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Evaluation of the Management of Shock in the Pediatric Emergency Department of the Centre Hospitalier Universitaire Départemental Ouémé (CHUD-O)

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Abstract

Introduction: Shock is an acute systemic circulatory failure that constitutes a major diagnostic and therapeutic emergency. In sub-Saharan Africa, delayed management leads to high mortality. The aim of this study was to evaluate the management of shock in children admitted to the Pediatric Emergency Department of CHUD-O. **Methods:** This was a descriptive and analytical study with retrospective data collection, conducted from June 2, 2022, to June 1, 2023. All children aged 1 month to 17 years who were hospitalized for shock were included. Deaths occurring upon admission before any resuscitation measures were excluded. Multivariate logistic regression analysis was performed to identify factors associated with unfavorable outcomes (death), with the significance threshold set at 5%. **Results:** Out of 3376 admissions, 233 children met the criteria for shock, corresponding to a hospital frequency of 6.9%. The mean age of the patients was 2.7 ± 2.5 years (median: 2.1 years; range: 1 month to 18 years), and children under 5 years of age accounted for 85.0% of the cohort (n = 198). The sex ratio was 1.02. The clinical presentations were dominated by septic shock (74.7%, n = 174) and mixed septic and hypovolemic shock (12.4%, n = 29). The main infectious etiologies (which could overlap) were severe malaria (39.0%), pneumonia (26.6%), and gastrointestinal infections (25.8%). Management included fluid resuscitation with 0.9% isotonic saline in 95.3% of children and oxygen therapy in 93.1%. The outcome was death in 66.5% of cases (n = 155). In multivariate analysis, a treatment initiation delay of more than 15 minutes (OR = 4.54; p = 0.011), septic shock (OR

= 3.82; p = 0.019), severe malaria (OR = 9.34; p < 0.001), coma (OR = 4.12; p < 0.01), and desaturation (OR = 3.45; p = 0.024) were independently associated with mortality. **Conclusion:** Shock states are frequent and associated with very high mortality. Improving prognosis requires the implementation of an effective emergency triage system that reduces the time to management to less than 10 minutes, along with strengthening pediatric resuscitation equipment.

Keywords

Shock, Pediatrics, Septic Shock, Emergencies

1. Introduction

Shock is defined as an acute systemic circulatory failure that poses a short-term life-threatening risk [1]. It encompasses all pathophysiological syndromes combining a sudden and pernicious reduction in blood perfusion, along with a profound alteration in the transport and delivery of energy substrates, ultimately resulting in generalized tissue hypoxia [1] [2]. Evolutionarily, the dynamic process of shock classically progresses through three stages (compensated, decompensated, and irreversible), underscoring the absolute diagnostic and therapeutic emergency of this condition, where any delay in initiating resuscitation measures leads to excess mortality [2] [3].

Globally, and particularly in low- and middle-income countries, the prevalence and severity of pediatric shock states are exacerbated by structural constraints within health systems, including limitations in first-line preventive and curative care [4] [5]. International literature highlights the gravity of this condition, with an estimated pooled global mortality reaching 18.6% in these regions; reference hospital settings sometimes report substantially higher rates depending on the etiological profile [4] [6]. In sub-Saharan Africa, late access to healthcare facilities, geographic isolation, and insufficient adapted technical platforms in pediatric intensive care constitute major aggravating factors [7] [8].

From a pathophysiological and etiological perspective, pediatric shock states involve various mechanisms: hypovolemic, cardiogenic, obstructive, or distributive (notably septic and anaphylactic). In tropical countries, the underlying etiologies are dominated by infections, foremost among which are severe malaria, acute respiratory infections, and gastroenteritis complicated by severe dehydration [7] [9].

