PATTERN AND OUTCOME OF PATIENTS ADMITTED AT THE PAEDIATRIC INTENSIVE CARE UNIT AT MUHIMBILI NATIONAL HOSPITAL, DAR ES SALAAM, TANZANIA

Dr Reema Ruparellia, MD

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Department of Paediatrics and Child Health

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By

Dr Reema Ruparellia

A Dissertation Submitted in (partial) Fulfillment of the Requirements for the Degree of Master of Medicine (Paediatrics and Child Health) of

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October, 2020

CERTIFICATION

The undersigned certify that they have read and hereby recommend for examination of dissertation entitled ***Pattern and Outcome of patients admitted at the Paediatric Intensive Care Unit at Muhimbili National Hospital, Dar es Salaam, Tanzania,*** in fulfillment of the requirements for the degree of Master of Medicine (Paediatrics and Child Health) of Muhimbili University of Health and Allied Sciences.

Dr Edward Kija

(Supervisor)

Date:

Dr Yasser Habresh Said

(Supervisor)

Date:

DECLARATION AND COPYRIGHT

I, **Reema M Ruparellia**, declare that this **dissertation** is my own original work and that this has not been presented and will not be presented to any other University for a similar or any other degree award.

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I also thank my colleague Dr Karpal Singh for his continuous comments and support during the study time.

DEDICATION

This research is dedicated to the Department of Paediatrics and Child Health, MUHAS.

ABSTRACT

Background: A paediatric intensive care unit (PICU) is a specialized unit that provides medical care to critically ill children. Critical care in developing countries remains to be a cause of concern, owing to lack of expert support, diagnostic facilities, appropriate medications and equipments. A PICU was established in March 2019 at the Muhimbili National Hospital (MNH), a national referral centre, aiming at maximizing care for the critically ill children. Being a newly established field, there is a paucity of information regarding the admission patterns and outcome of these patients at PICU.

Objective: The aim of this study was to determine the admission pattern, outcome, cause of death and factors associated with mortality among patients admitted at the PICU at MNH.

Methodology: A retrospective descriptive cross-sectional study was performed, and patients aged 1 month – 14 years admitted at the PICU between March 2019 and February 2020 were included in the study. Medical files of 484 randomly selected patients were retrieved from the medical records. Following the exclusion criteria, data of 480 patients was analyzed for the cause of admission, outcome, cause of death and associated factors of mortality. These factors included age, sex, admission source, admission diagnosis, length of stay, need of mechanical ventilation (MV), paediatric Glasgow Coma Scale (PGCS) and presence of chronic underlying conditions. The statistical significance was set at $p < 0.05$ and multivariate analysis was used to identify the association between mortality and the associated factors.

Results: Of the 653 admitted patients, data of 480 were analyzed. The median age at admission was 18 months (Interquartile range 1–174), with a male-to-female ratio of 1.4:1. The most frequent causes of PICU admissions were severe sepsis (22.9%), lower respiratory tract infections (LRTI) (22.5%), post-operative condition (12.3%), acute watery diarrhea (AWD)/dysentery (6.3%) and meningitis/encephalitis (5.6%). Infectious conditions accounting for 67.7% were the most common cause of admission in the PICU. The PICU mortality was 46.9%, and the most common cause of death (59.1%) was severe sepsis with or without multi-organ failure. Multivariate analysis showed that patients aged <1 year, patients admitted from

general wards, patients requiring mechanical ventilation during stay at PICU, and patients with a length of stay of less than a week had significantly higher mortality.

Conclusion: The common causes of PICU admissions at MNH were severe sepsis, LRTI, post-operative condition, AWD/dysentery and meningitis/encephalitis. The mortality rate in this study was 46.9%, and the most common cause of death was severe sepsis with or without multi-organ failure. The factors that were significantly associated with mortality in PICU included the age of the patient, admission source, need of mechanical ventilator and length of stay.

Recommendations: Deliberate efforts should be put to strengthen the management of sepsis in paediatric population as it was the common cause of admission and death at PICU. Efforts should be put for early identification and management of critically ill patients admitted in hospitals so as to reduce mortality in this vulnerable group.

MUHTASIRI

Utangulizi: Kitengo cha kuhudumia watoto mahututi (PICU), ni sehemu maalum katika hospitali ambayo hutoa huduma ya matibabu kwa watoto walio mahututi. Huduma hii kwa nchi zinazoendelea bado ni changamoto kutokana na ukosefu wa wataalamu wa kutosha, vifaa na dawa. Katika jitihada za kuboresha huduma za kimatibabu kwa watoto mahututi, kitengo hicho kilianzishwa katika Hospitali ya Taifa Muhimbili Machi 2019. Kutokana na kuwa kitengo kipya, kuna upungufu wa taarifa kuhusu muundo na matokeo ya matibabu kwa watoto wanaolazwa kwenye kitengo hicho.

Lengo: Kusudio la utafiti huu lilikuwa kuona muundo, matokeo ya wagonjwa, sababu na viashiria vya vifo, katika watoto waliolazwa PICU huko MNH.

Mbinu: Uchunguzi huu ulitumia kumbukumbu za awali za watoto mahututi wenye umri kati ya mwezi 1 na miaka 14 waliolazwa PICU kati ya Machi 2019 na Februari 2020. Takwimu za wagonjwa 484 waliochaguliwa kwa bahati nasibu zilitumika na majalada yao yalitafutwa. Kati ya hawa, majalada ya wagonjwa 480 yalikidhi vigezo vya kushirikishwa kwenye utafiti. Taarifa za wagonjwa zilizochukuliwa toka majalada yalikuwa ni pamoja na umri na jinsia ya mtoto, chanzo cha kulazwa, sababu ya kulazwa, urefu wa muda ambao mgonjwa alilazwa, hitaji la mitambo ya kupumilia (MV), Glasgow Coma Scale Scale (GCS) na uwepo wa magonjwa sugu. Uchambuzi ulifanyiwa kutambua uhusiano wa takwimu kati ya vifo na sababu yanayohusiana.

Matokeo: Kati ya watoto 653 waliolazwa, rekodi za wagonjwa 480 zilichambuliwa. Umri wa kati wa wagonjwa waliolazwa ilikuwa miezi 18 (kiwango cha kati ya mwezi 1 – miezi 174), na uwiano wa watoto wa kiume na kike (Me:Ke) ulikuwa 1.4:1. Sababu kuu za kulazwa PICU zilikuwa maambukizi makali ya damu (22.9%), maambukizi ya njia ya hewa (22.5%), uangalizi baada ya upasuaji (12.3%), ugonjwa ya kuharisha/kuharisha damu (6.3%) na homa ya uti wa mgongo (5.6%). Idadi kubwa (67.7%) ya wagonjwa walikuwa na magonjwa ambukizi. Vifo vya watoto waliolazwa PICU vilikuwa ni 46.9% na sababu kuu la vifo ilikuwa maambukizi makali ya damu (59.1%). Viashiria vya vifo vilikuwa ni umri wa mgonjwa,

chanzo cha kulazwa, hitaji la kutumia mitambo ya kusaidia kupumua na urefu wa muda wa kulazwa PICU.

Hitimisho: Sababu kuu za kulazwa PICU zilikuwa maambukizi makali ya damu, maambukizi ya njia ya hewa, uangalizi baada ya upasuaji, ugonjwa wa kuharisha/kuharisha damu na homa ya uti wa mgongo. Vifo vya watoto waliolazwa PICU vilikuwa 46.9%, na sababu kuu la vifo ilikuwa maambukizi makali ya damu. Viashiria vya vifo vilikuwa ni umri wa mgonjwa, chanzo cha kulazwa, hitaji la kutumia mitambo ya kusaidia kupumua na urefu wa muda wa kulazwa PICU.

Mapendekezo: Jitihadha madhubuti zinabidi zifanyike kuimarisha matibabu ya maambukizi makali ya damu kwa watoto kwa kuwa ndiyo sababu kuu la watoto kulazwa na kufa katika PICU. Vilevile, juhudi za ziada zifanyike katika kuwatambua mapema na kuwatibu wagonjwa mahututi walazwao katika hospitali ili kupunguza idadi ya vifo kwa watoto.

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LIST OF ABBREVIATIONS

AAP	American Academy of Pediatrics
ABG	Arterial Blood Gas
APACHE II	Acute Physiologic Assessment and Chronic Health Evaluation II
AWD	Acute Watery Diarrhea
CDC	Centers for Disease Control and Prevention
EMD	Emergency Medical Department
FOUR	Full Outline of UnResponsiveness
HIV	Human Immunodeficiency Virus
ICU	Intensive Care Unit
LMIC	Low- to Middle- Income countries
LOS	Length Of Stay
LSP	Long Stay Patients
MNH	Muhimbili National Hospital
MOF	Multi-Organ Failure
MUHAS	Muhimbili University of Health and Allied Sciences
MV	Mechanical Ventilation
OT	Operating Theatre
PGCS	Paediatric Glasgow Coma Scale
PICU	Paediatric Intensive Care Unit
SDG	Sustainable Development Goals
SOFA	Sequential Organ Failure Assessment
vs	Versus

DEFINITION OF TERMS

Outcome: in this study, the patient outcome refers to the clinical endpoint of the patient in PICU i.e. death or discharge from PICU.

