) than the control group [92]. Paul et al. (2014) also showed that a 5-component bundle (recognition, vascular access, fluid resuscitation, antibiotics, and vasoactive) within 60 minutes reduced mortality from 5% to 2% [93].

On the other hand, a large RCT and a meta-analysis of 5 RCTs have found that EGDT does not reduce mortality in patients with septic shock. However, EGDT does increase the use of vasopressors and ICU admission [84,94]. The ProCESS (Protocol-Based Care for Early Septic Shock) trial evaluated 3 resuscitation strategies for early septic shock in 1341 patients. The groups showed no notable differences in mortality or organ assistance needs. This RCT was conducted in 31 EDs across the United States between 2009 and 2015. The 60-day mortality rate was 21.0% in the protocol-based EGDT group, 18.2% in the protocol-based standard-therapy group, and 18.9% in the usual-care group [84].

Similarly, a 2015 systematic review and meta-analysis of 5 RCTs with 4735 patients with septic shock, found that EGDT did not reduce mortality at 60 days compared to usual care (pooled OR 1.01, 95% CI 0.88-1.16). EGDT did increase vasopressor use (OR 1.25, 95% CI 1.10-1.41) and ICU admission (OR 2.19, 95% CI 1.82-2.65). [94].

Although fluid resuscitation is the mainstay in the management of pediatric shock, there are uncertainties regarding various aspects of fluid therapy. The choice of fluid for pediatric shock resuscitation is crucial and has a big impact on the patient's prognosis; according to a 2021 RCT conducted in Thailand with 42 pediatric shock patients found that balanced crystalloids were associated with a lower risk of hyperchloremic acidosis (29% vs. 62%), AKI (14% vs. 38%), and overall mortality (14% vs. 38%) than crystalloids with higher chloride concentrations [95].

A 2018 update of a Cochrane Review found that synthetic colloids are associated with an increased risk of AKI (16% vs. 13%), coagulopathy (11% vs. 8%), and death (17% vs. 14%) in patients with septic shock. The review included 69 trials with a total of 30,020 participants of all ages [96].

The optimal fluid volume for resuscitation is also a subject of debate. The Fluid Expansion as Supportive Therapy (FEAST) study, a large-scale RCT conducted in Africa, found that conservative fluid therapy resulted in lower 48-hour mortality than liberal initial fluid therapy (RR 0.72, 95% CI 0.57-0.9). The study was conducted in Africa on 3141 children aged 60 days to 12 years old with intense fever and abnormal perfusion [97].

The FEAST study's findings prompted a revision of the SSC 2020 guidelines, which now recommend a 40-60 mL/kg fluid bolus within 1 hour in intensive care settings or 40 mL/kg for hypotensive patients [32].

Two pediatric RCTs compared the effects of 5-10 minute bolus fluid administration versus 15-20 minutes. one was conducted in 2017 and involved 96 children with septic shock, while the second study was conducted in 2008 and enrolled 147 children with shock of any origin. Both studies found that faster bolus fluid administration was associated with higher rates of intubation, mechanical ventilation, and hepatomegaly. However, the two groups had no difference in mortality [98,99].

A 2009 study of 102 pediatric trauma patients found that initial base deficit was an independent predictor of mortality and blood transfusion requirement within 24 hours. Mortality and blood transfusion requirements were significantly higher when the initial base deficit was less than -8 mEq/L [100].

In a cohort of 130 PICU patients, Weiss et al. (2014) found a delay in antibiotic delivery of more than 3 hours after septic shock diagnosis was an independent risk factor for mortality (OR 4.84, 95% CI 1.45-16.20) and prolonged organ dysfunction [101]. However, a study conducted by von Paridon et al. (2015) involving 79 children with sepsis admitted to a single PICU did not find any correlation between the time of antibiotic administration and patient outcome [102].

Fitzgerald et al. (2016) stated that the discrepancies between these studies [101,102] may be due to differences in sample size, inclusion criteria, and outcome measures. They suggested the need for further rigorous, prospective, multicenter study on this subject matter [33].

A more recent (2021) cohort involving 441 children with septic shock found that timely antibiotic administration within 1 hour of diagnosis reduced mortality, shortened shock reversal time, and increased ventilator-free and hospital-free days (20% vs 29%; AOR 1.83; 95% CI, 1.14-2.92; P = .01) [103].

A systematic review of 2 retrospective observational studies by the Surviving Sepsis Campaign (SSC) [32]. [3] has also indicated that faster initiation of antimicrobial therapy is associated with reduced mortality for children with septic shock (AOR, 0.77; 95% CI, 0.55–1.08). Furthermore, Other secondary endpoints reported to be associated with shorter time to initiation of antimicrobial therapy include shorter hospital stay, shorter time to hemodynamic stability, and improved organ function [101,104].