In Benin, despite the frequency of life-threatening emergencies received in reference health facilities, targeted epidemiological and clinical data on the overall assessment of pediatric shock management remain fragmentary, with no exhaustive study having specifically evaluated their management in pediatric emergency departments [10]. A significant number of children are admitted each year with critical clinical presentations of advanced hemodynamic failure, reflecting both delays in seeking care and inherent difficulties in monitoring and early therapeu-

tic intervention [8] [10].

Given this public health issue, it is imperative to thoroughly analyze the reality of managing these vital emergencies. The present study aims to evaluate the management of shock states in the pediatric emergency department of CHUD-O, in order to identify risk factors associated with therapeutic failures and to outline concrete avenues for optimizing emergency care.

2. Methods

This was a descriptive and analytical study with retrospective data collection, conducted from June 2, 2022, to June 1, 2023, in the Pediatric Emergency Unit of CHUD-O. All children aged 1 month to 18 years who were hospitalized for shock during the study period were included. Of the 251 children who presented with shock, 233 were included in the study. The exclusion criteria—comprising incomplete medical records with essential variables that could not be analyzed, as well as children who died immediately upon admission before any resuscitation measures were initiated—resulted in the exclusion of 18 children. Shock was operationally defined as the presence of at least two of the following clinical signs of circulatory failure: pallor of the skin and mucous membranes with cold extremities, capillary refill time (CRT) > 3 seconds, weak, impalpable, or absent peripheral pulses, and arterial hypotension (defined according to age- and height-specific reference percentiles) [2] [5].

The pathophysiological classification distinguished between septic shock (presence of a clinical or biological infectious syndrome associated with circulatory failure), pure hypovolemic shock (signs of shock secondary to severe acute dehydration or hemorrhage without a major systemic infectious component), mixed shock (infectious syndrome associated with significant gastrointestinal fluid and electrolyte losses), and cardiogenic and anaphylactic shock (cardiac pump failure or severe acute hypersensitivity reaction). Given the local epidemiological profile, co-infections and overlapping etiologies were recorded in a non-exclusive manner. The time to treatment initiation was defined as the interval between the child's physical arrival at the emergency unit and the effective implementation of the first resuscitation measure (insertion of an intravenous line and initiation of fluid resuscitation or oxygen therapy). Delays of 15 and 30 minutes were evaluated in relation to the target recommended by international guidelines (initiation within <10 minutes) [2].

Data were collected from admission registers, hospitalization records, and monitoring sheets using a digitized data extraction form. The variables collected included sociodemographic and anthropometric data (age, sex, parents' occupation), clinical data at admission (time to admission, temperature, heart rate, respiratory rate, oxygen saturation, urine output, level of consciousness), paraclinical data (blood glucose, serum electrolytes, urea, creatinine, complete blood count, CRP, thick blood smear, and parasite density), etiological and therapeutic data (main identified cause of shock, time to treatment initiation in the emergency de-

partment, vascular access, type of fluid used for resuscitation, oxygen therapy, blood transfusions, and use of catecholamines), as well as outcome and prognostic data (clinical outcome of hospitalization, classified as favorable or unfavorable, with unfavorable outcome defined as death).

The vasopressor agents used were adrenaline at 0.05 - 0.3 μg/kg/min and noradrenaline at 0.05 - 0.5 μg/kg/min. Fluid resuscitation was performed with 0.9% normal saline at a dose of 20 mL/kg of body weight over 20 to 30 minutes. A second fluid bolus could be administered depending on the patient's response. A child could have one or more etiologies.

Data analysis was performed using SPSS version 25.0. Qualitative variables were expressed as frequencies and percentages, while quantitative variables were presented as means ± standard deviation or medians. Comparisons of proportions were performed using Pearson's chi-square test or Fisher's exact test. A multivariate logistic regression analysis was conducted to identify factors independently associated with death. Variables with a p-value < 0.20 in the univariate analysis were included in the logistic regression model. Time-related variables (delay >15 min and >30 min) were analyzed in adjusted models to quantify the increased risk associated with treatment delay. Adjusted odds ratios (OR) and their 95% confidence intervals (95% CI) were calculated, with statistical significance set at $p < 0.05$.