Death on arrival: defined as any patient certified as dead within 1 hour of admission at PICU.

1.0 INTRODUCTION

1.1 Background

1.1.1 Introduction to Paediatric Intensive Care Unit

A paediatric intensive care unit (PICU) is a specialized unit that provides medical care to critically ill children. The special needs of a critically ill child demand a high level of expertise provided by teams of physicians, nurses, and ancillary personnel in sophisticated facilities with a wide variety of special equipment (1). Intensive care unit (ICU) was first established during the early 1950s. The introduction of sophisticated equipment such as newborn incubators, mechanical ventilators, renal dialyzers and defibrillators characterized intensive care therapy during the 20^{th} century (2).

Paediatric critical care services are provided in level I and level II units, whereby a level I PICU deals with multidisciplinary definitive care for a wide range of complex, progressive, and rapidly changing medical, surgical, and traumatic disorders. In a level II PICU, patients will present with less complex acuity and will be more stable (3). Critical care should ideally be provided by a PICU that meets level I specifications. Tables 1 and 2 compare requirements of a level I PICU as recommended by the American Academy of Pediatrics (AAP) (3,4), to what is available at the PICU at Muhimbili National Hospital (MNH).

Table 1: Recommended PICU personnel vs PICU personnel at MNH

Recommended guidelines by AAP	**PICU at MNH**
Physician staff: Physicians present in hospital 24 hours	
Paediatricians	Present
Anaesthesiologist	Present
Surgeons	Present
Sub specialty physicians on-call	Present
Nursing staff:	
Head nurse	Present
1:1 to 1:3 registered nurse-to-patient ratio	Present
Other team members:	
Respiratory therapist	Present
Biomedical technicians or equipment exchange capability (24 hours)	Present

Psychiatric support	Present
Child life specialists	Absent
Clergy	Present
Social workers	Present
Nutritionists	Present
Physical therapists	Present
Occupational therapists	Present

Table 2: Recommended resources by organ systems vs resources at PICU at MNH

Recommended guidelines by AAP	**PICU at MNH**
Cardiovascular	
Hemodynamic monitoring Non-invasive Invasive	 Present Absent
Inotropic support	Present
Echocardiogram (24-hours availability)	Present
Gastrointestinal	
Upper and lower endoscopy	Limited age-specific probes available
Hematologic	
Plasmapheresis or leukapheresis	Absent
Neurologic	
Intracranial pressure monitoring	Absent
External ventricular drain	Present
Lumbar drain	Present
Continuous EEG	Present
Video EEG	Absent
Respiratory	
Non invasive ventilation	Present
Conventional mechanical ventilation	Present
Advanced mechanical ventilation	Present
Conventional inhalation therapies (continuous albuterol)	Present
Bronchoscopy	Limited age-specific probes available
Renal	
Continuous renal replacement therapy	Absent
Hemodialysis	Limited age-specific catheters available
Peritoneal dialysis	Present
Charcoal hemofiltration	Absent
Radiology	
Diagnostic imaging, including CT (24-hours	Present

availability	
Advanced Diagnostic Imaging, including MRI (with sedation)	Present

Key: EEG - Electroencephalogram; CT - Computed tomography; MRI - Magnetic resonance imaging

Adequate critical care can reduce mortality levels significantly in a hospital setting. Setting up PICU services in a resource-limited country requires adequate considerations to be made on availability of manpower and physical resources, triage of patients based on individual characteristics and futility of care, and financial capability of the family (5). In addition, it is important to understand the demographic profile of critically ill patients admitted in a particular ICU setting as these can vary widely in different parts of the world.

A recent establishment was made at the Muhimbili National Hospital (MNH), a national referral centre, whereby a PICU was opened in March 2019 in order to maximize care for critically ill children. It comprises of 12 beds including 2 isolation rooms, and 11 fully functioning mechanical ventilators. In order for the hospital to continue developing its quality of care it is important to understand the diversity of conditions that are being dealt with at the PICU and invest in targeting the management of those conditions.

1.1.2 Common causes of PICU admissions

A PICU may care for both neonates (≤ 28 days of age) and older children, although some hospitals have a dedicated neonatal ICU. Admissions at PICU can vary from medical, surgical to traumatic cases. A variety of medical causes can lead to PICU admissions such as respiratory illnesses like bronchiolitis and severe pneumonia, cardiac illnesses like heart failure, and also other rare illnesses and complex congenital anomalies. Majority of surgical admissions are post-operative cares or post-operative complications, whereas traumatic injuries can be due to falls or motor traffic accidents. Causes of PICU admissions in developing countries can vary from those in developed countries, in that infectious diseases usually account for most of PICU admissions in the developing counties (6,7).

1.1.3 Mortality in PICU

Overall, mortality rates in the developing world continue to be significantly high (8,9). The under-five mortality rate in the United Republic of Tanzania fell gradually from 218.4 deaths per thousand live births in 1969 to 53 deaths per thousand live births in 2018 (8). However, the Sustainable Development Goals (SDGs), Goal 3 on good health and well-being, targets to reduce under-five mortality to at least as low as 25 per 1,000 live births by the year 2030 (10). Remarkable achievements in public health measures have been gained in recent decades in order to improve the life expectancy and reduce paediatric mortality in the low- to middle-income countries (LMIC) (11). With public health measures being taken to improve health care in the country, it is equally important to improve the measures of treating critically ill patients (11).

PICU mortality patterns vary in different settings of critical care, ranging from 1.69% in developed countries to 28% in developing countries (12–15). Several factors can be associated with these figures. Availability of adequate resources, the quality of care provided, together with the clinical characteristics of the patients admitted are all factors that can contribute to mortality. Owing to the fact that this is the first established PICU at MNH, no published data is available on the mortality rates at this PICU.

1.1.4 Factors associated with mortality in a PICU

1.1.4.1 Clinical characteristics of patients

The disease presentation and illness severity of a patient can strongly affect the outcome. Patients admitted with multiple medical diagnoses, including end-organ failure, are at risk of poor outcomes. The presence of complex chronic conditions can also be associated with death. Several scoring systems have been developed in order to predict patient mortality in an ICU setting. For instance, the Acute Physiologic Assessment and Chronic Health Evaluation II (APACHE II) score is calculated at the beginning of the ICU admission so as to determine patient's mortality risk on admission. The scoring is based on 12 physiologic variables, age, and underlying health, and is stated to be moderately accurate in predicting individual survival (16). Also, the need for life-sustaining equipment such as a mechanical ventilator

can further interfere with the outcome of the patient. Patients requiring prolonged mechanical ventilator can have poor outcomes, including poor quality of life, if they survive (17).

1.1.4.2 Availability of resources

Resource limited countries need to function with important limitations in physical manpower and monetary assets. Laboratory support, supply of consumables and medications, and maintenance of sophisticated equipment may also be limited (20,21). A retrospective analysis by *Sawe et al.* analyzed 4 tertiary referral hospitals in Tanzania and discovered that none of the ICUs had a point-of-care arterial blood gas (ABG) analyzer. In addition, none of the ICUs had an intensive care specialist or a nutritionist (22). In the United States, there are approximately 4 million ICU admissions per year, and annual critical care expenditures amount to $81.7 billion or 0.66% of the gross domestic product (5). Comparative data for LMIC are unavailable. For every 100 000 people in the country, Germany has 24.6 ICU beds, Canada 13.5 ICU beds, the United Kingdom 3.5 ICU beds, South Africa 8.9 ICU beds, Sri Lanka 1.6 ICU beds, and Uganda 0.1 ICU bed (23). These figures emphasize the scarcity of ICU beds availability in LMIC, and possibly missed opportunities of ICU admissions.

1.2 Problem statement

Paediatric critical care is an emerging field in medicine, however, developing countries face a vast number of challenges in implementing this care owing to the limited resources (24). Of recent a PICU has been established at MNH as a major investment to improve treatment outcomes in severely ill patients. It is the only centre in Dar-es-Salaam with a PICU, whereas other centers have combined ICU set ups for both adults and paediatrics. Considering that PICU is a new unit at the MNH, there is an existing knowledge gap regarding the common reasons for PICU admission, the outcome of patients, the causes of death and the factors associated with mortality in PICU.

Currently, there are no locally tailored treatment protocols at the PICU at MNH. Due to the existing knowledge gap, it is challenging for the medical team to develop these protocols for managing the patients admitted at the PICU, thus necessitating them to adopt medical practices from the recognized intensive care setups elsewhere. This may not always be relevant since the disease patterns and treatment guidelines of the critically ill patients can vary vastly between countries.

