Clinical-demographic profile, critical care and outcome of children admitted into a level III intensive care unit in southern Nigeria

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Abstract

Specialized services are provided in Intensive Care Units (ICU) during critical illnesses, but there are limited ICU bed spaces for children in developing settings with dire consequences.

The aim of this paper was to evaluate the clinical indications, treatments and short-term outcomes of children admitted into a mixed ICU at our centre. This study adopted a retrospective design. Data collection was done using a structured form comprising sections on each participant's clinical-demographic information, diagnoses, treatments, sub-specialty reviews, mechanical ventilation parameters, and outcomes. The data were extracted from patient's files over a five-year period. Descriptive and inferential analyses were done; $p < 0.05$ was considered significant. A total of 858 patients, including 74 (8.6%) children, were managed in the ICU during the study period. The mean age of the children was 6.9±4.3 years. Thirty-seven (50%) were transferred to the ICU from the Children's Emergency Room (CHER). Severe sepsis was diagnosed in 11 (14.9%) of the participants, bronchopneumonia in 2 (2.7%) and meningitis in 6 (8.2%). Also, 24 (32.4%) participants were admitted into ICU post-surgery. Sixteen (21.7%) needed mechanical ventilation. Their mean Fraction of Inspired Oxygen (FiO_2) was 69.8% (±0.97), and their mean Oxygen Saturation (SpO_2) was 93.4% (±3.83). Co-management involved respiratory (16.2%), neurology (4.1%), and cardiology subspecialties. Their mean duration of ICU admission was 6.2±3.9 days. Forty-three participants (58.1%) died, and 40.5% were discharged to the ward.

Paediatric intensive care is deliverable in a mixed ICU, but there is suboptimal survival of children. There is a need to boost paediatric ICU resources in the setting.

Introduction

Intensive care refers to specialized services given to patients to support their organ systems during a critical illness or medical emergency.[1] The priority is to provide organ-specific support as well as close monitoring in order to prevent the clinical deterioration of patients. Such critical care is often done in an Intensive Care Unit (ICU) with relevant equipment and an optimal supply of trained manpower.[2,3] ICUs are graded based on the complexity of services provided, based on Marshall *et al.*'s classification of the ICU system;[4] a level II ICU refers to a unit that can readily provide cardio-respiratory support to critically ill patients using invasive mechanical ventilation and ionotropic drugs, while a level III ICU can provide more complex forms of care, such as extracorporeal membrane oxygenation or varying positions, such as prone oxygenation.[4,5] ICUs can also be described as cardiac, caring mainly for post-cardiac surgery patients, or general ICUs with a wider range of patients. Again, stand-alone Paediatric ICU facilities

(PICUs) and general ICU bed spaces are not readily available in Low- and Middle-Income Countries (LMICs).[6,7] Touray *et al.*[8] in Gambia and Phu *et al.*[9] in Vietnam reported about 0.4 ICU bed spaces per 100,000 population in each country, while Atia *et al.*[10] in Libya and Bennett[11] in East Timor had 0.8 per 100,000. Osinaike *et al.*[12] in Nigeria reported the presence of 385 ICU beds, giving a rate of 0.19 ICU beds per 100,000 population. This shows that there is a paucity of ICU beds in Nigeria.

The indications for ICU admission in children are often related to their clinical state at presentation as well as their risk of deterioration. Severe respiratory insufficiency, circulatory failure, severe metabolic derangement, persistent raised intracranial pressure, traumatic injuries, and post-surgical instability are common indications for intensive care.[13-15] In a study by Edae *et al.*[16] in a general ICU in Ethiopia, indications for admission of children were acute kidney injury (14.2%), complicated meningitis (12.3%), severe pneumonia (11.5%), heart failure (10.4%) and septic shock (7.3%). Embu *et al.*[17] in Nigeria reported that most children admitted into their general ICU were for close monitoring post-surgery. Other indications in their study were related to trauma (31.6%) and medical cases (11.6%). In developing settings, a large number of acutely ill children often require ICU care due to their late presentation at health facilities and severe infections.[18] In 2018, Akindolire *et al.*[19] in southwestern Nigeria found that about one-third of children presenting in their emergency room require critical care, and only 2.8% were able to get access to ICU services, mostly due to a deficiency of space. Nonetheless, the outcomes of children managed in ICUs depend on the complexity of the underlying diseases as well as the availability of physical resources and relevant expertise within the unit. Olivier *et al.*[20] in Bangui reported the mortality of children as 22% in their paediatric ICU. In the Paediatric Intensive Care Audit Network (PICA-net)[21] report in 2022, the overall mortality rate of children admitted into PICU in the UK was 15%. However, most of the patients included in the report were cardiac patients managed in ultramodern facilities. The mortality of children managed in LMICs' ICUs often varies, ranging from 54% reported by Purcell *et al.*[22] in Malawi, 50% by Nyirasafari *et al.*[23] in Rwanda, and 27% by Ballot *et al.*[24] in South Africa. Although there is a high burden of critically ill children in Nigeria, there is a paucity of data on their outcomes following ICU admission.[25,26]

