

**Pediatric critical care in resource-limited settings:  
An overview**

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**Abstract**

Paediatric critical care in lower resource settings can often become the responsibility of the anaesthetist, whether there has been formal training in paediatric care or not. Here we aim to provide an overview of the current state of pediatric critical care in resource-limited settings: the burden of illness and need, staffing, outcomes, and capacity. Barriers to the provision of consistent quality care are reviewed, as are ethical considerations at the level of the institution and the patient.

**Key words:** pediatric intensive care units; pediatrics; resource allocation; resource-limited settings

**INTRODUCTION**

The provision of paediatric critical care in low- and middle-income countries (LMIC) presents unique challenges for physicians and nurses. The increasingly frequent acquisition by hospitals of equipment such as mechanical ventilators, drugs which can provide vasoactive support, and the expanding capacity to provide emergency surgical care have all translated into a need for thoughtful deployment of existing personnel and resources. Here we touch on some of the relevant issues in the current practice of pediatric critical care in LMIC.

**Burden of Critical Illness**

Several web-based databases such as World Health Organization's Global Health Observatory report the burden of discrete diseases such as malaria, HIV and meningitis. Literature on the incidence and prevalence of critical illness syndromes, such as multiorgan failure, acute kidney injury, and sepsis, are difficult to find because no single test exists to diagnose them; they rely on multiple tests that include both radiological, laboratory, clinical and physiological criteria agreed upon by experts who are constantly debating and revising the criteria. While these might be readily available in resource-rich countries, the majority of low and middle-income countries will not have the necessary resources to diagnose these syndromes during critical illness, document it effectively, and carry out research. Even the SPROUT study, which aimed to assess the global point prevalence of paediatric severe sepsis worldwide, garnered the majority of its data from high-income countries (HIC), with only three hospitals from Africa (all from South Africa) reporting.<sup>1</sup>

The true burden of paediatric critical illness therefore remains unclear and this hinders both local and global appreciation.

However, the under-five mortality rate in many LMIC remains markedly higher than that in most HIC. It is known that the majority of childhood deaths result from preventable and reversible illnesses like meningitis, malaria and tuberculosis and complications from birth asphyxia in the neonatal period. All of these present with a period of critical illness during their disease progression.<sup>2</sup> By extrapolation, the burden of critical illness - even though debated - is clearly significant.

**PICU Staffing in LMIC**

While many children receiving critical care in LMIC are cared for in mixed adult/paediatric units, even when designated PICUs are in place, significant staffing challenges exist. There is a marked lack of paediatricians trained in critical care in most LMIC, and consequently the care of critically ill children is often assumed by some combination of general paediatricians, adult anaesthetists, trainees/registrar, and/or general practitioners, particularly in smaller district hospitals.<sup>3-5</sup> It is not uncommon for physicians to work in shifts with duties split between multiple hospitals in order to maintain their income. Subspecialized allied professionals such as respiratory therapists, dieticians, pharmacists, and physical therapists are generally lacking. Nursing staff may not have critical care training, but rather be assigned to ICU by virtue of having more clinical experience or increased seniority compared to other staff.

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These practices, in our experience, are complicated by a dearth of published information regarding staffing of critical care units in resource-limited settings. A systematic review of ICU capacity in low-income countries (based on World Bank definition) in 2015 revealed that the majority of LIC had no literature on ICU capacity; of the remaining countries for whom data existed, only one reported physician staffing while two reported nursing ratios.<sup>3</sup>

### **PICU Outcomes**

A paediatric intensive care unit is a designated space/facility that is specifically designed to admit children who because of life threatening conditions, severity of illness, or post-surgical state require continuous care by the nursing and physician teams with or without ICU-specific supports such as mechanical ventilation or vasoactive infusions. The goal of the PICU staff is to support the body during the transition time of physiological deficiencies while the underlying cause is treated or resolves. PICU admission is determined by the admission criteria that is generally unique to specific centers but is designed to maximize benefit to both the patients and hospitals that they serve.