Several studies have emphasized that shock management requires frequent clinical assessment and continuous monitoring of hemodynamic variables, regional and global tissue perfusion, and fluid responsiveness (FR) [88-89,105-106].

A 2013 systematic review conducted in the UK, from 47 years of data revealed that respiratory variation in aortic blood flow peak velocity was the only reliable predictor of fluid responsiveness in children. This study included 12 trials involving 438 pediatric patients. [107].

A prospective observational study of 48 children with unresolved septic shock found that monitoring (echocardiography and invasive BP monitoring) allowed for precise titration of fluid, inotropes, and pressors in 87.5% of patients, leading to improved shock resolution and survival rates. The investigation was conducted at 2 Indian tertiary care PICUs between Jan 2009 and Dec 2012. In this study, vasodilatory shock was present in 85.5% of patients based on invasive BP, and 3 patients developed septic myocardial dysfunction [88].

In a 2018 prospective RCT of 90 children admitted to a PICU in Egypt, addition of serial echocardiography provided early recognition of septic myocardial dysfunction and hypovolemia that was not apparent on clinical assessment and resulted in faster shock reversal (3.3 vs. 4.5 days), less fluid overload (11% vs. 44%), shorter LOS (8 ± 3 vs. 14 ± 10 days), and lower mortality (38% [5/13] vs. 88% [15/17]; p = 0.006) compared with the group without serial echo. [108].

A matched cohort study of cardiogenic shock (CS) in Hospitals across the United States in 2018 found that patients treated with ECMO had higher mortality (48.9% versus 4.0%, p <

0.001) and cost of care than those without ECMO, with no significant difference in LOS (21.3 versus 11.6 days, $p < 0.0010$). The study was conducted using the 2013 Nationwide ED Sample and acknowledged that the findings were unexpected, given that ECMO is considered a life-saving intervention in patients with refractory CS [109].

Randomized controlled trials (RCTs) have shown that epinephrine was associated with lower mortality than dopamine in children with septic shock. For example, a 2015 RCT of 120 children admitted to a Brazilian PICU with refractory septic shock, found that dopamine was associated with higher mortality (20.6% vs 7% $p=0.033$) and healthcare-associated infection (OR 67.7, $p=0.001$) [110].

In 2016, another RCT of 60 children, showed epinephrine was superior to dopamine in achieving shock resolution (41% vs. 13%) and improving organ function, but there was no discernible variation in adverse events or mortality [111].

In a 2017 cohort study of 102 children by Patregnani et al., (2017) the safety of short-term vasoactive administration through peripheral lines until central access is achieved was demonstrated [112].

In Feb 2008, the Vasopressin and Septic Shock Trial (VASST), the largest and most rigorous randomized, double-blind, placebo-controlled trial of vasopressin in septic shock, found no mortality benefit at 28 days (35.4% vs. 39.3%, respectively; $P = 0.26$). The trial, which involved 199 medical facilities spread across 33 countries, assessed the impact of low-dose AVP as an adjuvant drug in 779 adult patients suffering from septic shock. It found no benefit in terms of mortality; however, the authors noted a noteworthy decrease in death in the subgroup of patients with less severe septic shock (baseline norepinephrine-14 $\mu\text{g/kg/min}$). [113].

According to a 2014 observational study, corticosteroids may suppress the immune system in children with septic shock. A gene expression test was developed and tested on 125 children to identify a subset of patients ($n=70$) who might not benefit from corticosteroid therapy and who are at high risk of death. Although this might be utilized at the patient's bedside, the authors highlighted that the risk-benefit analysis of adjunctive corticosteroid medication should consider these findings [114].

A systematic review and meta-analysis from 2013, analyzed 8 RCTs with a total of 447 children and found no difference in mortality rates with corticosteroid therapy (relative risks, 0.744 [95% CI, 0.475-1.165]; $p = 0.197$) [115].

A 2015 single-centered cohort study (27), which included 71 children admitted to a PICU in Pakistan for fluid-refractory septic shock, showed a correlation between higher Vasoactive Inotrope Score (VIS) and mortality. All of the children with $VIS > 20$ died. According to the authors, VIS is a simple tool that can be used as an outcome predictor, especially in resource-limited settings [116].

Early prediction of morbidity and mortality is crucial because patients with septic shock who are at risk of re-hospitalization and death may benefit from a close follow-up [33,117-118].

Wong et al. developed a risk stratification model using biomarkers to predict septic AKI at day 3 of septic shock in 441 children. The model performed well in both the derivation and test cohorts (AUC 0.95 in derivation and 0.83 in test cohorts), outperforming other mortality prediction models. The model was more predictive of septic AKI rather than illness severity and the authors postulate that the identification of these at-risk patients could inform clinical decision making [117].