The study was conducted after obtaining formal administrative authorization from the CHUD-Ouémé administration and the Pediatric Department. Anonymity of the data was strictly maintained. A waiver of individual informed consent was granted given the retrospective and observational nature of the study.

3. Results

Out of 3376 admissions, 233 children presented with shock, corresponding to a hospital frequency of 6.9%. The mean age of the patients was 2.7 ± 2.5 years (median: 2.1 years; range: 1 month to 18 years). The most represented age group was 6 months to 2 years (n = 101; 43.3%), and children under 5 years of age accounted for 85.0% of cases (n = 198).

The sex ratio (M/F) was 1.02. The time from onset of illness to hospital admission exceeded 24 hours in 92.3% of the children. Global malnutrition was observed in 28.3% of cases (n = 66). At admission, all children (100%) presented with cold extremities, weak or impalpable pulses, and a capillary refill time (CRT) > 3 seconds. Tachycardia was present in 75.1% (n = 175), tachypnea in 77.2% (n = 180), desaturation (SpO_2 < 95%) in 73.0%, and altered consciousness (coma) in 81.5% (n = 190). Blood pressure could be recorded in only 27 children (11.6% of cases), among whom 16 (6.8% of the overall cohort and 59.2% of those measured) had arterial hypotension. Septic shock was the predominant pathophysiological type (n = 174; 74.7%), followed by mixed septic and hypovolemic shock (n = 29; 12.4%), pure hypovolemic shock (n = 24; 10.3%), cardiogenic shock (n = 3; 1.3%), and anaphylactic shock (n = 3; 1.3%). The main identified etiologies are presented in Table 1.

Table 1. Distribution of children according to the retained etiologies.

Retained etiologies	Number (n)	Proportion (%)
Severe malaria	91	39.0
Severe pneumonias	62	26.6
Digestive infections	60	25.8
Acute meningitis	49	21.0
Other sepsis	25	10.7
Heart diseases	3	1.3
Other etiologies	12	6.4

Biologically, anemia was observed in 62.7% of patients (n = 146), including 21.5% (n = 50) with severe forms characterized by a hemoglobin level below 5 g/dL.

The time to initiation of emergency care exceeded 10 minutes in 52.8% of children (n = 123) and exceeded 30 minutes in 26.2%. A peripheral intravenous line was established in 97.9% of children (n = 228); no intraosseous or central venous access was used. Fluid resuscitation was administered to 95.3% of patients (n = 222). Oxygen therapy was initiated in 93.1% of children (n = 217). Blood transfusion was performed in 45.9% of the overall cohort (n = 107), corresponding to 73.3% of anemic patients. Empirical antibiotic therapy was given to 50.2% of children (n = 117). Vasopressor agents (noradrenaline or adrenaline) were used in only 21.0% of cases (n = 49). The hospital outcome resulted in 155 deaths, corresponding to an overall in-hospital mortality rate of 66.5%. Specific mortality reached 75.5% in septic shock and 8.4% in pure hypovolemic shock.

Multivariate logistic regression analysis independently identified several prognostic factors associated with the occurrence of death (Table 2).

Table 2. Factors associated with unfavorable outcome (death) in multivariate analysis.

Exposure factors	Odds Ratio (OR)	95% Confidence Interval	p-value
Time to management > 15 min	4.54	[1.42 - 14.53]	0.011
Time to management > 30 min	5.53	[1.83 - 16.64]	0.002
Septic shock	3.82	[1.25 - 11.68]	0.019
Etiology: Severe malaria	9.34	[3.91 - 22.31]	<0.001
Coma on admission	4.12	[1.56 - 10.88]	<0.01
Desaturation (altered SpO_2)	3.45	[1.18 - 10.08]	<0.024

4. Discussion

Pediatric shock remains an absolute therapeutic emergency that poses a short-term life-threatening risk [1] [2]. In our cohort, the hospital frequency of shock states was 6.9%. This result is higher than those reported by Singh *et al.* in India (4.3%) and Mbevi *et al.* in Kenya (1.5%) [11] [12]. This high frequency is explained

by the strategic position of CHUD-O, which serves as a referral center that concentrates extremely severe clinical cases, often referred late from peripheral facilities within the health pyramid [10].