Moreover, owing to the limited resources available, not knowing the admission patterns and outcome of patients at PICU renders difficult for the hospital management to procure appropriate medical supplies that may be used for the management of patients.

1.3 Conceptual framework

The PICU admission pattern was defined by socio-demographic characteristics and the admission diagnosis of the patients. The immediate outcome following treatment at PICU was defined as whether or not the patient survived, thus giving the PICU mortality rate. Factors such as presence of multi-organ involvement, presence of chronic underlying condition, paediatric Glasgow coma scale (PGCS), need of mechanical ventilation (MV) and length of stay (LOS) at PICU can affect the mortality rate and were thus studied. The study finding will indicate the PICU mortality rate and causes of death, but also indirectly reflect on the quality of care provided at the PICU, and allow for better planning on the allocation of resources. [Figure 1]

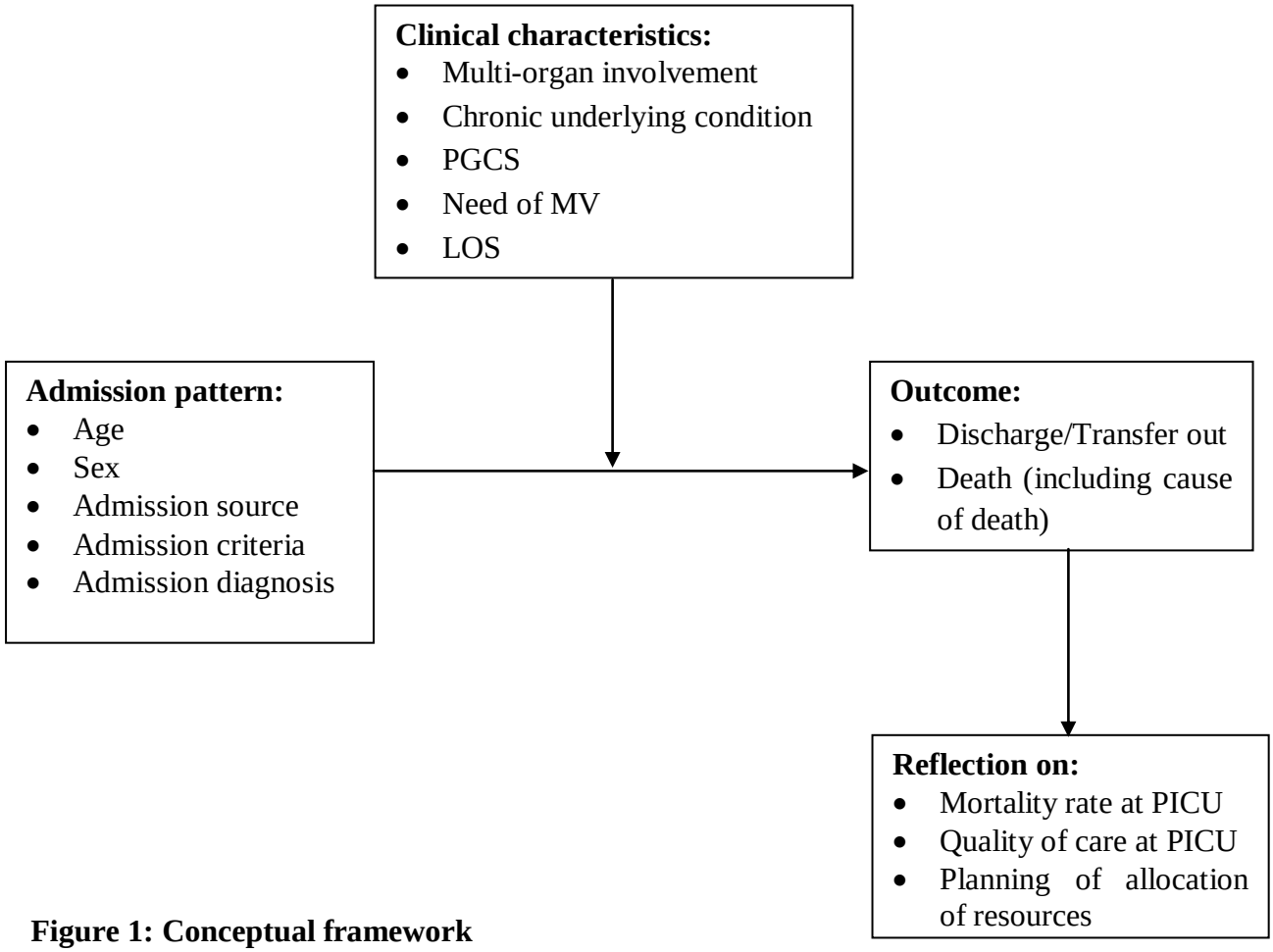


Figure 1: Conceptual framework

1.4 Rationale

The results from this study will provide baseline information on the common causes of PICU admissions at MNH, the mortality rate, causes of death and associated factors. This information will help the clinicians to target patient care towards the common disease conditions being seen at our setup and possibly use this information to design locally tailored treatment protocols for managing the patients admitted in the MNH – PICU, thus targeting to improve outcome.

The study will also provide necessary information to the hospital management for effective allocation of limited resources based on the epidemiology and disease characteristics experienced at the PICU.

1.5 Hypothesis

The mortality of patients admitted at PICU is high.

1.6 Research questions

1) What are the causes of admission to the PICU at MNH?
2) What is the mortality rate at the PICU at MNH?
3) What are the causes of death at the PICU at MNH?
4) What are the factors associated with mortality at the PICU at MNH?

1.7 Objectives

1.7.1 Broad objective

To determine the admission pattern, outcome, cause of death, and factors associated with mortality among patients admitted at the PICU at MNH.

1.7.2 Specific objectives

1) To determine the causes of PICU admissions at MNH.
2) To determine the mortality rate of patients admitted at the PICU at MNH.
3) To determine the causes of death at the PICU at MNH.
4) To determine the factors associated with mortality of patients at the PICU at MNH.

1.8 Literature review

1.8.1 PICU admission diagnoses

Admission diagnoses of patients in PICU in high income countries differ from those in low income countries. Both medical and surgical diagnoses can be cared for in a PICU. *Dünser et al.* (25) discovered that the most frequent paediatric admission diagnosis in a rural Ugandan hospital ICU was post-operative state (39.1%), compared to 13.8% with medical diagnoses. *Ibiebele et al.* (26) in a study done in New South Wales, Australia, stated respiratory disease as the common PICU admission diagnosis, whereas, in a study by *Siddiqui et al.* (7) in Karachi, Pakistan, sepsis was the common primary admitting diagnosis. A similar study by *Shah et al.* in Nepal stated respiratory illnesses, such as bronchiolitis and pneumonia, to be the common primary PICU diagnoses (12).

1.8.2 Mortality and Causes of mortality in PICU

Mortality rates in PICUs of low income countries are reported to be greater than in the high income countries (24). PICU mortality in Australia dropped from 15.2% (148/974) in 1982 to 5.1% (103/2004) in 2006, whereas the mortality rate was 12.9% (248/1919) in Pakistan 2007-2012, 7.14% (35/490) in Iran 2011-2012, 25% (242/987) in Mozambique 2013, and 8.5% (34/400) in Ethiopia in 2015 (6,7,14,27,28).

Conditions leading to PICU mortality can vary in different countries. *Thakkar et al.* in their study involving 26 countries from the high income countries extracted data from 128 PICU, in which, higher mortality risk was seen in post-surgical patients with sepsis compared to the non-surgical (medical) patients with sepsis (29). *Haftu et al.* studied 680 patients in a PICU in Ethiopia, of whom 85.2% were admitted due to medical problems, and with a mortality rate of 8.5%, the most common cause of death was stated to be infectious, mostly affecting the respiratory and central nervous systems (14).

Another retrospective study done in Bangladesh studied 119 children admitted at the PICU, and the results showed a 21% mortality rate in the PICU, with the case fatality being high in patients with septicemia, pneumonia and meningitis (30).

Sepsis is a common cause of mortality in Africa, with rates stated to be higher compared to the industrialized world (31). A self-reported survey of anaesthesia providers in Africa showed that drugs, equipment, and disposable materials required to implement the Surviving Sepsis Campaign guidelines were less frequently available in African countries, and the ability to comply with sepsis guidelines is minimal in most of Sub-Saharan Africa, despite the presence of an ICU (32).

1.8.3 Factors associated with PICU mortality

1.8.3.1 Need of mechanical ventilation in PICU

Mechanical ventilation (MV) is a common treatment provided in PICU, with rates varying from 14-60% (33,34). Even though it is undoubtedly life-saving, MV can lead to complications, especially if prolonged. *Bhori et al.* showed a 15.9% rate of patients requiring MV, with the common indication being respiratory failure (20.8%), and a mortality rate in the mechanically ventilated patients being as high as 38.9% (33). In the study by *Haftu et al.*, of the 3.5% of patients intubated, 35.7% died. According to the study, patients who needed MV had a 17.6 times increased risk of mortality than those who did not need MV (14).