Different metrics in the assessment of ICU outcomes exist; one can assess mortality or morbidity of targeted populations such as patients with septic shock, traumatic brain injury or acute respiratory distress. Mortality or morbidity can be measured at different timelines such as at 6 months, 1 year or even prolong it further to assess quality of life at 10 years post-discharge from the ICU.

The world all over is moving away from simply looking at mortality after ICU admission. Instead research is now focusing on the ability to live a normal or close to normal childhood and the ability to integrate into society of both the child and their caregivers.

While there are no agreed guidelines on assessment of outcomes in critically ill children and no registries for children that have gone through the existing intensive care units in LMICs, reported mortality rates in literature from the available PICUs range from 2.1% in India<sup>6</sup> to as high as 42% in some sub-Saharan African countries.<sup>7</sup> These figures, when compared to those coming from high-income countries (8-18%), are a reflection of the room for growth in this young field of medicine.

### **ICU Resources and Capacity**

The definition of an ICU bed and therefore an ICU varies around the world and is largely shaped by economic factors, hospital priorities, and public health regulatory requirements and priorities. Factors that generally delineate an ICU from a ward include physical space, support and monitoring technology, human resources to provide intensive nursing care, critical services provided that are beyond the immediate demands of the individual patients such as rehabilitation, and the ability to carry out research, education and quality improvement.<sup>8</sup> A survey done in 2016 from 34 low and middle income countries found that the number of paediatric intensive care unit (PICU) beds is comparable to high income countries<sup>3</sup> while some research respondents in other studies say that they do not have designated space to call a PICU but rather paediatric critical care is carried out in a mixed adult/paediatric ICU.<sup>9</sup> Even when available, the average number of PICU beds can be quite small; in a study from Pakistan, the rate ranged from 0.5-1 per 100,000 children<sup>10</sup>.

### **Barriers to Quality Care**

Barriers to the implementation of high-quality critical care in LMIC are significant. Care for life-threatening conditions in resource-limited settings is often limited to basic health care resources and thus presents a challenge to implementation, development and sustainability of critical care services. Even while some private hospitals in urban centers are able to offer ICU services on par with those found in high-income countries, resources at these facilities can stand in stark contrast to the typical resources available at district hospitals in the same country, or even public hospitals in the same city.<sup>5</sup> Illustratively, a survey of anaesthetists and ICU physicians in 2011 concluded that the most recent Surviving Sepsis guidelines cannot be implemented in Africa, particularly sub-Saharan Africa due to the shortage of required hospital facilities and equipment.<sup>11</sup> Impediments to the provision of critical care are various: challenges in personnel, equipment, and health care systems all contribute to suboptimal care and paediatric mortality.

With respect to the existence of appropriately trained personnel, few formal training programs for physicians or mid-level providers in paediatric critical care exist outside of high-resource settings.<sup>12</sup> The so-called “brain drain” has led to emigration of physicians from LMIC to higher-income countries that are made attractive by training opportunities, better income, and increased resources. Programs such as the African Paediatric Fellowship Program, which since 2008 has offered focused training for six months to two years in paediatric subspecialties for physicians committed to returning to their home country, aim to increase local capacity in countries where specialists are either few or nonexistent.<sup>13</sup> PECC-Kenya launched in January 2019 as the first combined paediatric emergency and critical care fellowship program in Africa<sup>12</sup>; the Ecuadorian Laude program in PCCEM has innovatively utilized interprofessional education since 2013 to train providers who are already caring for critically ill children.<sup>4</sup> These initiatives are encouraging, but it will be some years before the workforce will increase dramatically. Until then, critically ill children will continue to receive care from physicians and providers without specialized PICU training. Online resources such as OPENPediatrics<sup>14</sup> can be effective stopgaps, but the need to increase the resources for training is clear.

Similar to the barriers physicians face when seeking specialized training in critical care, opportunities for training in critical care nursing in LMIC are often scarce. These programs, when available, often remove experienced nurses from their home institutions, leaving a gap in nursing leadership for the duration of their training. And just as promising young physicians often emigrate from their home countries, trained nursing staff can be subsequently lost to higher paying jobs in more desirable locations after they have gained these new and valuable skills.