According to Wiens et al. (2015), mortality following discharge is a poorly recognized contributor to child mortality. They developed a risk prediction model for post-discharge mortality for 1,242 Ugandan children admitted to hospitals due to acute infections, using readily measured variables. The model identified 35% of children as having a high risk of death and had an AUC of 0.82 [119].

3. OBJECTIVES

3.1. General Objective

To investigate the pattern, outcome, and associated factors of shock in pediatric patients at St. Paul Hospital Millennium Medical College PICU from October 30, 2022, to November 1, 2023

3.2. Specific objectives

To determine the demographic and clinical characteristics of patients with shock at SPHMMC PICU from October 2022 to May 2023

To observe and describe the outcome of shock patients depending on the category of shock and treatment given at SPHMMC PICU from October 2022 to May 2023

4. METHODS

4.1. Study Area and Period

This study was conducted at SPHMMC Pediatric Intensive Care Unit, located in Addis Ababa, the capital city of Ethiopia. St Paul's Millennium Medical College, as it is known today, was established through a decree of the Council of Ministers in 2010. The medical school opened in 2007, and the hospital was founded in 1968 by the late Emperor Haile Selassie. This tertiary care hospital is among the largest government hospitals in the nation, offering medical care, teaching, and research as its core services. The college has more than 2800 clinical, academic, and administrative staff members. It offers specialized medical services to patients referred from across the country, while also training medical and nursing students, and conducting basic and applied research. With over 700 beds for inpatients, the college serves an average of 1200 emergency and outpatient clients daily, with an annual average of 200,000 patients and a catchment population of 5 million. The SPHMMC PICU was established in 2016 to meet Ethiopia's growing demand for specialized care for critically ill children. With six beds, this unit provides critical care services to children under the age of 15 from all regions of the country [120]. The study was conducted from October 30, 2022, to November 1, 2023.

4.1. Study Design

An institution-based cross-sectional study was conducted. Patient charts were reviewed.

4.3. Population

4.3.1. Source population

All patients who visit SPHMMC Pediatric Intensive Care Unit who presented in the study period will be the source population.

4.3.2. Study Population

Selected patients who visit SPHMMC Pediatric Intensive Care Unit and are diagnosed with Circulatory shock in the study period were the study population

4.4. Sample Size

A single-proportion formula to calculate the sample size

$$n = \frac{(z_{\alpha/2})^2 \cdot pq}{d^2}$$

✓ n = required sample size

- ✓ $Z_{\alpha/2}$ = Critical value = 1.96 (normal Standard deviation usually set at 1.96 which corresponds to the 95% confidence interval)
- ✓ d = precision (marginal error) = 0.05
- ✓ $q = 1 - P$

To calculate the P –value there is no previous study done that determined the prevalence of shock at the PICU in a setting similar to my study area which is a low-income country PICU setting. Using the outcome the only studies that might be compared to the study was conducting being similar were the aforementioned studies at the national level on children admitted to the PICU and the overall mortality for shock was 56.8%. But due to patients admitted to ICU being more critical and having increased mortality, it might not being the best previous research to use the P —value. So finally, decided to used the p value as 50%.

When calculating the sample size:

$$n_0 = \frac{(1.96)^2 (0.5)(0.5)}{(0.5)^2}$$

$$n_0 = 384$$

Since the target population is less than 10,000, the sample size has been adjusted accordingly. Therefore, the corrected sample size will be:

$$n = \frac{n_0}{[1 + n_0/N]}$$

$$n = \frac{384}{1 + 384/280}$$

$$n = 162$$

Then when finally adding 10% of the sample size to the calculated sample size (considering the non-response rate) the final sample size will be 178.

$$\text{Final sample size} = 178$$

4.5. Sampling Procedure

A simple random sampling technique was used to select study participants. The patient card numbers from the registration logbook and patient charts of St. Paul Millennium Medical College's Pediatric Intensive Care Unit (PICU) who were admitted between October 30, 2022, and November 1, 2023, was utilized to identify all shock patient cases that meet the inclusion criteria. The card numbers were randomly assigned a sequential numeric code, starting from 1. A random number table was generated using a computer program. The first sample was selected by randomly marking a number in the table while looking away or

closing eyes. Subsequent samples were selected by moving down the same column and continuing to the next column until the desired sample size of 178 is reached.

4.6. Inclusion and exclusion criteria

Inclusion Criteria

All children who presented to the PICU and were treated there from Oct 2021 to May 2022 November with the diagnosis of Shock documented on their charts signed by a resident or senior physician

Exclusion Criteria

Patients with a diagnosis of shock that has not been made or signed by a resident or senior physician, but rather by other health professionals such as interns were excluded in the study, Children under 1 month of age who are admitted directly into the neonatal intensive care unit Patients with charts were eligible to being included but with incomplete charts or missed information

4.7. Study variables

4.7.1. Dependent variables

- ✓ Pattern of shock
- ✓ Outcome of Shock

4.7.2. Independent Variable

Age, Sex, Referral status, vital signs at diagnosis of shock, Investigation results, underlying diagnosis, co morbidity, nutritional status, initial GCS, treatment given (Type/ timing), urine output, Complications during admission, length of stay, and cause of death.