From an epidemiological standpoint, the mean age of our patients was 3.09 years, with a marked vulnerability in children under 5 years, who accounted for 85.0% of the sample. This predominance is consistent with data from the literature in pediatric settings with limited resources and is physiologically explained by the immature immune system of young children, as well as their increased susceptibility to hydro-electrolyte disorders and severe sepsis [5] [9] [13].

From a pathophysiological perspective, septic shock accounted for 74.7% of cases. This observation aligns with trends reported in pediatric intensive care in North America (62%) and Nepal (30% to 45%), but contrasts with data from certain Asian or Kenyan series in which pure hypovolemic shock due to acute dehydration predominated [12] [14]-[16]. In Benin, improvements in vaccination coverage and gradual access to oral rehydration solutions largely explain the relative decline of pure hypovolemic shock in favor of systemic failures of infectious origin [10]. In our series, severe malaria (39.0%) and severe acute pneumonia (26.6%) were the main contributors to these septic shocks, accurately reflecting the endemic infectious epidemiological profile of the region [7] [8].

The analysis of therapeutic practices highlights major structural and operational limitations [8]. Although vascular filling with crystalloids (0.9% isotonic saline) and oxygen therapy were widely implemented (in 95.3% and 93.1% of patients, respectively), the use of vasoactive catecholamines remained restricted to 21.0% of children. This underuse reflects local material and technical constraints, including the absence of central venous lines or intraosseous access, the shortage of electric syringe pumps, and the lack of a dedicated pediatric intensive care unit [2] [3] [8]. Furthermore, blood pressure documentation was recorded in only 11.6% of files, reflecting difficulties in hemodynamic monitoring and contributing to unrecognized compensated shock phases, thereby further delaying the initiation of vasoactive drugs [2] [11].

Hospital mortality was 66.5%. This rate far exceeds figures reported in the international literature, whether in Kenyan (34%), Indian (17.6% to 38.9%), or American (10%) series [11] [12] [14]. Beyond the delay in admission (more than 24 hours of evolution in 92.3% of children), our multivariate analysis clearly demonstrates that a time to initiation of medical care in the emergency department exceeding 15 minutes multiplies the risk of death by more than four (OR = 4.54; $p = 0.011$), with this risk rising to 5.53 when the delay exceeds 30 minutes [2] [13]. The arrival of patients in a state of irreversible multi-organ failure, evidenced by the high prevalence of coma on admission and profound desaturation, constitutes the major prognostic determinant of this excess mortality, underscoring the urgent need to strengthen triage and access to critical pediatric care [3] [4] [8].

This study has several methodological limitations. Its retrospective and single-

center design exposes it to information and selection biases. The exclusion of ultra-early deaths occurring before any care could have slightly underestimated the overall mortality associated with shock. In addition, the rarity of blood pressure monitoring and the absence of lactate measurement or perfusion indices did not allow for precise hemodynamic stratification. Finally, the non-experimental nature of the study suggests that the observed associations should be interpreted as statistical associations rather than causal relationships.

5. Conclusion

Shock states in the pediatric emergency department of CHUD-O represent a major cause of mortality, predominantly due to septic shock in children under five years of age. This high mortality is largely attributable to delays in seeking care and in the initiation of in-hospital treatment. To address this, it is urgent to equip the department with a dedicated pediatric resuscitation unit, to institutionalize a triage protocol that reduces the time to treatment to less than 10 minutes, and to make the recording of vital signs, particularly blood pressure, systematic.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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