Even when adequately-trained personnel are present, necessary supplies and equipment – for example, reliable electricity, functioning ventilators, oxygen supply, timely laboratory support, or monitors – may not be. Children seen and evaluated in the community may have to travel some distance to access critical care resources; availability of transportation, cost, and late presentation can all compromise the ability to receive life-saving care, even when available. Finally, the triage of patients in centers where need for critical care far outstrips

the capacity of the institution can suffer from the frequent practice of caring for the very sickest patients in the ICU. The Society for Critical Care Medicine guidelines for adult ICU admission suggest “ICU admission criteria should select patients who are likely to benefit from ICU care”<sup>15</sup>, but that determination in resource-limited settings can be fraught with challenges. Identification of reversible illness – and distinguishing that from illness which might have been reversible three days ago but is no longer – is not straightforward, even in previously healthy children.

### Ethics Surrounding Provision of PICU Care in LMIC

Critical care is a resource-intensive undertaking, and the arguments surrounding the pro and con views on its provision in resource-limited settings are ongoing. The main relevant ethical principle is that of justice: while a more global view of justice affirms that all children ought to be able to access the same types and quality of medical care<sup>5</sup>, the practical aspects of resource allocation render that goal currently unachievable. In addition, some argue that the high cost of critical care for a few children is inappropriate in the setting of ongoing mortality from disease in which lower-cost community-health level interventions (e.g. vaccination programs) have the potential for a larger impact in mortality rates. However, as progress has been made toward the WHO’s Millennium Development Goal #4 (reduction of the under-5 mortality rate), the relative merit of higher-cost, resource-intensive care has increased.

In LMIC, resources are often either unavailable or limited in quantity and are simply inaccessible to children who might benefit from them. Their provision may, in some situations, devastate the finances of the family whose child receives them.<sup>5</sup> In circumstances in which they are available, therefore, transparency and consistency surrounding these difficult life-and-death decisions are essential to the development of a robust critical care service. As an example, in South Africa, the Red Cross War Memorial PICU team has created explicit triage criteria to assist in selecting children appropriate for admission to their PICU.<sup>16</sup> Their process delineated specific populations who would be excluded from PICU admission based on futility of care or likely poor prognosis, reducing pressure on PICU staff by outlining clear expectations in advance. Frameworks such as this can help identify children who are most likely to benefit from ICU care with return to a baseline state of health.

Aside from the ethics of resource allocation, a nuanced approach to local beliefs and customs is necessary in the provision of critical care to children. For example, in higher-resource settings, it is generally accepted that withdrawal of intensive supports is ethically equivalent to withholding them. However, in many LMIC it is culturally or religiously inappropriate to consider withdrawal of life-sustaining therapies, even in the face of an extremely poor prognosis or inevitable cardiopulmonary death. Similarly, while the concept of brain death is widely accepted in the medical literature, understanding in the lay public in resource-limited settings is lacking. Compounding the lack of public knowledge is a lack of protocol for its declaration: brain death protocols did not exist in the majority of LMIC in a 2015 survey.<sup>17</sup> A retrospective chart review in a Malawi ICU identified patients with neurologic signs concerning for brain death; all 43 patients were declared dead after cardiac death.<sup>18</sup> Lack of consensus around the

concept of brain death can lead to misuse of precious ICU resources for patients in whom ongoing supportive care is futile.

In short, accessibility of critical care resources, criteria for their provision, and cultural context are all ethically essential considerations in the establishment and ongoing administration of paediatric critical care.

### CONCLUSIONS

The argument for an increase in the capacity to care for critically ill children in resource-limited settings is compelling as we find ourselves in a season of shifting priorities and health care system investments. It is clear that thoughtfulness and intentionality are necessary as decisions are rendered by individual institutions around the type of care provided, how to allocate resources, and how to identify skilled providers. With the burgeoning interest in paediatric critical care, we anticipate that the coming years will provide ample opportunity to rigorously build a body of knowledge around best practices and, ultimately, improve the quality of care children receive in resource-limited settings.