4.8. Data collection Procedures

Data was collected from all eligible shock patient charts using a structured questionnaire. The data was collected from St Paul Millennium Medical College PICU registration logbook, patient charts, health management information system, referral paper, death reports, vital sign sheets, and medication sheets. So all the above data sources was reviewed for the age of the patient, sex, whether the patient was referred or came from home, vital signs at presentation, underlying disease(diagnosis), co morbidity, length of stay, investigation results, shock category, treatment given, complication developed, the outcome of the patient using a structured questionnaire. The questionnaire was prepared from the articles in the literature reviews and based on the objective of the research relevant questionnaire components were added. The data collection tool was prepared in English language and be filled in. Data

collectors with medical practice like pediatric nurses, interns, and general practitioners were employed as necessary

4.9. Operational definitions of variables

Pattern of shock: refers to the type of shock that the patient has, the 4 main categories: cardiogenic, hypovolemic, obstructive, and distributive shock

Outcome of Shock: presented as the final destination of the patient after or while treatment given at the PICU like is the patient died or survived, required mechanical ventilation, developed MOF, or length of stay.

Associated factors of shock: refer to factors that are associated with an increased risk of shock, such as age, sex, comorbidities, and underlying cause of shock.

Hypovolemic Shock: when a patient is in shock as a result of intravascular volume loss could be due to GI, renal, blood loss other loss.

Septic Shock: when a patient with evidence or suspected infection remains in shock despite adequate fluid resuscitation with an adjunct evaluation with POCUS and IVC status.

Cardiogenic Shock: when a patient is in shock due to impaired cardiac activity with evidence of cardiac failure due to prior cardiac disease, or bedside or cardiologist echocardiography findings suggestive of poor cardiac function or motion abnormalities.

Obstructive Shock when a patient is in shock with evidence of cardiac output obstruction with clinical findings together with bedside ultrasound findings, chest x-ray findings, or chest CT findings suggesting causes of obstruction like PTE, Cardiac Tamponed, and Tension pneumo-thorax.

Distributive shock: when a patient is in shock with abnormal redistribution of blood flow, such as from sepsis or anaphylaxis

Septic Shock: when a patient is in shock that results in cardiovascular dysfunction (including hypotension, need for treatment with a vasoactive medication, or impaired perfusion)

Anaphylactic Shock: patient who has a history of allergy to a known or unknown offender or who at first time presents with shock after taking a specific allergenic substance whose shock couldn't be attributed to other causes of shock category.

Undifferentiated shock - refers to a situation where shock is recognized but the cause is unclear

Treatment given: refers to type of treatment that the patient receives, the timing of treatment, and the patient's response to treatment

4.10. Data Analysis Procedure

Data was checked manually for completeness and then it was coded and entered into SPSS version 22. Categorizations of continuous variables were done before any analysis was commenced. Every data was checked by frequency and cross-tabulation before any analysis was started. Descriptive statistics and frequencies were used. Both bivariable logistic regression analysis (COR) and multivariable logistic regression (AOR) were performed to assess the association between outcome and independent variables. Variables having a p-value <0.05 were declared as significant causes of death. Confidence interval (CIs) was used for the odds ratios. Finally, the result was presented by using tables and texts.

4.11. Data Quality Management

The assessment tool was pretested on 5% of the sample size in the hospital (was not included in the main study) before actual data collection to check for availability and validity of the questionnaire data. Training and orientation about the objectives and relevance of the study for each item included in the study tools and the whole process of data collection was provided for data collectors and supervisors. During data collection, frequent regular supervision and follow-up was undertaken. Each questionnaire was checked by the principal investigator for completeness and consistency of data.

4.12. Ethical consideration

This study was approved by the Institutional Review Board of St. Pauli Millennium Medical College before it was begun to conduct. Additionally, the objective of the study was explained to the hospital administrators, medical director, and card room staff.

Confidentiality of the patient's information contained within their registration books, cards, and referral papers was assured by using code numbers rather than patients' identification names and by keeping questionnaires locked.

4.13. Dissemination of the result

The result will be presented in the emergency Medicine and critical care department as a defense. The copies of the final results will be submitted to St. Paul Millennium Medical College and will be distributed to the library, to postgraduate office, and St Paul Hospital administration office, and the Federal Ministry of Health. Lastly, it will be presented at workshops and seminars and will be sent for publication in an international journal.

