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Paediatric critical care needs assessment in a tertiary facility in a developing country

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Abstract*:* *Introduction and Aim:* There is a great burden of critically ill children in developing countries where paediatric critical care is still in its early stages. The actual burden of critically ill children is necessary for healthcare planning however, in Nigeria the magnitude is unknown. In order to provide the basic paediatric intensive care services which will likely reduce mortality and improve patient outcomes, the specific burden and need for various aspects of paediatric critical care services must be quantified.
This study set out to determine the volume, specific critical care needs and outcomes of critically ill paediatric emergencies in the UCH.
Methods: It was a prospective study of all consecutive patients admitted into the children's emergency ward over a three-month period. Data on clinical state on admission and the need or otherwise for critical care using the paediatric assessment triangle (PAT) were documented.
Results: There were 391 admissions during the study period, of which 130 were critically ill. They had one or more of the following; respiratory distress 93(28.3%), respiratory failure 35 (19.0%), shock 65(50%), central nervous system/metabolic derangements 64 (49.2%). Eighty-nine (68.5%) of the critically ill were under-5s. The diagnoses commonly associated with critical illness were malaria, 59 (45.4%), septicaemia, 18, (13.8%) and meningitis 17 (13. 1%). Four of the critically ill children (2.8%) were admitted into the general ICU and 33 (25.4%) died within 48hours of presentation.
Conclusion: There is a huge burden of critical care needs among children presenting to the children's emergency ward, which remains largely unmet. There is an urgent need to address paediatric critical care services in order to improve child survival.

Introduction

Paediatric critical care consists of identification of children at risk of dying or having adverse outcomes, intensive monitoring and provision of appropriate interventions. It is a high technology discipline requiring equipment for cardiorespiratory monitoring and support such as mechanical ventilators and high flow oxygen as well as circulatory support medications. Such services usually require specifically trained and highly skilled staff.
Nigeria still has a high under 5 mortality rate, UNICEF estimates that over 700,000 children under 5 years die annually in Nigeria, majority of the cause of mortality is from pneumonia, malaria and diarrhoeal diseases.[1] In developing countries like Nigeria, majority of mortalities occur due to infectious diseases which are treatable and have potential for full recovery if appropriate definitive care as well as intensive care is given to those who come critically ill.[2,3]
However, paediatric critical care services are largely unavailable in most developing countries.[4,5] Information on the exact magnitude of critically ill children in Nigeria and their specific needs are not available rather most studies only show mortalities which are used as estimates of critical illness in children. Specific information on burden of critical illness is required for appropriate healthcare planning that will make judicious use of scarce resources. This study therefore set out to evaluate the burden of critical illness and the critical care needs of children presenting at a busy paediatric emergency room in Nigeria.

Aim

To determine the volume, specific critical care needs and outcomes of critically ill paediatric emergencies in the University College Hospital, Ibadan, Nigeria.

Materials and Methods

It was a prospective study of all consecutive admissions

into the children's emergency ward of the University College Hospital Ibadan over a three-month period from April to June 2016.
The children's emergency room annually receives approximately 1,600 sick children excluding neonates and trauma cases for triage, resuscitation or stabilisation and are then transferred to appropriate units, wards or when indicated, the general intensive care unit (ICU). The patients are triaged immediately on arrival into one of the seven pathophysiologic groups using the Paediatric assessment triangle see Table 1.[6] The hospital has no paediatric intensive care unit and in view of the limited spaces for paediatric patients in the general ICU, not all critically ill children are able to get into the ICU. In the hospital, point of care user fees are charged for all services except those on the National Health Insurance Scheme.

Data on clinical state on admission and classification based on the paediatric assessment triangle (PAT) and the World Health Organisation (WHO) definition of critical illness were obtained with a structured questionnaire. The need or otherwise for critical care was determined based on the PAT and the outcome at 48 hours documented.

The PAT assesses appearance, work of breathing and circulation to the skin and uses these to classify a patient as stable if all three parameters are normal or into one of 6 categories namely respiratory distress, respiratory failure, compensated shock, decompensated shock, CNS/ metabolic dysfunction or cardiopulmonary failure.

Results

General characteristics

There were 391 medical emergencies admitted during the study period, 201 (51.4%) males and 190 (48.6%) females, aged between one month and 16 years with a mean ±SD age of 4.4±4.2 years. One hundred and ninety six (50.1%) of the patients, were referred from various health facilities while 195(49.9) came straight from home.
One hundred and ninety five (49.9%) received potentially life-saving interventions like intravenous fluids 95 (48.5%), oxygen 24 (12.2%) and anticonvulsants 18 (9.2). Hydrocortisone 6(3.1). One hundred and thirty (66.3%) had received antibiotics and 71(36.2%) had received anti-malaria drugs prior to presentation.