### REFERENCES

1. Weiss SL, Fitzgerald JF, Pappachan J, Wheeler D, Jaramillo-Bustamante JC, Salloo A et al. Global Epidemiology of Pediatric Severe Sepsis: The Sepsis Prevalence, Outcomes, and Therapies Study. *Am J Respir Crit Care Med.* 2015 May 15; **191(10)**: 1147-1157.
2. GBD 2013 Mortality and Causes of Death Collaborators. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a Systematic Analysis for the Global Burden of Disease Study 2013. *Lancet.* 2015; **385(9963)**: 117-71.
3. Tripathi S, Kaur H, Kashyap R, Dong Y, Gajic O, Murthy S. A survey on the resources and practices in paediatric critical care of resource-rich and resource-limited countries. *Journal of Intensive Care.* 2015; **(3)**: 40.
4. Biskup T, Phan P, Grunauer M. Lessons from the Design and Implementation of a Pediatric Critical Care and Emergency Medicine Training Program in a Low Resource Country-The South American Experience. *J Pediatr Intensive Care.* 2017; **6(1)**: 60-65.
5. Turner EL, Nielsen KR, Jamal SM, von Saint Andre-von Arnim, Musa NL. A Review of Pediatric Critical Care in Resource-Limited Settings: A Look at Past, Present, and Future Directions. *Front Pediatr.* 2016; **4**: 5.
6. Abhulimhen-Iyoha BI, Pooboni SK, Vuppali NKK. Morbidity pattern and outcome of patients admitted into a paediatric intensive care unit in India. *Indian Journal of Clinical Medicine.* 2014;(5): <https://doi.org/10.4137/IJCM.S13902>
7. Abebe T, Girmay M, Michael G, Tesfaye M. The epidemiological profile of paediatric patients admitted to the general intensive care unit in an Ethiopian university hospital. *International Journal of General Medicine.* 2015; **(8)**: 63-67.
8. Marshall JC, Bosco L, Adhikari NK, Connolly B, Diaz JV, Dorman T et al. What is an intensive care unit? A report of the task force of the World Federation of Societies of Intensive and Critical Care Medicine. *J Crit Care.* 2017; **(37)**: 270-276.
9. Slusher TM, Kiragu AW, Day LT, Bjorklund AR, Shirk A, Johannsen C et al. Pediatric Critical Care in Resource-Limited Settings—Overview and Lessons Learned. *Front Paediatr.* 2018; **(6)**: 49.
10. Haque A, Ladak LA, Hamid MH, Mirza S, Siddiqui NR, Bhutta ZA. A National Survey of Paediatric Intensive Care Units in Pakistan. *Journal of Critical Care Medicine.* 2014; <https://doi.org/10.1155/2014/842050>
11. Baelani I, Jochberger S, Laimer T, et al. Availability of critical care resources to treat patients with severe sepsis or septic shock in Africa: a self-reported, continent wide survey of anaesthesia providers. *Crit Care.* 2011;15(1):R10. doi:10.1186/cc9410
12. <http://www.pecc-kenya.org/>

13. Wilmshurst JM, Morrow B, du Preez A, Githanga D, Kennedy N, Zar HJ. The African Pediatric Fellowship Program: Training in Africa for Africans. *Pediatrics*. 2016;137(1):10.1542/peds.2015-2741.
14. <https://www.openpediatrics.org/>
15. Guidelines for intensive care unit admission, discharge, and triage. Task Force of the American College of Critical Care Medicine, Society of Critical Care Medicine. *Crit Care Med*. 1999; **27(3)**: 633–638.
16. Argent AC, Ahrens J, Morrow BM, et al. Pediatric intensive care in South Africa: an account of making optimum use of limited resources at the Red Cross War Memorial Children's Hospital. *Pediatr Crit Care Med*. 2014; **15(1)**: 7–14.
17. Wahlster S, Wijdicks EF, Patel PV, et al. Brain death declaration: Practices and perceptions worldwide. *Neurology*. 2015; **84(18)**: 1870–1879.