5. RESULTS

5.1. Socio- demographics

A total of 165 participants were included in this study within the response rate was 92.7% of which 91(55.2 %) of the participants were male and the mean age (SD) of participants was 20.88 ± 32.3 months. The sources of PICU patient admissions were 127(77.0%) patients from emergency unit while 30(18.3%) patients were admitted from wards or outpatient department. One hundred fifty nine (98.1%) patients were admitted to the PICU for the first time (Table 1).

Table 1: Socio demographic characteristics among PICU patients at SPMMC in AA, 2024

Variable	Frequency	Percent (%)
Age in months		
1-12	106	64.2
13-24	27	16.4
25-60	14	8.5
61-168	18	10.9
Sex		
Female	74	44.8
Male	91	55.2
Nutritional Status		
Normal	117	70.9
MAM	18	10.9
SAM	30	18.2
Vaccine Status		
fully vaccinated	144	87.3
partial vaccinated	18	10.9
not vaccinated	3	1.8
Previous admission		
Yes	6	3.6
No	159	96.4
Sources of Admission		
ED	127	77.0
transfer from ward/ OPD	30	18.2
from refer	8	4.8

5.2. Clinical Profile of Participants

Among the patients included in the study, the most common symptom was altered mentation 85 (51.5%) followed by fast breathing 72(43.6), vomiting 48 (29 %) and fever 45(27.2%). A total of 47 (28.4%) of them were presenting after one week of illness, while 48 (29%) presented within two days of illness.

The most common clinical sign noticed was tachycardia 114 (69%), tachypnea 110 (66.7%), feeble pulse volume 94 (57%), saturation below 90% in 73 (44.2%), and decreased urine output in 102 (62%). Blood pressure measurement was taken for 141 (85.5%) and it was unrecordable in more than 50 (30.3%) of them. Mean Glasgow Coma Scale (GCS) of participants was 12.5 (SD±2.6) and 9 (5.5%) patients were comatose at presentation.

Nutritional assessment has showed severe acute malnutrition in 55 (41.7%) of them

A complete blood count was done for 161 (98%) of the cases and the result showed that 29 (61.3%) of them had low hemoglobin level. Creatinine level test was done in 146 (88.4%) cases and AKI was diagnosed in more than 28 (17%) patients. Serum electrolyte was done in 133 (80.6%) patients of which 61(37%) was abnormal and the analyzed electrolyte abnormalities result showed cases with hyponatremia 16 (26.2%), Hypokalemia 15 (24.5%), hypernatremia 14 (22.9), hyperkalemia 10 (16.4%) and hypocalcemia 10 (16.4%) (Table 2)

Table 2: Physical Finding and Measurements of Pediatric Shock Patient

Variable	Frequency	Percent (%)
HR		
Tachycardia	114	69
Normal	13	7.8
Bradycardia	7	4.2
Not palpable	31	18.7
RR		
Tachypnea	110	66.7
Normal	50	30.3
Bradypnea	5	3.03
SPO2		
<90%	73	44.2
> 90%	92	55.7
BP		
Recordable	91	55.2
Un recordable	50	30.3
not documented	24	14.5
Temperature		
Febrile	73	44.2
Hypothermic	37	22.4
Normal	55	33.3
Pulse volume		
Weak	94	57.0
Un recordable	31	18.8
Strong	17	10.3
not documented	23	13.9
GCS of Child at admission		
13-15	85	51.5
9-12	48	29.1
≤8	9	5.5
incubated or sedated	23	13.9
RBS		
Normal	134	81
Hypoglycemia	24	14.5
Hyperglycemia	6	3.6
Nutritional Status		
Normal	117	70.9
MAM	18	10.9
SAM	30	18.2

5.3. Admission Characteristics

The most common admission diagnosis were severe sepsis or septic shock secondary to different disease 79(47.9%), followed by pneumonia with impending respiratory failure 41(24.8%), Congestive Heart Failure 17(10.3%), complicated Meningitis 11(6.7%) and Cardiogenic-shock 9(5.5%). From the total of 165 cases, one-third 54 (32.7%) of them had chronic medical illness. These include cardiac 18 (10.9%), Down syndrome 8(4.8%), GI Malformation 7 (13%), Cerebral palsy 5 (3%) and diabetes 4 (2.4%).The sources of PICU patient admissions were 127 (77.0%) patients from emergency unit while 30 (18.3%) patients were admitted from wards or outpatient department. One hundred fifty-nine (98.1%) patients were admitted to the PICU for the first time. The PICU stay ranged from six hour to 63 days with a mean of 6.95 ± 8.19 . Ninety (63.1%) patients stayed for 2 – 7 days (Table 3).