Sahoo et al. performed a retrospective study in 1172 PICU admissions in Odisha, India, of whom 8.6% required MV, with common indications being respiratory failure and low Glasgow coma scale, and a mortality rate of 38.6% in mechanically ventilated patients (35). *Shah et al.* studied 230 paediatric patients admitted in a PICU in Nepal, of which 17.8% required mechanical ventilation. Out of these, 34.1% died, compared to 7.9% in the non-ventilated children (12).

1.8.3.2 Length of stay in PICU

The length of stay (LOS) in PICU reflects on the critical care efficiency and is also an important measure of effective utilization of resources. A retrospective review by *Nupen et al.* in South Africa showed that even though long-stay patients (LSPs – defined in the study as PICU admission >19 days) represented a small proportion of admission, it was associated with a higher mortality rate (29.6%, vs 12% in short-stay patients), and consumed disproportionately high PICU resources (36). *Haftu et al.* also reported LOS as an independent

risk factor of mortality whereby the risk of dying increased with a prolonged LOS (14). Another multi-institutional study by *Fiser et al.* studied 11,104 patients from 16 PICUs and found that children with mild cerebral deficits (assessed in the study by measuring the patients' Pediatric Overall Performance Category and Pediatric Cerebral Performance Category scales) had 18% longer ICU stay ($p < 0.01$), and also greater mortality risk ($p < 0.03$) (37).

1.8.3.3 Presence of chronic underlying conditions in PICU patients

The presence of chronic underlying conditions may further influence the survival of patients in PICU. *Haftu et al.* reported higher mortality in PICU patients with comorbid illness (14.8% vs 3.2% in those without comorbid illness) (14). In the study, 45.8% of the participants had comorbid illnesses. In contrast, a retrospective cohort study by *Verlaat et al.* that studied 492 high-risk PICU patients saw no association between complex chronic conditions and PICU mortality (38).

Studies have been done to assess the effect of individual chronic conditions on critical care outcome. *Kwizera et al.* performed a retrospective cohort study on the outcome of 101 patients with human immunodeficiency virus (HIV) admitted in an African ICU, in which, mortality was shown to be higher in the HIV population compared to the non-HIV population. Furthermore, a statistically significant association was seen in the HIV population requiring mechanical ventilation and mortality (39).

Bagri et al. retrospectively studied 332 critically ill children to assess the impact of their nutritional status on their outcome. According to the results, increasing odds of mortality, ventilation, duration of mechanical ventilation, and prolonged PICU stay was seen with increasing severity of malnutrition (40).

1.8.3.4 Paediatric Glasgow coma scale

The paediatric Glasgow coma scale (PGCS) is a common tool used to examine the patients' conscious level. GCS has been reported to be a useful tool for predicting outcome in ICU's. *Ramazani et al.* compared the SOFA (Sequential Organ Failure Assessment), GCS (Glasgow

Coma Scale), and FOUR (Full Outline of UnResponsiveness) scores to assess the prediction of ICU mortality in critically ill children, of which, GCS was found to be superior in predicting the outcome of the patients (41). *Verlaat et al.* derived from their study that a higher GCS at admission was associated with a lower mortality in PICU admissions (38). Similar findings were seen by *Haftu et al.* in which a strong association was observed between level of consciousness and mortality. According to the study, severe impairment of consciousness (GCS < 8) increased mortality by 7.8 times as compared to those with mild level of impaired consciousness (14). In contrast, *Khajeh et al.* reported the FOUR score to be more capable in predicting mortality and discharge of patients in PICU, compared to GCS (42).

2.0 METHODOLOGY

2.1 Study area

The study was conducted at the Paediatric Intensive Care Unit at Muhimbili National Hospital, Dar-es-Salaam, Tanzania. Muhimbili National Hospital is a national referral hospital, and a university teaching hospital. The paediatric ICU at MNH, which was established in March 2019, is the only established PICU in Dar-es-salaam. It accommodates 12 patients and has 11 mechanical ventilators.

The PICU at MNH provides critical care services to children aged 1 month up to 14 years. Both medical and surgical paediatric patients requiring critical care are admitted at the PICU. Patients admitted at MNH are either self-referrals or, for majority of the cases, referred from other hospitals including district hospitals and regional hospitals in Tanzania. Patients from paediatric wards (including both medical and surgical wards) who develop critical illness are also transferred to PICU for the necessary care. Once stabilized, patients are transferred out to paediatric wards.

The medical staff at the PICU at MNH include 5 paediatricians, 3 residents, 1 medical officer and 2 intern doctors. The staffing team during the day shift includes 3 paediatricians, 2 residents/medical officer, and 1 intern doctor. The night shift is handled by 1 paediatrician, 1 resident/medical officer, and 1 intern doctor. During all shifts, the nurse-to-patient ratio is 1:1. Upon admission, the patient is reviewed by the medical officer/resident, and by the paediatrician on duty.

2.2 Study design

A retrospective descriptive cross-sectional study was performed.

2.3 Study duration

The study was conducted from March to May 2020.

2.4 Study population

All patients aged between 1month and 14 years admitted in PICU at MNH were eligible for this study.

2.5 Sample size

The following formula was used to determine the sample size (43) :

$$n = \frac{Z^2 P (1-P)}{e^2}$$

Where;

n = Sample size

Z = Standard normal deviation, set at 95% (1.96)

P = mortality of mechanically ventilated children in PICU, studied by *Bhori et al*. in *A study of mechanical ventilation in children* (33) = 38.89%

e **=** Marginal error**,** set at 4.5%

$$\text{Sample size, } n = \frac{1.96^2 \times 38.89(100-38.89)}{4.5^2}$$

$$n = 450.9 = 451$$

After adjusting the sample size for missing information (z) of 7%, the minimum sample size (N) was

$$N = n / (1 - (z/100))$$

n = calculated sample size = 451

$$N = 451 / (1 – (7/100)) = 484$$

The study thus required a minimum of 484 patients.

2.6 Sampling technique

A simple random sampling technique was used for the study. The records book at PICU was used to identify admissions from March 2019 to February 2020. The file number of each second patient documented in the records book was extracted. Upon reaching the end of the list, the process was restarted from the beginning of the list of the unselected names. The process was continued until 484 patient file numbers were identified, after which these patient files were obtained from the medical records department.

2.7 Inclusion criteria

Records of patients between 1 month and 14 years of age admitted at the PICU at MNH from March 2019 to February 2020 were included in the study.

2.8 Exclusion criteria

Records of patients who died on arrival were excluded from the study.

2.9 Variables

2.9.1 Independent variables

The independent variables were: age, sex, admission source, admission diagnosis, number of organ systems affected, paediatric Glasgow coma scale (PGCS), need for mechanical ventilation, presence of chronic underlying conditions, and length of stay.

The age and sex of the patient were recorded from the patient file.

The admission source was identified depending on whether the patient was admitted from the Emergency Medical Department (EMD), transferred in from general paediatric wards, or transferred in from the operating theatre (OT).

The admission diagnosis was identified as the diagnosis of the patient made within 24 hours of admission after being reviewed by a medical officer or a resident, and a paediatrician. These diagnoses were categorized as medical vs surgical diagnoses, and as infectious vs non-infectious. The number of organ systems affected was also documented.

The patient's PGCS on admission as documented in the case notes was recorded.

Whether or not the patient required to be kept on a mechanical ventilator during the stay at PICU was noted, and the duration (number of days) of ventilation was recorded.

Any chronic underlying conditions, as stated in the patient's case notes was noted down.

The length of PICU stay was identified as the number of days the patient was in PICU – from the day of admission up to the day of death in PICU, or up to the day of being transferred out, or being discharged from PICU.

If death occurred, the cause of death as documented in the patient's file by the doctor who certified the patient's death, was recorded.

2.9.2 Dependent variable

Outcome – death vs discharge/transfer out.

2.10 Survey instrument, validity and reliability

Data was collected from:

- PICU registry books
- Patient case notes.

An electronic structured data extraction form with coded questions was used to extract information from patients' case notes. The electronic data extraction form was piloted to assess the clarity and to identify for any missing information and thereafter analyzed to ascertain the validity of results.

2.11 Data collection method

PICU registry books were used to identify patients admitted from March 2019 to February 2020. Patient file numbers were identified and files traced from the medical records section of the hospital. Data was extracted from patient case notes using the electronic data collection form, and entered into a Microsoft Excel Sheet.

2.12 Data analysis

Data entry was done after developing the template on IBM SPSS version 26. Data was categorized into groups, coded and entered into a computer. Data cleaning was done after entering data into the computer and frequency distribution tables were made to identify outliers or missing entries. Categorical data was summarized using percentages, and tests of significant difference or association between independent variables and dependent variables were assessed using Chi-square test or Fisher's exact test where appropriate**.** Associations with a *p*-value < 0.2 on univariate analysis were then included in multivariate analysis. On multivariate analysis, *p*-value < 0.05 was considered significant.