Table 1: Components of the Paediatric Assessment Triangle

Component	Appearance	Work of breathing	Circulation to skin
Stable	Normal	Normal	Normal
Respiratory Distress	Normal	Abnormal	Normal
Respiratory Failure	Abnormal	Abnormal	Normal/ Abnormal
Compensated Shock	Normal	Normal	Abnormal
Decompensated Shock	Abnormal	Normal/ Abnormal	Abnormal
CNS/Metabolic Dysfunction	Abnormal	Normal	Normal
Cardiopulmonary Failure	Abnormal	Abnormal	Abnormal

Burden of critically ill children

Using the PAT classification, 130 (33.2%) out of 391 admissions had one or more feature of critical illness as shown in Table 2, below. Eighty-nine of these (68.5%) were under 5 years with a mean ± SD age of 4.4 ±3.4 and a male: female ratio of 1(one). One hundred and twelve (86.2%) of the critically ill required ICU admission based on need for mechanical ventilation, airway support or circulatory support having failed to respond to fluid management as shown in Table 4.
Definition of respiratory failure under the PAT includes those with severe respiratory distress and abnormal appearance.
Using the WHO criteria 165(42.4%) were critically ill, with some having more than one deranged parameter. Eighty-eight (53.3%) had airway/ breathing problem, 129(78.2%) circulation problem while 82(49.7%) had either unconsciousness or seizures.

Table 2: Criteria defining critical illness among the paediatric emergencies using the Paediatric Assessment Triangle

PAT Classification	Number of patients in each PAT class n (%) N=391
Stable	178(45.5)
Respiratory distress only	93(23.8)
Respiratory failure	35(19.0)
Compensated shock	18(4.6)
Decompensated shock	47(12.0)
CNS/ Metabolic	64(16.4)

PAT- Paediatric assessment triangle; *Some patients had multiple features of critical illness

Clinical diagnoses of the critically ill children

Ninety seven percent of patients who were critically ill were as a result of infections. None had genetic disorders or congenital malformations that were potentially untreatable. The clinical diagnoses are as shown in Table 3.

Table 3: Clinical diagnoses of the critically ill

Clinical diagnosis	n(%) N=130
Malaria	59(45.4)
Meningitis	21(16.2)
Septicaemia	18(13.8)
Acute diarrhoeal disease	13(10.0)
Pneumonia	12(9.2)
Epilepsy	2(1.5)
Dengue fever	2(1.5)
Kerosene poisoning	2(1.5)
Croup	1(0.8)

Critical care needs

Specific critical care needs of the 130 patients who were critically ill are as shown in Table 4. Critical care management for comatose patients and cardiovascular system (CVS) monitoring were the most frequent needs. Thirty patients (23.1%) required mechanical ventilation. Some had more than one specific critical care need.

Care received and Outcomes

Of the 130 who were critically ill, only 4 (3.1%) were able to get into the general ICU. Of the 4, 3 were mechanically ventilated, one was admitted for intensive monitoring others could not be admitted due to lack of space and/or financial constraints. The other critical care needs met and unmet are as shown in Table 5. Of the total number of critical care requirements identified, only 14.4% were met due to inadequate staffing and/or financial constraints.

Table 4: Type of critical care needed

Type of care required	n (%); N-130
Critical care management for comatose patients	71(54.6)
Continuous electronic *CVS monitoring (Non invasive)	50(38.5)
Circulatory support	41(31.7)
Mechanical ventilation	30(23.1)
Sedation for intractable seizures	12(9.2)
High flow oxygen	12(9.2)

*CVS- cardiovascular system

Table 5: Critical care needs met and unmet

Critical care need	Number needed N 130	Number met
^ICU admission	112	4(3.6)
Mechanical ventilation	30	3(10.0)
Continuous electronic *CVS monitoring (Non-invasive)	50	4(8.0)
Hourly $^{+}$TPR monitoring by nurses	130	18(13.8)
Hourly input/ output	130	14(10.8)
Daily electrolytes and urea	130	41(31.5)
Total	582	84(14.4)

^- intensive care unit;*- cardiovascular system monitoring;
$^{+}$- temperature, pulse and respiration

Thirty-three (25.4%) of those who were critically ill died within 48hours of admission, 13(39.4%) from septicaemia, 12(36.4%) from malaria, 4(12.1%) from meningitis, 3(9.1%) from pneumonia and 1(3.0) from dengue fever. Only one (0.4%) patient out of the 261 who were not critically ill at admission died within 48 hours.
Of these mortalities, all required ICU admission and monitoring of which only 3.6% were met, other critical care needs of the patients who died are as shown in Table 6.

Table 6: The critical care needs of the 33 patients who died

Critical care need	Number needed	Number met n(%)
^ICU admission	33	4(3.6)
Mechanical ventilation	25	3(10.0)
Continuous electronic *CVS monitoring (Non-invasive)	33	4(8.0)
Hourly $^{+}$TPR monitoring by nurses	29	18(13.8)
Hourly input/ output	33	14(10.8)
Daily electrolytes and urea	33	41(31.5)

^- intensive care unit;*- cardiovascular system monitoring; $^{+}$- temperature, pulse and respiration

Among all the critically ill, there was significantly higher mortality among those whose critical care needs were unmet except manual monitoring and daily electrolytes and urea as shown in Table 7.