Table 3: Admission Characteristics of PICU patients at SPMMC in Addis Ababa, 2024

Variable	Frequency	Percent (%)
Chronic health condition		
Yes	54	32.7
No	111	67.3
Admission diagnosis		
Sever septic shock secondary to different disease	79	47.9
pneumonia with impending respiratory failure	41	24.8
Congestive Heart Failure	17	10.3
complicated Meningitis	11	6.7
Cardiogenic-shock	9	5.5
Diabetic Keto-acidosis	4	2.4
Others	4	2.4
Previous admission		
Yes	6	3.6
No	159	96.4
Sources of Admission		
ED	127	77.0
transfer from ward/ OPD	30	18.2
from refer	8	4.8
PICU length of stay		
< 2 days	48	29.1
2-7 days	90	54.5
8-14 days	16	9.7
15-28 days	9	5.5
> 28 days	2	1.2

5.5. Pattern of shock and Management of Shock

The most common type of shock was septic shock (69.1%) followed by hypovolemic shock and cardiogenic shock each accounting for 23% and 7.9% respectively. Only one patient presented with obstructive shock (Figure 2). Complications or additional diagnosis were seen in 100(39.4%) and 59(35.7%) of participants had multi-organ failure.

Out of the 127 (76.9%) cases who required vasoactive drugs and multiple vasoactive drugs were needed in 75% of them took. Sixty-three (38.2%) patients were put on a mechanical ventilator (Table 4)

Table 4: Management of PICU patients with Shock at SPMMC in Addis Ababa, 2024

Variable	Frequency	Percent (%)
vasoactive drugs needed		
Yes	127	76.9
No	38	23.1
Number of vasoactive		
Single	52	54.5
Multiple	75	45.5
Need mechanical ventilator		
Yes	63	38.2
No	102	61.8

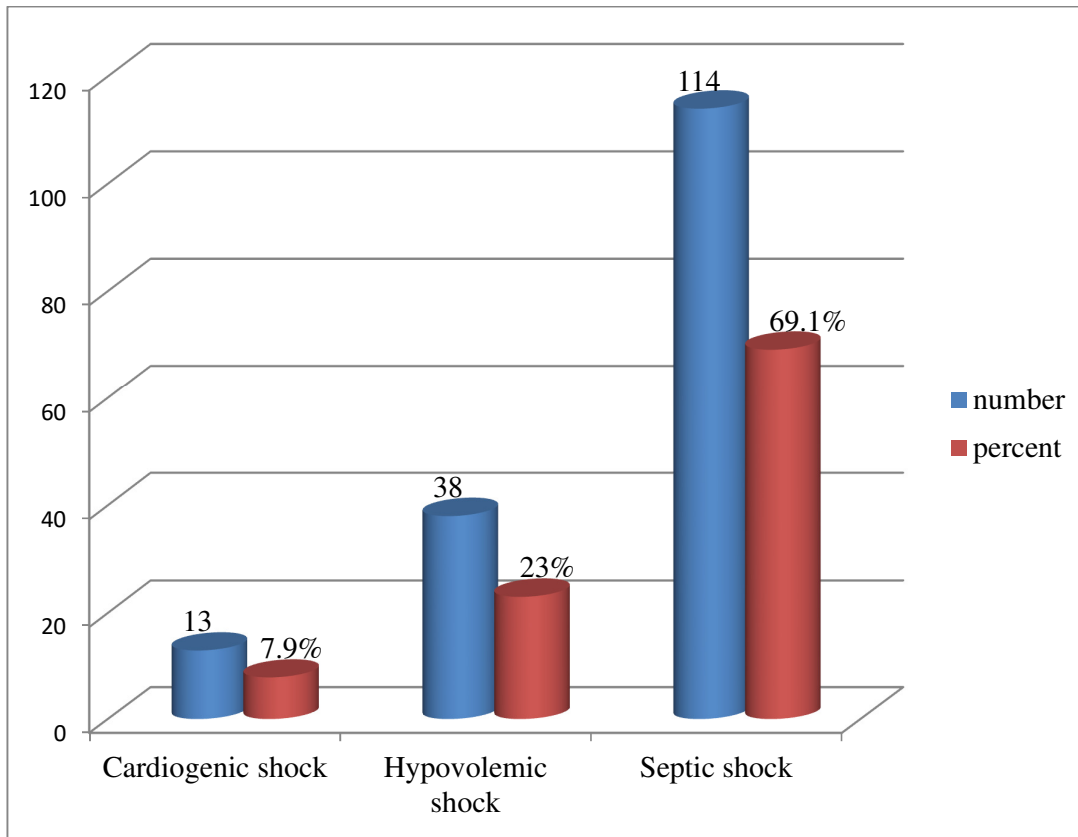


Figure 1: Type of shock among PICU patients at SPMMC in Addis Ababa, 2024

5.4. Pattern Outcome of Shock in Pediatric Intensive Care

From all study subjects, 97(58.8%): 95%CI [51.5, 66.7] of patients was survived discharged from PICU while of which 70(42.4%) of them were transferred to wards and 68(41.2%) were died (Figure 2).