2.13 Ethical clearance and considerations

Ethical clearance to carry out this study was requested from the Research and Publications Committee of MUHAS (Ref. No. DA.287/298/01A/) (Appendix II), and permission to conduct the study was sought from the Director of Research, Training and Consultancy of MNH. Permission to access and collect data from patient case notes was also obtained from the medical records committee at MNH and patient consent was waivered. The study did not pose any risks to the study population. All data collected was treated with confidentiality and was not made accessible to unauthorized personnel.

3.0 RESULTS

A total of 653 patients were admitted at PICU from March 2019 to February 2020. Of these, 484 patients were randomly selected. Four patients were excluded as they died on arrival at PICU. Therefore, data of a total of 480 patients was analyzed for this study.

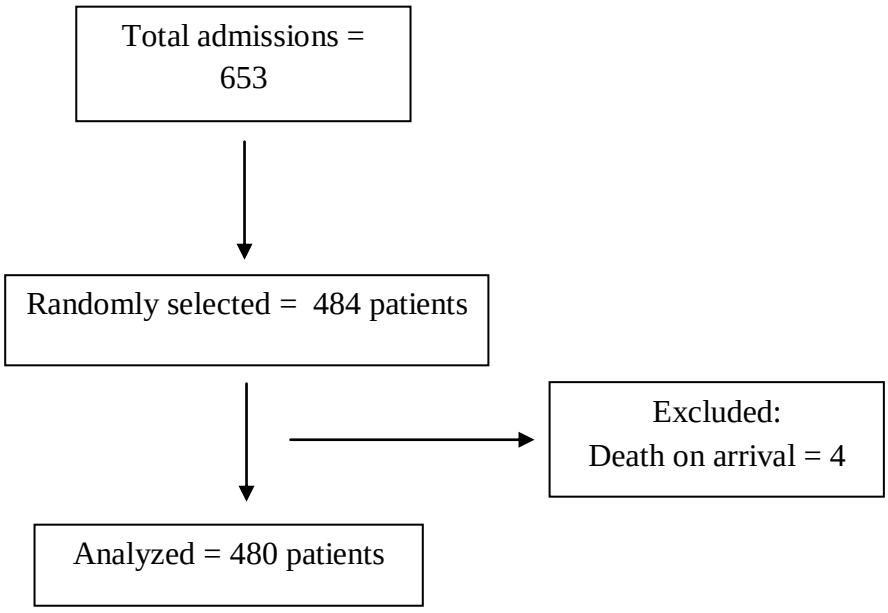


Figure 2: Flow chart on enrollment of study participants

3.1 Socio-demographic characteristics of study participants

Of the 480 study participants, 276 (57.5%) were male and 204 (42.5%) were female, giving a male: female (M:F) ratio of 1.4:1. The median age of patients on admission was 18 months (1 – 174 months). From the study participants, 374 (77.9%) were children under 5 years of age. Almost half (54%) of the patients were admitted from the Emergency Medical Department (EMD), and majority (82.1%) of the admissions had medical criteria. [Table 3]

Table 3: Socio-demographic characteristics of study participants

Variable	n (%)
Age (years)	
<1	158 (32.9)
1 - <5	216 (45.0)
5 - <10	64 (13.3)
10 – 14	42 (8.8)
Sex	
Male	276 (57.5)
Female	204 (42.5)
Admission source	
EMD	259 (54.0)
General ward	173 (36.0)
OT	47 (9.8)
Clinic	1 (0.2)
Admission criteria	
Medical	394 (82.1)
Surgical	86 (17.9)

Key: EMD - Emergency medical department; OT - Operating theatre.

3.2 Clinical characteristics of the study population

Majority (67.7%) of the admissions in PICU were due to infectious diseases. Of those admitted, 143 (29.8%) had a chronic underlying condition, of which, malignancy (23.8%), congenital anomalies (22.4%) and cerebral palsy (20.9%) were the commonly encountered conditions. On admission, 64.9% of the patients had a PGCS score of less than 13.

Two hundred fifty-four patients (52.9%) required mechanical ventilation (MV) during their stay at PICU, with a median duration of being on a mechanical ventilator of 3 days (0 – 34 days). The median length of stay at PICU was 3 days (0 – 60 days) with three-quarters of patients staying for less than a week. [Table 4]

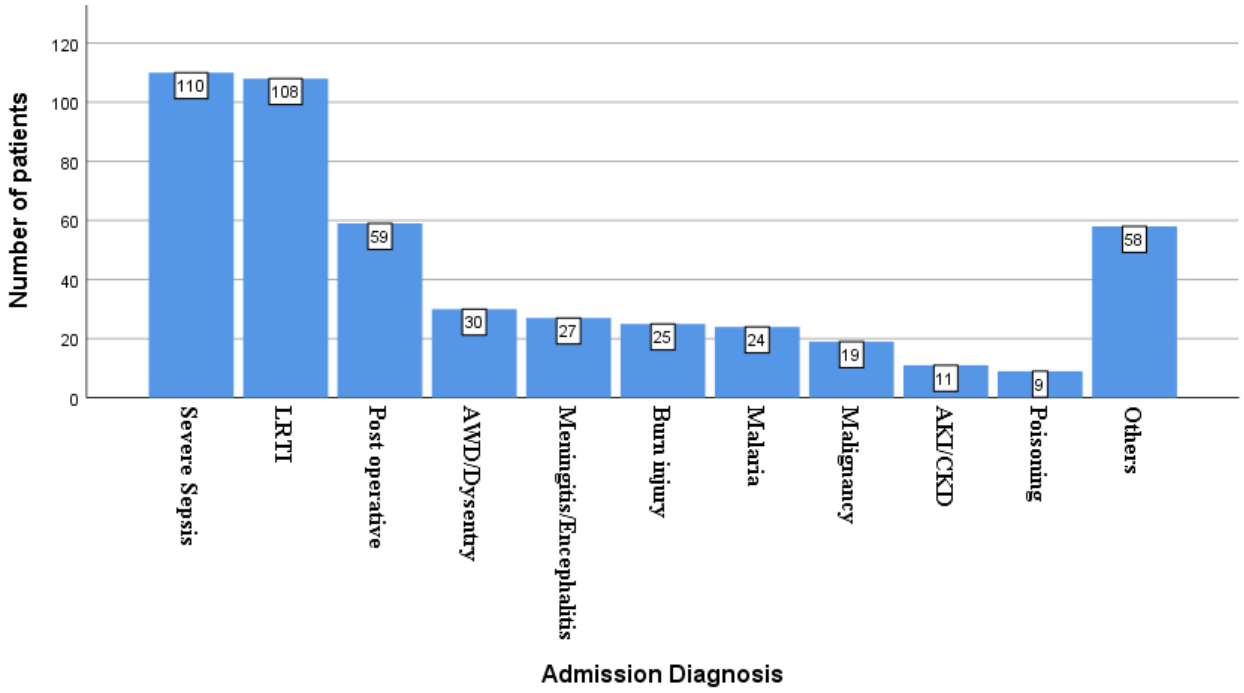
Table 4: Clinical characteristics of study participants

Variable	n (%)
Diagnoses	
Infectious	325 (67.7)
Non – infectious	155 (32.3)
Number of organ systems affected	
Multi-organ	185 (38.5)
Single organ	295 (61.5)
Presence of chronic underlying conditions	
Yes	143 (29.8)
No	337 (70.2)
Types of chronic underlying conditions	
Malignancy	34 (23.8)
Congenital anomalies	32 (22.4)
Cerebral palsy	30 (20.9)
Others	47 (32.9)
PGCS on admission	
Sedated/Intubated	102 (21.3)
3-8	126 (26.2)
9-12	83 (17.3)
13-15	169 (35.2)
Need of MV	
Yes	254 (52.9)
No	226 (47.1)
MV duration (days)	
< 1	27 (10.6)
1-7	179 (70.5)
8-14	36 (14.2)
>14	12 (4.7)
LOS at PICU (days)	
<1	30 (6.3)
1-7	355 (74.0)
8-14	65 (13.5)
>14	30 (6.2)

Key: PGCS-Paediatric Glasgow coma scale; MV - mechanical ventilation; LOS - length of stay; PICU - Paediatric intensive care unit.

3.3 Causes of admission at PICU

The common diagnoses that led to PICU admissions included severe sepsis (110/480), lower respiratory tract infections (LRTI) (108/480), post-operative conditions (59/480), acute watery diarrhea (AWD)/dysentery (30/480), and meningitis/encephalitis (27/480). Overall, majority (325/480) of the diagnoses were in the infectious category. Other diagnoses are displayed in Figure 3.



N.B. Others - URTI, Myasthenia gravis, Guillain-Barre syndrome, Stevens-Johnson syndrome, Systemic lupus erythematosus, Severe acute malnutrition, Sickle cell anemia, Aplastic anemia, Hemophilia, Congenital malformations, Status asthmatics, HUS, DKA, Rabies, Tetanus, Goodpasture syndrome, Epilepsy, PRES.