Considering the foregoing and the ongoing strategic improvement of critical care services in our centre, there is a need to evaluate the outcome of children receiving intensive care services at the centre. Therefore, we evaluate the baseline characteristics, clinical indications, and short-term outcomes of paediatric admissions in the general ICU. We also hypothesize that modifiable factors influence children's survival in the unit.

Materials and Methods

Study setting and participants

The study took place at the 20-bed mixed Intensive Care Unit (ICU) of the University of Benin Teaching Hospital (UBTH). The ICU is an ultramodern upgraded level III critical care facility that manages both children and adults. UBTH is a 900-bed institution located along Ugbowo-Lagos Express Road, sharing boundaries with the University of Benin. Almost 4000 children are admitted every year at UBTH; approximately 1 in 6 children seen at the centre requires intensive care. The study period was from January 2019 to December 2023.

Study design

This study adopted a retrospective design. Clinical records of all eligible patients during the study period were extracted and reviewed.

Sample size

This was a total population study of all patients that met the inclusion criterion during the study period. Participants were purposively recruited.

Data collection

This was done using a structured data collection form comprising sections on each participant's clinical-demographic information, clinical diagnoses and treatments, sub-specialty reviews, Mechanical Ventilation (MV) parameters, and outcomes. Their Socio-Economic Classification (SEC) was based on their parental educational levels and occupations as described by Oyedeji GA. The SEC is graded into categories 1 to 5, with one being the highest SEC and five being the lowest SEC. The upper class comprises categories 1 and 2, the middle class is category 3, while the lower class consists of categories 4 and 5. Clinical variables included presenting complaints and respiratory examination findings of the participants; other variables were MV indications and settings as well as their outcomes. The form was used to extract data from patients' case notes; their steady oxygenation levels (Fraction of Inspired Oxygen, FiO_2, and Oxygen Saturation, SpO_2) on the first day of ICU admission were recorded. Indications for ICU admission, diagnoses, and outcomes were based on the documentation of managing consultants or intensivists.

Data analysis

The data were analysed using the IBM Statistical Package for Social Sciences (SPSS) version 26.0 for Windows. Categorical variables like gender, parental socioeconomic class, symptoms, and outcomes were presented as frequencies and percentages, while continuous data like age, MV settings, and duration of admission were summarized as means and standard deviations. Fisher's Exact test or Chi-squared test was used to compare categorized data, while the Student t-test assessed for any significant difference between means of continuous variables. A p-value <0.05 was considered significant.

Results

Baseline characteristics of participants

A total of 858 patients, including 74 (8.6%) children, were managed in the ICU during the study period. Forty-three (58.1%) of the children aged 5 years or older and 31 (41.9%) were under 5 years. Their mean age was 6.9±4.3 years. The sex distribution was nearly equal, with 38 (51.4%) male and 36 (48.6%) female. Most participants resided in Benin City (75.7%), followed by Delta (20.2%) and villages (4.1%). Regarding maternal education, 27 (36.5%) had secondary education, 25 (33.8%) tertiary, 20 (27%) had no education, and 2 (2.7%) had primary education. Social class distribution showed 28 (37.8%) were in upper class, 21 (28.4%) middle class and 25 (33.8%) lower class. The mean duration of admission into the ICU was 6.2±3.9 days; the majority of admissions lasted less than one week (73%). Thirty-seven (50%) were transferred to the ICU from the Children's Emergency Room (CHER) (Table 1).