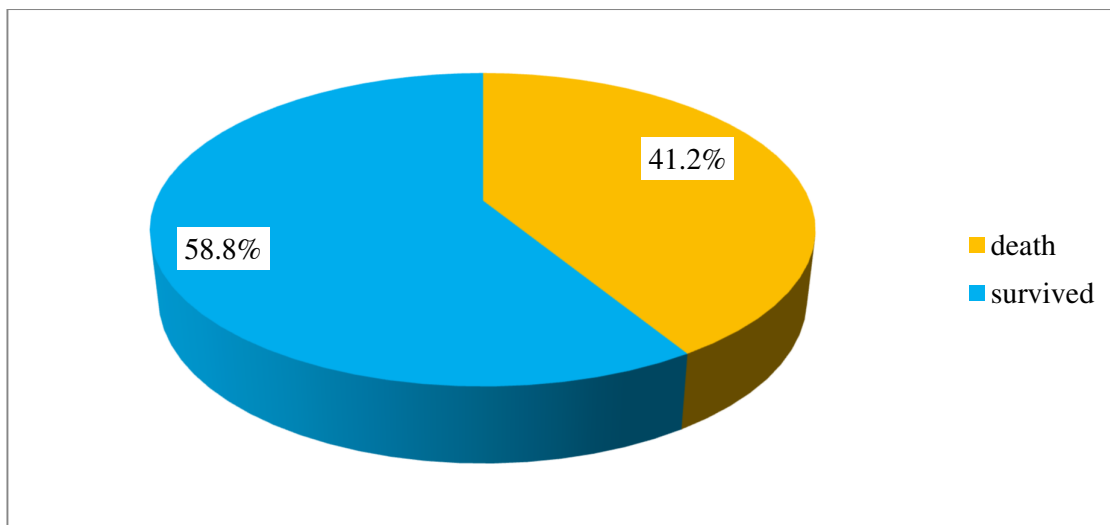


Figure 2: Pattern Outcome of shock among PICU patients at SPMMC in Addis Ababa, 2024

6. DISCUSSIONS

Intensive care unit performance can be evaluated based on mortality or survival outcomes. With the proper evaluation of PICU performance, we can identify and standardize appropriate interventions and guide efforts to manage resources needed to deliver care in intensive units. This study assessed the treatment outcome of patients who were admitted to the PICU of St Paul's Hospital Millennium Medical College, Addis Ababa.

In the current study 58.8% of patients was survived and discharged from PICU of which 70(42.4%) of them were transferred to wards while 41.2% were died. It was in lower than similar study conducted at a PICU in Yogyakarta, Indonesia found a high mortality rate of 88.2%[59], in Japan, with a low survival rate, some of them survivors recovered without any long-term problems[63]. A 2019, 3-month prospective study of 23 children with shock TASH found that septic shock was the most common cause of death in ED, with a mortality rate of 88.2%. Septic shock mortality was highest within the first 24 hours of admission, and fever, vomiting, and tachypnea was the most common initial presentation. Notably, Children with hypovolemic shock[49]and A 2022 prospective cross-sectional study found that 1.9% of pediatric patients at SPHMMC were diagnosed with shock, with hypovolemic shock being the most common type (64.2%) and had a mortality rate of 15%. The study enrolled 1605 children and septic shock was the most common cause of death (50%). Only 1 patient was diagnosed with carcinogenic shock [48]. It may be due to different in study period and PICU setup modification.

However it was higher than similar study a teaching hospital in Jordan, Septic shock had a mortality rate of 24%. Patients who died were younger (with a median age of 11 months) and 85% of them had co morbidities [61], children admitted to 14 hospitals in Kenya, with a high case fatality rate (34%). Co morbidity was almost invariably diagnosed with hypovolemic shock (99%), most often pneumonia or malaria and these patients had a higher mortality rate (36%)[65] and A systematic review of observational studies from 2015 to 2022 found that pediatric mortality in Ethiopia's PICUs is higher than in middle- and high-income countries with an overall mortality rate of 28.5%. The reported mortality rate ranged from 8.5% to 43.8% in the included 8 studies from 4 distinct regions of Ethiopia, with a total of 2,345 children. According to the studies, severe sepsis/septic shock was one of the top 3 common causes of death in these studies [50]. The discrepancy may be due to possible effects of

increase PICU demands since evidences showed in most case mechanical ventilation required and patients increase from time to time.

The In this study, 69.1%) of the patients had septic shock and 23.0% of patients in PICU were diagnosed hypo-volumic shock. It was lower than similar retrospective study in Turkiye found that 79.1% of patients admitted to the PICU with cardiogenic shock had acute myocarditis as the underlying cause, however it was A retrospective single-center cohort study of 797 AHF hospitalizations in children aged 0-18 years at Texas/Houston University, USA from 2004 to 2018 found that 26% of children developed cardiogenic shock with the most common etiologies of AHF were cardiomyopathy (53%) [66]. It may be due to the fact that co morbidity altered it and It also may be due to different in socio demographic and PICU setup.