Key: LRTI - Lower respiratory tract infections; AWD - Acute watery diarrhea; AKI - Acute kidney injury; CKD - Chronic kidney disease; URTI - Upper respiratory tract infection; HUS - Hemolytic-uremic syndrome; DKA - Diabetic ketoacidosis; PRES - Posterior reversible encephalopathy syndrome.

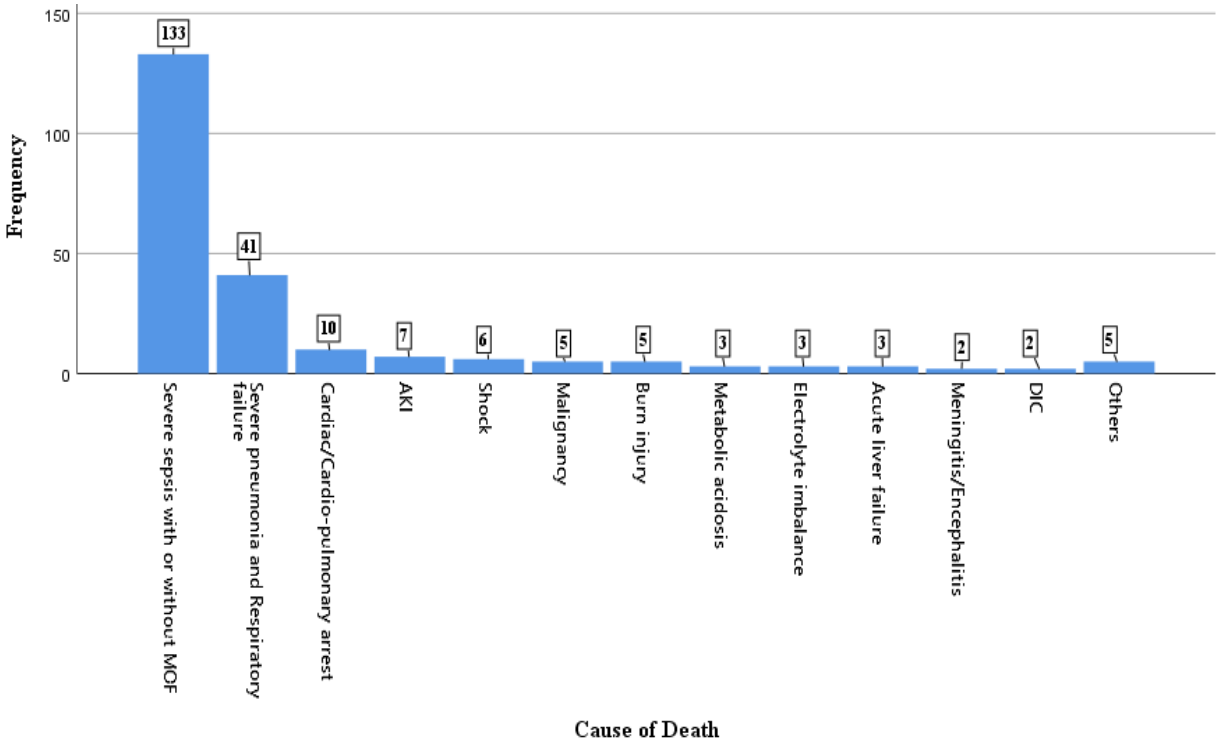
Figure 3: Common causes (diagnoses) of PICU admission

3.4 Mortality at PICU

Of the 480 patients, 225 succumbed to the illness, thus giving a mortality of 46.9%. Majority (84%) of deaths occurred in children <5 years of age. Of the 225 deaths, 30.7% had an admission diagnosis of severe sepsis, and 22.2% had an admission diagnosis of LRTI. One hundred eighty-five (82.2%) of the 225 patients required MV during stay at PICU.

3.5 Cause of death at PICU

The common cause of death reported was severe sepsis with or without multi organ failure (MOF) (59.1%), followed by severe pneumonia and respiratory failure (18.2%). Other causes of death are illustrated in Figure 4.



N.B. Others – Stroke, Brainstem death, Pulmonary tuberculosis.

Key: MOF - Multiple organ failure; AKI - Acute kidney injury; DIC - Disseminated intravascular coagulation

Figure 4: Causes of death

3.6 Factors associated with mortality at PICU

Upon performing univariate analysis [Table 5], the age of the patient, admission source and diagnosis, presence of chronic illness, number of systems affected, PGCS on admission, need of MV and LOS at PICU had a statistically significant association with mortality in PICU ($p < 0.05$). However, the sex of the patient and the criteria for admission were not associated with mortality ($p > 0.05$).

Table 5: Factors associated with PICU mortality (Univariate analysis)

Factor	PICU Mortality n (%)	COR (95% CI)*	p-value
Age (years)			
<1	86/158 (54.4)	4.4 (2.0-10.0)	< 0.001
1 - <5	104/216 (48.1)	3.4 (1.6-7.5)	0.002
5 - <10	26/64 (40.6)	2.5 (1.0-6.1)	0.043
10 – 14	9/42 (21.4)	Ref	Ref
Sex			
Male	133/276 (48.2)	1.1 (0.8-1.6)	0.502
Female	92/204 (45.1)	Ref	Ref
Admission Source			
EMD	122/260 (46.9)	3.7 (1.7-8.0)	0.001
General ward	94/173 (54.3)	5.0(2.3-11.0)	< 0.001
OT	9/47 (19.1)	Ref	Ref
Admission Criteria			
Medical	187/394 (47.5)	1.1 (0.7-1.8)	0.581
Surgical	38/86 (44.2)	Ref	Ref
Admission Diagnoses			
Infectious	165/325 (50.8)	1.6 (1.1-2.4)	0.014
Non-infectious	60/155 (38.7)	Ref	Ref
Number of organ systems affected			
Multi-organ	104/185(56.2)	1.8 (1.3-2.7)	0.001
Single organ	121/295 (41.0)	Ref	Ref

Presence of chronic illness			
Yes	57/143 (39.9)	0.7 (0.4-1.0)	0.045
No	168/337 (49.9)	Ref	Ref
PGCS on admission			
Sedated/Intubated	66/102 (64.7)	5.9 (3.4-10.1)	< 0.001
3-8	77/126 (61.1)	5.1 (3.1-8.4)	< 0.001
9-12	42/83 (50.6)	3.3 (1.9-5.8)	< 0.001
13-15	40/169 (23.7)	Ref	Ref
Need of MV			
Yes	185/254 (72.8)	12.5 (8.0-19.3)	< 0.001
No	40/226 (17.7)	Ref	Ref
LOS			
<1			
1-7	27/33 (81.8)	6.8 (2.1-21.3)	0.001
8-14	152/352 (43.2)	1.1 (0.5-2.4)	0.736
>14	34/65 (52.3)	1.6(0.7-4.0)	0.266
	12/30 (40.0)	Ref	Ref

*Crude Odds Ratio(95% Confidence interval)

Key: EMD - Emergency medical department; OT - Operating theatre; PGCS - Paediatric Glasgow coma scale; MV - mechanical ventilation; LOS - length of stay.

Multivariate analysis [Table 6] was performed on all factors associated with mortality with a p-value < 0.2 in univariate analysis [Table 5]. On performing the multivariate analysis, compared to children aged 10-14 years, children <1 year of age had a 6 times high risk of dying [AOR = 5.9 (2.1-16.4), CI=95%], whereas those aged 1-<5 years were 3 times more likely to die [AOR = 3.3(1.2-8.6), CI=95%] and children aged 5-<10 were 4 times more likely to die [AOR = 4.3 (1.4-13.2), CI=95%].