Clinical features and diagnoses of participants

Among the participants, 49 (66.2%) experienced fever, 43 (58.1%) had dyspnea, and 37 (50%) suffered from convulsions. Other clinical features included cough (20.3%), pallor (10.8%), shock (8.1%), and stridor (5.4%). Additionally, 73% of participants presented with other symptoms related to their underlying diseases (Table 2). Severe sepsis was diagnosed in 11 (14.9%) of the participants, bronchopneumonia in 2 (2.7%) and meningitis in 6 (8.2%). Also, 24 (32.4%) participants had surgical disorders and were admitted into the ICU post-surgery. Burns and traumatic brain injury were present in 15 (20.3%), while intracranial space-occupying lesions such as intracranial tumors and intracerebral abscesses in 18 (24.3%) participants. Further details of the underlying diagnoses in the participants are shown in Table 2.

Indications for Intensive Care Unit admission

The primary indications for ICU admission included severe respiratory disorders: 21 (29.7%) had respiratory distress, 13 (17.6%) were in respiratory failure, and 11 (14.9%) were classified as having imminent respiratory failure. Post-surgical instability was the reason for admission of 24 participants (32.4%) (Table 3).

Critical care and co-management of the participants

In the ICU, 19 (25.7%) participants required endotracheal intubation, and 16 (21.7%) needed mechanical ventilation; the remaining 3 participants were admitted intubated post-surgery but were briefly weaned with T-piece devices before extubation. Among those ventilated, 85.7% were in Synchronized Intermittent Mandatory Ventilation (SIMV) pressure-controlled mode and 14.3% in Intermittent Mandatory Ventilation (IMV). The mean FiO_2 was 69.8% (±0.97), and the mean SpO_2 was 93.4% (±3.83). Other treatment measures included transfusions (43.2%), noradrenaline (5.4%), nebulization (1.4%), and dialysis (1.4%). Co-management involved specialties like respiratory (16.2%), neurology (4.1%), and cardiology (4.1%) (Table 4).

Table 1. Baseline characteristics of children admitted into the Intensive Care Unit (ICU) (N=74).

Characteristics	Frequency, n	Percentage (%)
Age (years)		
<5	31	41.9
≥5	43	58.1
Gender		
Male	38	51.4
Female	36	48.6
Place of residence		
Benin City	58	78.3
Delta	13	17.6
Village	3	4.1
Mother's education		
None	20	27.0
Primary	2	2.7
Secondary	27	36.5
Tertiary	25	33.8
Social class		
Upper	28	37.8
Middle	21	28.4
Lower	25	33.8
Duration of admission		
<1 week	54	73.0
≥1 week	20	27.0
Transferred to ICU from		
CHER	37	50.0
Theatre	24	32.5
Others	13	17.5

Table 2. Clinical features and diagnoses of acutely ill children admitted into the Intensive Care Unit (ICU) (N=74).

	Frequency, n	Percentage (%)
Clinical features[a]		
Fever	49	66.2
Dyspnea	43	58.1
Convulsion	37	50.0
Cough	15	20.3
Pallor	8	10.8
Shock	6	8.1
Stridor	4	5.4
Others	54	73.0
Diagnoses		
Burns/traumatic brain injury	15	20.3
Pneumonitis (aspiration/lipoid), pneumonia/ pulmonary oedema	12	16.2
ICSOL (tumors, abscesses)[b]	18	24.3
Meningococcemia, raised ICPc, status epilepticus	9	12.2
Typhoid peritonitis, intestinal obstruction, severe tetanus, others	20	27.0

[a]Multiple features are present in some children; [b]ICSOL, Intracranial Space Occupying Lesions; [c]ICP, Intracranial Pressure.

Table 3. Indications for admission into Intensive Care Unit (ICU) among the participants (N=74).

Indication	Frequency, n	Percentage (%)
Post-surgical instability	24	32.4
Severe respiratory distress	21	28.4
Respiratory failure	13	17.6
Imminent respiratory failure	11	14.9
Others	5	6.7

Table 4. Critical care and co-managing teams of children admitted into the Intensive Care Unit (ICU) (N=74).

	Frequency, n	Percentage (%)
Critical care		
Endotracheal intubation	19	25.7
Mechanical ventilation	16	21.7
Ventilator settings (n=16)		
SIMV	14	85.7
IMV	2	14.3
Oxygen values (Mean ± SD)		
FiO_2	69.8±0.97	
SpO_2	93.4±3.83	
Interventions		
Noradrenaline infusion	4	5.4
Nebulization	1	1.4
Dialysis	1	1.4
Transfusion	32	43.2
Co-managing pediatrics team		
Cardiology	3	4.1
Respiratory	14	16.2
Neurology	3	4.1
Nephrology	1	1.4
Co-managing surgical team		
Neurosurgery	5	6.8
Paediatric surgery	3	4.1
Cardiothoracic surgery	1	1.4
Burns and plastic surgery	1	1.4
Ophthalmology	1	1.4

SIMV, Synchronized Intermittent Mandatory Ventilation; IMV, Intermittent Mandatory Ventilation; SD, Standard Deviation; FiO_2, Fraction of Inspired Oxygen; SpO_2, Oxygen Saturation.