Limitation and strength of the study

Since the study was retrospective design and the limited availability of data in the registers because it was secondary data. The study lacks statistical power on some of the results to make conclusions based on the findings observed here only, therefore, findings must be interpreted with this caution and those findings need another study with larger sample size and long duration of the study and retrieval also led to missing patient records it also has limitation to identify factor related to shock and treatment outcome. However this study might fill a variety of gaps in information regarding the determinants of birth asphyxia in the study population and helps policymakers to consider contextual intervention.

7. CONCLUSIONS AND RECOMENDATIONS

Conclusions

This study identified septic shock as the most common type of shock (69.1%), followed by hypovolemic shock (23%) and cardiogenic shock (7.9%). Pneumonia was the leading cause of septic shock (58.7%), while acute gastroenteritis accounted for the majority of hypovolemic shock cases (76.9%). Infants aged 1 to 12 months were the most affected group (64.2%), highlighting their vulnerability to severe illnesses.

The overall survival rate was 58.8%, with 42.4% of patients successfully transferred to wards, while 41.2% succumbed to their condition. Notably, mortality was higher among patients with septic and cardiogenic shock compared to those with hypovolemic shock. Critical factors associated with increased mortality included the presence of comorbidities, the need for mechanical ventilation, and the development of multi-organ failure.

Recommendations

The following recommendations were forwarded:

The hospital and for PICU health care providers

This highlights the importance of early detection and the transfer of critical patients to the ICU to improve their outcomes. Additionally, a continuing effort should be made to improve the quality of care through support focusing on hemodynamic support and mechanical ventilator use.

For further researcher: to conduct qualitative study on the subject matters.

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Assurance of Principal Investigator

I the undersigned agree to accept all responsibilities for the scientific and ethical conduct of the research project. I will provide timely progress reports to my advisor and seek the necessary advice and approval from my primary advisors in the course of the research. I will communicate timely to my advisors all stakeholders involved in the study including any source of funding for this research.

Name of the student: Dr. Alula Haileselassie

Signature: _____

Date: _____

Approval of Advisors

Name & signatures of advisors: _____

Dr. Etsegenet

Aklog

Date: _____

Annexes

Data Collection Questionnaire for shock Patients at St Paul Millennium Medical College Pediatric Intensive Care Unit

1. Patient identification

- a** MRN
- b** Age <1yr 1-5 yrs. 5-15 yrs.
- c** sex Male Female
- d** Residence or Address A.A Oromia Amhara Other
- e** Sources of Admission Health care facility Home Other
- f** PICU admission date (day/month/year)
- 6** Nutritional Status Normal Malnourished

2. Recognition of shock

- A** Was shock diagnosed in the PICU?
- Yes If yes, Duration after admission patient developed shock?
- No If No, Duration of shock prior to PICU admission ?.....
- B** Vital signs at shock diagnosis
- a.** Systolic BP
- b.** PR (Bpm)
- c.** RR (Bpm)
- d.** SpO₂(%)
- e** T^o (°C)
- Shock index (SBP/PR)
- f** Mental State Is the patient on sedative?
- Yes If yes, how long was the child sedated?
- No If no, what was (GCS and/or AVPU)?

AVPU 1

g RBS (mg/dl)

3. Category of Shock

	Septic	Anaphylactic
a Distributive shock	Neurogenic	other (specify).....

b Hypovolemic Shock	GI loss	Hemorrhagic (traumatic)
	post-op	other (specify)

c Cardiogenic Shock

Underlying heart disorder

d Obstructive Shock
Cause.....

4. Investigation results (if available)

a	WBC (/μL)	.....
b	Hb (g/dL)	.....
c	PLT (/μL)	.....
d	PT – INR:	.....
e	creatinine	.....
f	Blood/urine culture/CSF:	.....
g	Chest x-ray	.....
h	Bedside Ultrasound	.....
i	ECG index	.....
j	Other	.....

5. Underlying diagnosis

6.. preadmission Comorbidity

7. Treatment Given

i.	Type of fluid	crystalloids (NS/RL/DNS)	Balanced	other
ii.	Amount of fluid			
	Rate of fluid (time to administer the above amount of fluid)			

c Antibiotics

ii. Type of empiric Abx used

ii. Types vasoactive used

ii. How long was the patient on MV (hrs.)

If, yes when was MV initiated	before MV	after MV
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Death (duration after initiation of management)

survived	died
1	0
0	1

10 length of stay at PICU

Additional Questions (optional)

What are your thoughts on the care that your child received in the PICU?

Do you have any suggestions for how the care of pediatric patients with shock could be improved?