Patients who were admitted from the general wards were 7 times more likely to die than those admitted from OT [AOR = 6.8 (2.2-21.2), CI=95%] and those who required MV were 17 times more likely to die than those who didn't require MV [AOR = 17.0 (9.3-30.9), CI=95%]. Overall, the risk of dying in the PICU was decreasing with increased length of stay. [Table 6]

Table 6: Factors associated with PICU mortality (Multivariate analysis)

Factor	PICU Mortality n (%)	AOR (95% CI)*	p-value
Age (years)			
<1	86/158 (54.4)	5.9(2.1-16.4)	0.001
1 - <5	104/216 (48.1)	3.3(1.2-8.6)	0.017
5 - <10	26/64 (40.6)	4.3(1.4-13.2)	0.011
10 - 14	9/42 (21.4)	Ref	Ref
Admission Source			
EMD	122/260 (46.9)	2.6(0.8-8.0)	0.104
General ward	94/173 (54.3)	6.8(2.2-21.2)	0.001
OT	9/47 (19.1)	Ref	Ref
Admission Diagnoses			
Infectious	165/325 (50.8)	0.6(0.3-1.1)	0.106
Non-infectious	60/155 (38.7)	Ref	Ref
Number of organ systems affected			
Multi-organ	104/185(56.2)	1.6(0.9-2.7)	0.087
Single organ	121/295 (41.0)	Ref	Ref
Presence of chronic illness			
Yes	57/143 (39.9)	0.8(0.5-1.4)	0.412
No	168/337 (49.9)	Ref	Ref
PGCS on admission			
Sedated/Intubated	66/102 (64.7)	1.7(0.8-3.5)	0.153
3-8	77/126 (61.1)	1.9(1.0-3.9)	0.062
9-12	42/83 (50.6)	2.3(1.1-4.6)	0.025
13-15	40/169 (23.7)	Ref	Ref
Need of MV			
Yes	185/254 (72.8)	17.0(9.3-30.9)	<0.001
No	40/226 (17.7)	Ref	Ref
LOS			
<1	27/33 (81.8)	33.6(7.5-150.0)	<0.001
1-7	152/352 (43.2)	3.6(1.4-9.1)	0.007
8-14	34/65 (52.3)	1.8(0.6-5.0)	0.277
>14	12/30 (40.0)	Ref	Ref

*Adjusted Odds Ratio (95% Confidence interval); Key: EMD - Emergency medical department; OT - Operating theatre; PGCS - Paediatric Glasgow coma scale; MV - mechanical ventilation; LOS - length of stay.

4.0 DISCUSSION

Paediatric Critical Care is a relatively new concept in Tanzania. This study aimed at identifying the common causes of admission at the PICU, the mortality rate, the causes of death and its associated factors. The association between the outcome and factors such as age, sex, criteria of, source of, and diagnosis on admission, number of systems affected, presence of chronic underlying condition, PGCS on admission, need of MV and LOS were studied. Of these, age, source of admission, need of MV and LOS were significant factors associated with mortality.

The study population consisted of more males with a M:F of 1.4:1. This was similar to studies done in Ethiopia (14) and Nepal (12). The median age of patients on admission was 18 months (1 – 174 months) with 77.9% of children aged <5 years. This was lower compared to studies done in Greece (15) and Ethiopia (14) where the mean ages were 54 months and 62 months respectively. This could be attributed to the fact that children residing in developing countries have poor physical health and development, thus increasing their susceptibility to illnesses at an early age (44). Another explanation could be the wide age distribution of patients admitted in these ICU whereby in the study done in Ethiopia, the study population was aged 2 weeks – 18 years (14).

Majority of the PICU admissions were from the EMD (54%). This was similar to studies done in the USA (40) and Ethiopia (22). This finding was anticipated in this study as MNH is amongst the tertiary referral hospitals providing critical care, and the only centre with an established PICU in Tanzania. Therefore, all the referral cases are admitted via EMD, which is the triage centre. The medical criteria (82.1%) for admission predominated and this finding was similar to studies done in Greece (15), India (46) and Ethiopia (14); however, it was in contrast to another study done in Ethiopia (47) whereby surgical and trauma admissions predominated. This could be due to the fact that not all post-operative cases require PICU care, and also because trauma patients at MNH are admitted in a separate facility.

The findings from this study pointed out that 21.3% of the patients were already sedated/intubated during admission, and about 26% had a PGCS ranging between 3-8

indicating a critical state of illness. Such findings indicate that there may be a delay in recognition, late presentation and high illness severity among patients who are admitted in PICU.

4.1 Causes of PICU admission

The most frequent causes of PICU admissions were severe sepsis, LRTI, post-operative condition, AWD/dysentery and meningitis/encephalitis. Majority (67.7%) of these diagnoses were categorized as infectious. This was also evident in previous studies done in Tanzania (22) and Ethiopia (14). However, it was in contrast to a report from Greece (15) where trauma, coma and accidents were amongst the common causes. The finding that infections were the most common cause of admission indicate that in our setting this group of diseases are most prevalent as it is elsewhere in developing counties owing to multiple factors such as poverty, malnutrition, and prevailing multi-drug resistance.

4.2 PICU mortality

The mortality rate in this study was 46.9%, this was higher compared to studies done at the PICU in India (28%), Ethiopia (8.5%), Brazil (10.8%), Greece (9.7%), and Hong Kong (1.69%) (13–15,48,49). The high mortality seen in this study could be explained by several factors such as, being the only level I PICU in the country, the admissions of critically ill paediatric patients who have higher chances of succumbing to their illness increased, thus also increasing the mortality figure. Another factor could be the differences in the admission criteria. Amongst other admissions, the PICU at MNH also accommodates patients with critical burn injuries, whereby other hospital setups such as in Ethiopia (14) have an isolated burn unit for such patients. This could have been a contributing factor to the mortality seen in this study. In addition, limited resources (human and equipment) may also be a contributing factor as it has been clearly demonstrated in literature that availability of essential resources leads to a better outcome of patients in PICU (13,15).

4.3 Causes of death

The common causes of death were severe sepsis with or without multi organ failure, followed by severe pneumonia and respiratory failure. This was in line with a previous study done in Tanzania by *Sawe et al.* (22) whereby, non-Tb pneumonia and septicemia were among the top 5 conditions with highest ICU mortality in children <5 years. In contrast, a study done in Greece stated brain death as the main cause of mortality (62%), which could be explained by the fact that trauma patients accounted for a high percentage of its PICU admissions (15). Severe sepsis was the main cause of death in this study and this could be explained by the burden of anti-microbial resistance in Tanzania which is known to be high (50).

4.3 Factors associated with PICU mortality

4.3.1 Age

Patients under 5 years of age were noted to have significantly higher mortality (84.4%). This was in contrast to the study done by *Haftu et al.* in Ethiopia. Majority (74.1%) of children <5 years were admitted with an infectious diagnosis. This was similar to other studies in developing countries (14,22). Infections, especially those that lead to sepsis, are a major cause of paediatric morbidity and mortality globally, however, they are more prevalent in the low- and middle- income countries (51). Though progress is being made to reduce the global under-5 mortality, Sub-Saharan Africa continues to remain a region with higher under-5 mortality (52) because the children in these regions are exposed to multiple risks including poverty, poor health, undernutrition and unstimulating home environments**.** A socioeconomic instability deprives one from access to daily nutritional requirements thus leading to undernutrition and a compromised immune system.

4.3.2 Admission source

On multivariate analysis there was a difference in mortality of patients between those admitted from the general wards and those admitted from OT, whereby patients who were admitted from general wards were 7 times more likely to die than those admitted from OT. This could be explained by the fact that with an exception of emergency cases, elective surgical procedures are carried out in fairly stable patients. These patients are subsequently admitted at

PICU for post operative care thereafter transferred out within 1-2 days. In contrast to this, patients transferred from general wards are usually in deteriorating conditions, hence at risk of dying.

4.3.3 Need of MV

Mortality was significantly associated with the use of mechanical ventilation and this was also seen in other studies (12,14,15). Illness severity can worsen the outcome of mechanically ventilated patients due to the already compromised physiologic mechanics. In this study, 31.9% of the patients requiring a mechanical ventilator had an admission diagnosis of severe sepsis. Sepsis can cause organ dysfunction, which can progress to septic shock, which is a severe stage of sepsis involving circulatory dysfunction, abnormal cell metabolism, cellular hypoxia, and mitochondrial dysfunction. Such physiological state could be a contributing factor that leads to an increase in mortality in mechanically ventilated patients (53).

4.3.4 Length of PICU stay

A short PICU stay (<7 days) was significantly associated with mortality. This was however in contrast to what was seen in studies from USA (37) and Ethiopia (14) whereby a longer LOS was associated with mortality. The finding in this study could be explained by illness severity during hospital presentation and deferred health-seeking behavior. This explanation is augmented by the clinical characteristics of the study population during admission whereby 47.6% of the patients were either intubated/sedated or had an altered mental status (PGCS score of less than 9) during admission. Also, delayed referral practices could be a compounding factor which can be supported by the fact that majority of the PICU admissions were from the EMD.

4.4 Strength of the study

This is the first-ever study to be carried out in Tanzania to assess the pattern and outcome of patients admitted at PICU. It captured data of all patients admitted at PICU at MNH for a period of 1 year thus giving a larger and a representative sample. Moreover, being a cross-sectional study design, multiple variables associated with mortality in PICU were analyzed as

such, the results of this study cast light on the quality of care being provided at PICU. In addition to that, the information obtained from this study is very relevant to all medical specialties that are involved in taking care of critically ill paediatric patients. Being a first study of the kind in Tanzania, it will aid the relevant authorities and health institutions in making appropriate evidence-based training programs for the general practitioners as far as PICU is concerned, and in doing so there will be improvements in the management of paediatric patients in the country.