Outcome of the participants

Of the 74 participants, 43 (58.1%) died, 30 (40.5%) were discharged to the wards, and 1.4% left against medical advice. Follow-up information was available for three participants; it showed that 3 (2.8%) were stable, and one participant (1.4%) had anemic heart failure as a complication (Table 5). Indication for ICU admission (p=0.007) and duration of ICU admission (p=0.025) showed a statistically significant association with the outcomes of participants. The comparison of other factors with outcomes indicated no significant differences in age, gender, mother's education, social class, or the source of ICU transfer between those who were discharged/transferred and those who died (p-values >0.05). Specifically, 45.2% of those discharged/transferred were under 5 years old compared to 39.5% of those who died (p=0.642); also, 54.8% of males were discharged/transferred compared to 48.8% who died (p=0.610); further details are shown in Table 6. Also, the underlying diagnoses of the participants did not significantly influence their outcomes (p=0.209).

Discussion

This study shows that the main indications for ICU admission of children at the center were post-operative instability and respiratory disorders, comparable to earlier reports by Embu *et al.*[17] in Ethiopia and de Visser *et al.*[27] in Malawi that respiratory failure and traumatic injuries were the leading causes of ICU admission among children in their hospitals. One of these facilities was a mixed ICU admitting children and adults as obtainable in our centre, while the other was a dedicated PICU, yet possessed similar results. The common clinical features preceding ICU admission among our participants were fever, respiratory distress, and convulsion, while few patients had circulatory failure, which is relatively common in cardiac ICUs. Giri *et al.*[28] in Nepal reported that injuries, altered consciousness, and respiratory problems were common presentations among children managed in their pediatric emergency care centre. Likewise, Cassel-Choudhury *et al.*[29] in New York reported that about a fifth of patients in their series had arrhythmias with no underlying cardiac pathology prior to admission. Although supra-ventricular tachycardia and symptomatic bradycardia can occur in critically ill children with pericarditis or other infections, none of our participants manifest significant dysrhythmia in contrast to prior studies.[30,31]

Furthermore, the sources of patients in this study mainly included theatres and the Children Emergency Room (CHER), consistent with earlier reports that most ICU admissions were post-surgery and Emergency Department (ED) transfers[17,23]. Edae *et al.*[16] in Ethiopia reported that three-quarters of their pediatric ICU admission was from the emergency room and pediatric wards. Likewise, Purcell *et al.*[22] in Malawi found that the High Dependency Unit (HDU) and operating room transfers were the leading sources of ICU admission in their facility. The surgical patients included in this study were admitted following neurosurgical interventions, post-trauma, and other non-cardiac morbidities, unlike the PICA-Net report that significantly focused on cardiac patients.[21] Nevertheless, a tangible number of acutely ill children who presented in CHER with non-surgical disorders require ICU care in our setting. This reiterates the need to improve the availability of paediatric critical care services in our setting as dis-

Table 5. Outcome of children admitted into the Intensive Care Unit (ICU) (N=74).

	Frequency, n	Percentage (%)
Outcome		
Discharged against advice	1	1.4
Died	43	58.1
Discharged to ward	30	40.5
Follow-up		
Stable	2	2.8
Anemic heart failure	1	1.4

Table 6. Factors associated with outcome of children admitted into the Intensive Care Unit (ICU).

Factors	Outcome		Chi-square	p
	Survived	Died		
Age (years)				
<5	14 (45.2)	17 (39.5)	0.234	0.642
≥5	17 (54.8)	26 (60.5)		
Gender				
Male	17 (54.8)	21 (48.8)	0.260	0.610
Female	14 (45.2)	22 (51.2)		
Mother's educational level				
Tertiary	11 (35.5)	14 (32.6)	0.069	0.808
Others	20 (64.5)	29 (67.4)		
Social economic class				
Upper	11 (35.5)	13 (30.2)	0.348	0.840
Middle	9 (29.0)	12 (27.9)		
Lower	11 (35.5)	18 (41.9)		
Source of patient				
CHER	14 (45.2)	26 (60.5)	1.699	0.240
Theatre/others	17 (54.8)	17 (39.5)		
Indication for ICU admission				
Severe respiratory distress	4 (12.5)	18 (42.8)		
Respiratory Failure (RF)/imminent RF	10 (31.3)	17 (40.5)	14.477	0.007*
Unstable post-surgery	18 (56.2)	7 (16.7)		
Duration of ICU admission				
<5days	15 (44.1)	28 (70.0)	5.058	0.025*
≥5days	19 (55.9)	12(30.0)		

*Statistically significant.

cussed by Akindolire *et al.*[19] and Abiodun *et al.*[25] in prior studies in the setting.