Table 7: Percentage mortality among all critically ill subjects whose critical care needs were met and those unmet

Critical care need	No unmet	% mortality in those whose needs were unmet	No met	% mortality among those whose needs were met
^ICU admission	108	29.6	4(3.6)	25.0
Mechanical ventilation	27	88.9	3 (10.0)	33.3
Continuous electronic *CVS monitoring (Non-invasive)	50	64.0	4(8.0)	25.0
Hourly $^{+}$TPR monitoring by nurses	112	20.5	18 (13.8)	55.5
Hourly input/ output	116	23.2	14 (10.8)	42.3
Daily electrolytes and urea	89	14.6	41 (31.5)	48.8

Discussion

This study shows that the burden of critically ill children is very high in this setting, constituting about a third of paediatric medical emergencies seen in the UCH, majority of whom were under-5. The mean age of critically ill children was 4.4±4.2 which is comparable to 4.9±4.4 reported by Hariharan *et al* in Barbados.[7] This burden of critical illness among under-5s underscores the vulnerability of this age group to critical illness and consequently death. It is therefore essential to provide adequate facilities to cater for this group of children or better still prevent diseases that may lead to such states. Critical illness scores from resource rich countries are not easily translatable to resource poor countries due to the presence of parameters not readily available in most hospital settings in resource poor countries. The PAT however is a simple tool, which utilises basic signs in triaging critically ill children for prompt attention especially in a busy and under staffed emergency room in a resource poor setting like ours. This tool had been recently introduced in the children's emergency room prior to conduct of the study as the primary tool in sorting out medical emergencies. The introduction of a triage tool such as the PAT, suited for the local setting, which will promptly and correctly identify critically ill children has been shown to reduce mortality and provide better outcomes.[8] Similar guidelines would include the WHO parameters for definition of critical illness which in this study also identified a similar proportion of critically ill children, though the objective of this study was not to compare both tools.

Critically ill children require comprehensive care that begins with pre hospital care and appropriate transport to the hospital to improve outcomes. Less than half of the patients who were referred from other hospitals had

potential lifesaving care such as intravenous fluids and oxygen prior to referral. Oxygen is particularly important in this environment because a considerable number of under 5 deaths are from acute respiratory illnesses.[5] As observed in the current study a significant proportion of the critical illness had respiratory component and as such oxygen therapy was vital. However, only few of the patients in this study who were referred were given oxygen prior to or during referral. It is not known whether this was due to non availability or non recognition of the need, but studies and interventions to strengthen pre hospital care including transport of critically ill patients are urgently needed in order to improve outcomes in this group of patients. Oxygen is therefore one of the essential elements that must be available in health facilities especially since it has reported to be cheap in Nigeria.[9]

In this study of paediatric emergencies, majority of the critically ill patients had infections with prospects for full recovery, this makes it cost effective to make available paediatric critical care services which includes adequate number of trained personnel in recognition and management of such children as well as the basic equipment and supplies needed. In a study of PICU admissions from Brazil, it was reported that critically ill patients admitted from the wards were more likely to die than those from the emergency room probably because the ward patients had more of diseases associated with poor prognosis like oncologic diagnosis.[10] For this reason, recognition of critical illness and provision of necessary interventions to paediatric emergency cases is expedient. That infections were responsible for most of the critical illness in this study, is similar to other reports which have shown that infectious disease is both a common precipitant and final common pathway to critical illness in the developing world and as such there is a good chance of full recovery if timely critical care is given.[3,11] This is unlike in the developed countries where infections account for less than 20% of reasons for ICU admissions.[12] While interventions targeting prevention of these diseases need to be strengthened it is also essential to be adequately equipped for those whose illness gets to this critical level.

The types of critical care required by patients in this study included high flow oxygen and cardiovascular monitoring and circulatory support, which should not be beyond the reach of most secondary and tertiary hospitals even in the face of limited financial resources and high technology prior to establishment of definitive PICUs. Such facilities are available in high dependency units of even small hospitals in developed countries like the UK.[13]

Despite the fact that the type of critical care required were not high tech, majority of those needs were unmet mostly due to understaffing, limited resources and point of care fees. The care of critically ill children should not depend on the financial capability of the family. This makes it imperative for appropriate policies and provisions based on proper healthcare planning to be put in place, however this requires that the actual burden be known. Multicentre studies quantifying such needs in resource limited countries like Nigeria are recommended.

The first 48 hours of admission is the most crucial period in the care of critically ill children as mortality is highest in this period.[2,3,14] In this study, 25.2% of the critically ill patients died within 48 hours of admission. Studies have shown that mortality is three fold higher in patients who required ICU care but did not get it and this may be one of the factors responsible for the high early mortality observed in this study as only 3.6% of those who required ICU admission got it.[15] Even other aspects of critical care such as cardiovascular monitoring were not met due to inadequate staffing, equipment and bed space.

While it may not be immediately feasible to set up proper paediatric intensive care units as obtained in developed countries, the principles of prevention, recognition appropriate triaging and management of critical illness as appropriate for low income countries ought to be given priority. This is to ensure progress towards reduction in child mortality in order to meet the Sustainable development goals. In implementing such principles in low income countries specific clinical evidence, standards of care and quality improvement should be the focus.

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