4.5 Limitations of the study

The study did not assess the long term outcome of the patients which could otherwise reinforce the results of the study, or provide new information. Furthermore, the study was limited to only one of the national referral centers in the country and therefore the results derived may not be generalized to a wider population group. Poor documentation was another setback in the study as the admission diagnoses and cause of death may have been miscalculated with overuse of the term “Sepsis”. Furthermore, the immediate causes and the underlying causes of deaths were not well-differentiated.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The common causes for PICU admissions at MNH were severe sepsis, LRTI, post-operative condition, AWD/dysentery and meningitis/encephalitis. The mortality rate in this study was 46.9%, with the most common cause of death being severe sepsis with or without multi-organ failure. The factors that were significantly associated with mortality in PICU included the age of the patient, admission source, need of mechanical ventilator and length of stay. Children under-five years of age accounted for majority of admissions and were also at a higher risk of dying. Those who were admitted from the general wards were at high risk of dying. Likewise, risk of dying was more in children who required mechanical ventilation, and those with a shorter length of stay (<7 days).

5.2 Recommendations

The following are the recommendations based on the study findings:

i. Build strategies to strengthen the management of sepsis in hospital settings, as it was identified to be the common cause of admission and of death in this study.
ii. The under-five mortality in this study was high, therefore IMCI strategies need to be improved to strengthen the provision of health care to this vulnerable group.
iii. According to the study findings, children admitted from the general wards were at a higher risk of dying, therefore close monitoring of clinical condition and early identification of critically ill patients in the general ward with immediate transfer to PICU is required.
iv. A multi-centered study to assess the applicability of the study findings in a wider population group.
v. Further studies are recommended to assess the quality of care provided at the PICU.

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APPENDICES

Appendix I: Data collection form

Pattern and outcome of patients admitted at the PICU, MNH

Study ID number:_____

1. Date of birth:_____

2. Age (years/months):_____

3. Sex:

    1) Male

    2) Female

4. Date of admission:_____

5. Admission source:

    1) From EMD
    2) From general wards
    3) From operating theatre (recovery room)
    4) Others, specify:_____

6. Admission criteria:

    1) Medical
    2) Surgical
    3) Others, specify:_____

7. If surgical, reason for admission:

    1) Post op care
    2) Post-op complications
    3) Burn
    4) Others, specify:_____

8. If medical, number of systems affected:

    1) One 2) Two 3) Three 4) More than three

    Select which system is/are affected:

1) Respiratory system
2) Circulatory system
3) Digestive and Excretory system
4) Renal system
5) Nervous system
6) Endocrine system
7) Integumentory/Exocrine system
8) Muscular and skeletal system
9) Immune and lymphatic system
10) Reproductive system
11) Others _____

9. State admission diagnosis/diagnoses: _____

10. Presence of chronic underlying conditions:

1) Yes
2) No
3) Not documented

If yes, select:

1) Severe Acute Malnutrition
2) Cerebral palsy
3) SCA
4) Aplastic anemia
5) Leukemia
6) Lymphoma
7) HIV/AIDS
8) Congenital heart disease
9) Epilepsy
10) Others: _____

11. Level of consciousness on admission:

1) PGCS score 3 -8
2) PGCS score 9 - 12
3) PGCS score 13 – 15
4) Sedated
5) Not documented

12. Need of mechanical ventilation at any point in time during stay at PICU:

1) Yes
2) No

13. Duration of use of mechanical ventilation (in days):

1) < 1
2) 1 – 7
3) 8 – 14
4) >14

14. Length of PICU stay (in days):

1) < 1
2) 1 – 7
3) 8 – 14
4) >14

15. Outcome:

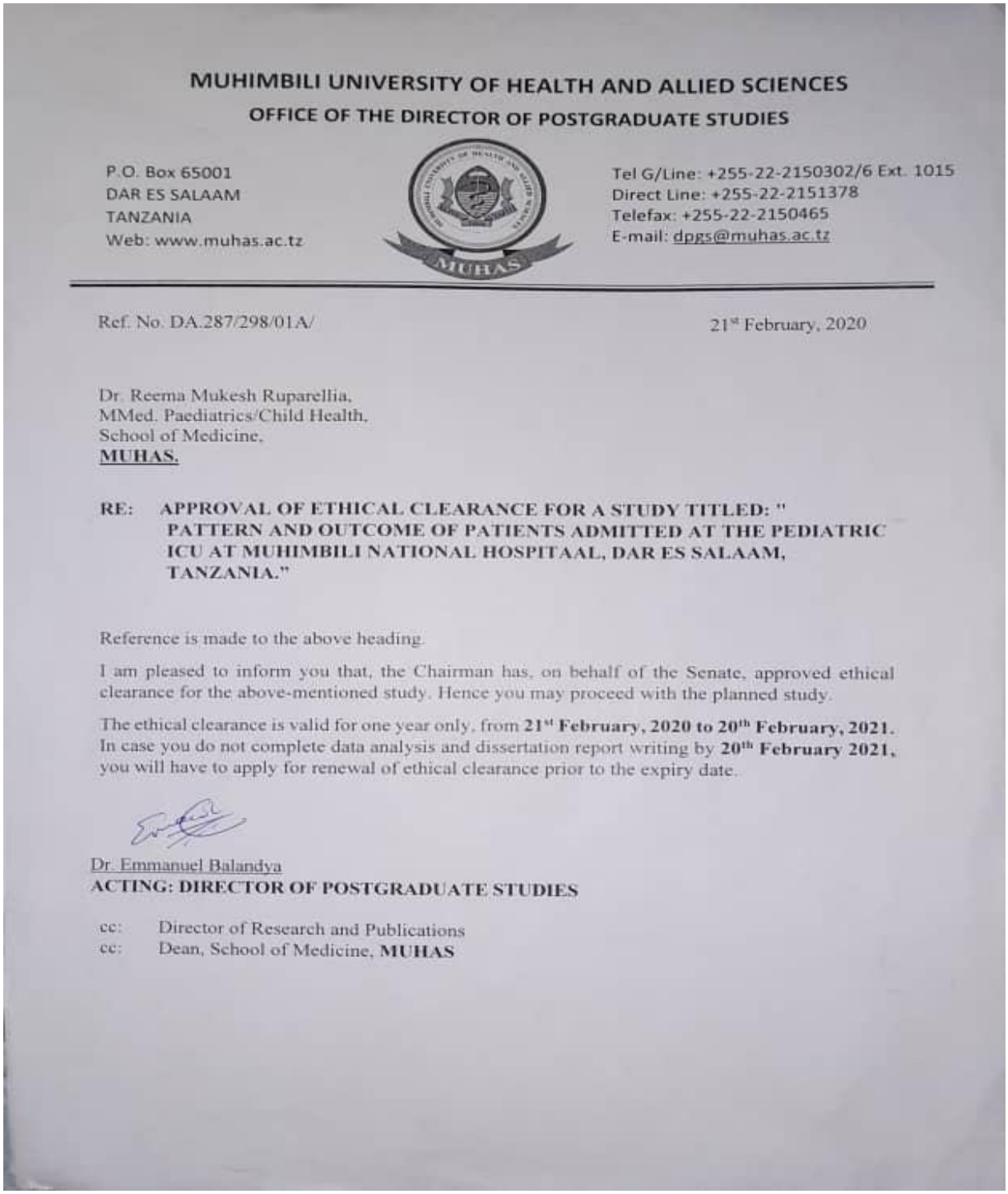
1) Death
2) Transferred out to the ward
3) Discharged home
4) Discharged against medical advice

16. If death, state:

Immediate cause of death: _____

Underlying cause of death: _____

Appendix II: Ethical clearance



MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

OFFICE OF THE DIRECTOR OF POSTGRADUATE STUDIES

P.O. Box 65001
DAR ES SALAAM
TANZANIA
Web: www.muhas.ac.tz

Tel G/Line: +255-22-2150302/6 Ext. 1015
Direct Line: +255-22-2151378
Telefax: +255-22-2150465
E-mail: dpgs@muhas.ac.tz

Ref. No. DA.287/298/01A/

21st February, 2020

Dr. Reema Mukesh Ruparellia,
MMed. Paediatrics/Child Health,
School of Medicine,
MUHAS.

RE: APPROVAL OF ETHICAL CLEARANCE FOR A STUDY TITLED: " PATTERN AND OUTCOME OF PATIENTS ADMITTED AT THE PEDIATRIC ICU AT MUHIMBILI NATIONAL HOSPITAAL, DAR ES SALAAM, TANZANIA."

Reference is made to the above heading.

I am pleased to inform you that, the Chairman has, on behalf of the Senate, approved ethical clearance for the above-mentioned study. Hence you may proceed with the planned study.

The ethical clearance is valid for one year only, from **21st February, 2020 to 20th February, 2021.** In case you do not complete data analysis and dissertation report writing by **20th February 2021,** you will have to apply for renewal of ethical clearance prior to the expiry date.

Dr. Emmanuel Balandya
ACTING: DIRECTOR OF POSTGRADUATE STUDIES

cc: Director of Research and Publications
cc: Dean, School of Medicine, **MUHAS**