The participants received a variety of therapeutic supports during their ICU stay, including non-invasive ventilation, mechanical ventilation, and renal replacement therapies, depending on the level of organ-system compromise that was present in them during admission. This reflects the specialized skill sets available in ICUs and the multi-disciplinary nature of services provided.[2,6] Our participants were co-managed by visiting paediatric teams, including cardiologists, neurologists and nephologists, consistent with reports by Simon *et al.*[32] in America that one-sixth of patients in their ICU were reviewed by visiting specialists while on admission, but contrasts with a report by Tripathi *et al.*[33] among LMIC's which showed that most pediatric ICUs had difficulties in obtaining consistent specialist care in the management of critical cases. Also, the primary surgical teams who owned the patients continued to review them throughout their ICU admission period. This is comparable to a hybrid ICU care model where the intensivist continues to co-manage patients during ICU admission with their primary physicians[34,35] Also, a Multi-Disciplinary Team (MDT) comprising the managing specialties, visiting physicians and sometimes caregivers meets to review treatment decisions, clinical responses, and prognosis; this guarantees safety and patient satisfaction throughout ICU admission.[35]

The mean length of ICU stay (6.2±3.9 days) in this study was relatively short, comparable to the duration of ICU admission reported by Sawe *et al.*[15] in Tanzania and Enyuma *et al.*[36] in Calabar, which had an average of 5 and 2 days in ICU admission respectively. In contrast, Purcell *et al.*[22] in Malawi reported about 4 weeks of stay, apparently due to the high level of dependence of the respondents on interventions such as mechanical ventilation and recovery from major surgical procedures. The severity of the disease and the complexity of therapy often influence the duration of admission. Patients receiving advanced therapies such as haemo-filtration and Extracorporeal Membrane Oxygenation (ECMO) in ICU are likely to stay longer than others.[21] Our study participants, however, did not receive such complex interventions. The short ICU stay of our participants is advantageous in averting the economic burden of ICU admission, especially in fee-for-service facilities and morbidities associated with prolonged ICU stays.[9]

Survival till hospital discharge among the children was suboptimal, similar to prior reports in resources–limited settings by Baker *et al.*[37] in Kenya, Zambia, and Tanzania and Edae *et al*.[16] in Ethiopia. This finding contributes to the baseline data needed to enhance the ongoing upgrade of paediatric critical care services in our centre. In contrast, the overall survival of children in ICUs in the UK was good, as highlighted in the 2022 PICA-Net report.[21] This disparity in outcomes of ICU care between resource-constrained and high-income countries is often accentuated by delayed presentation in health facilities and inefficient paediatric emergency transport services in the LMIC.[2,7,18] Both indication and duration of ICU admission influenced the outcomes of participants in this study; children in respiratory failure were more likely to die compared to those admitted for post-surgical instability without severe respiratory insufficiency. This corroborates a recent report by Eki-Udoko *et al.*[38] of high paediatric mortality rates and unmet intensive care needs in the setting. Nonetheless, social-demographic factors were not significantly associated with mortality in the index study.

The strength of this study is that it assesses patients' clinical course and outcomes over several years at the centre. Also, the various paediatric subspecialties that were co-managing the children with adult intensivists in the mixed ICU were also reviewed. Nevertheless, this research has inherent limitations due to its retrospective design. Real-time clinical and biochemical changes in the patients during ICU admission were not fully documented or retrievable from notes in patients' files. Also, details of their follow-up reports in the wards could not be obtained. In addition, ICU mortality prediction scores for children, such as the Paediatric Index of Mortality (PIM-3), which had been used in African children, were not documented in our participants.[39]

Conclusions

Paediatric intensive care is deliverable in a mixed unit in settings with limited ICU bed spaces. The rate of survival till discharge is low among children managed in the ICU in the study locale. There is a need to improve human and physical resources to boost ICU care and outcomes for children in our medically underserved region. Also, a regular audit of ICU services provided to children in the setting is desirable.

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