A REVIEW OF PEDIATRIC ADMISSIONS AND OUTCOMES AT THE INTENSIVE CARE UNIT, KENYATTA NATIONAL HOSPITAL.

DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF MEDICINE IN ANAESTHESIA OF THE UNIVERSITY OF NAIROBI.

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DECLARATION:

This dissertation is my original work and has not, to my knowledge been presented for a degree in any other university.

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INDEX:

APACHE	Acute Physiology and Chronic Health Evaluation
ARDS	Acute respiratory distress syndrome
ASA	American Society of Anaesthiologists
ICU	Intensive Care Unit
KNH	Kenyatta National Hospital
NBU	New born unit
OPD	Out patient department.
PICU	Pediatric Intensive Care
PIM	Pediatric Index of Mortality
PRISM	Pediatric risk index of mortality
PSI	Physiologic stability index

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SUMMARY

This was a prospective cross sectional study targeting all pediatric cases admitted to the Kenyatta National Hospital (KNH) Intensive Care Unit (ICU) within the study period.

The study aimed at examining/determining correlates and predictors of outcome. The outcomes were found to be either mortality or discharge to the pediatric or surgical wards. These were then correlated to age, sex, duration of stay in the ICU and organ/system involvement.

During the period of study, 100 patients were admitted and followed up. 74% of these were surgical patients. Mortality rate for pediatric patients admitted into the ICU was found to be 38% with the highest mortality rate seen in neonates at 66%.

Respiratory system was not only the most commonly affected system, but also showed the worst outcome. Patients with single organ/system involvement had a mortality rate of only 20% whereas those with 3-organ system involvement had a mortality rate of 100%.

INTRODUCTION

Intensive care units exist mainly in the private hospitals within the country. Kenyatta National Hospital (KNH) is the only public hospital with a relatively well-equipped and functional intensive care unit. The KNH ICU is a multidisciplinary unit catering for adult and pediatric population and medical and surgical cases. It has a bed capacity of 20 serving a hospital with a bed capacity of 2000. Other public hospitals with ICUs include Moi Referral Hospital in Eldoret and Coast General Hospital in Mombasa. Provincial General Hospitals e.g. Nyeri and Rift Valley have Acute Wards that cater for the critically ill patients. Although acute wards have not developed into intensive care units, there is still great demand for such a facility in each of these hospitals. There is need for specialized facilities, financial support and staff trained in intensive care.

The ICU provides a wide Spectrum of Critical Care to medical and post-surgical patients. These include patients with multi organ system failure, trauma care, peri operative care, pediatric care, neurosurgical care and acute medical emergencies[1]. At the KNH, these patients are received from the medical, surgical and pediatric wards, the Accident and Emergency departments, operating room, transfers or referrals from other hospitals within the country, as well as the East and Central African regions.

The number of critically ill patients all over the world is growing both by absolute numbers and also in proportion to the general population[2]. Hospitals will always need a Critical Care Centre, an Intensive Care Unit (ICU) for the care of this class of patients: the main role of such units being to reduce morbidity and mortality and long term disability[1].

The intensive care units in public and private hospitals in Kenya are multidisciplinary units. These are units that care for critically ill patients in all age groups and are non-specific to the organ/system affected. Gertrude Children Hospital, a private hospital in Nairobi, is the only hospital with a pediatric Intensive Care Unit (PICU). In the developed world, the ICUs are more specific to the age and organ systems e.g. Pediatric ICUs (PICU), Cardiac Support Units and Respiratory Support Units.

Admission into PICUs include children who were previously well but develop life threatening illnesses requiring ventilatory and/or cardiovascular support, those requiring

support after complex surgical interventions and those with either congenital or acquired chronic conditions with superimposed acute illness.

LITERATURE REVIEW:

HISTORY AND DEVELOPMENT OF PEDIATRIC INTENSIVE CARE

Intensive care units date back to the early 1950s when there was great need for treatment of acute and chronic debilitating respiratory complications of Poliomyelitis as initially recognized in the Scandinavian Countries[3]. The initial attention was focused on mechanical ventilation of lungs, as in the (crude) iron lungs of Polio era.

Between 1950s and 1960s, the 'iron lungs' ventilators were replaced by more modern methods of ventilation with the ability to give pediatric patients prolonged mechanical ventilation for diseases such as respiratory failure in neonates with respiratory distress syndrome and the use of positive end – expiratory pressure (PEEP) in the treatment of ARDS[4]. Attention also focused on other systems especially the cardiovascular system, monitoring of arterial blood gases, reliable blood pressure measurements and cardiac surgery. The development of cardiopulmonary by-pass played a major role in the development of pediatric intensive care[3].

Critical neurosurgical care also followed to take care of increased Intracranial Pressure, decreased Cerebral perfusion and decreased cerebral blood flow associated with head injury and diseases such as meningitis, encephalopathy, Reyes Syndrome and Anoxic Encephalopathy[2]

There was also the development of speciality of neonatology along side all these. Its effect in pediatric care was a profound change in patient care for all critically ill newborns. It contributed a great deal to the formation of Pediatric Intensive Care with the first multidisciplinary Pediatric ICUs being developed in 1955[5], mainly due to the pediatric needs for trauma care, Post operative Care and Post resuscitative cardio respiratory Care. Among the stimuli for establishment of PICU were; the technique of prolonged nasotracheal intubation, new developments in pediatric anesthesia, medicine and surgery, technological and therapeutic advances in neonatal and adult intensive care medicine and improved knowledge and understanding of physiology and mechanisms of severe illness in children[5, 6].

In the last 15 years, ventilators that can deliver continuous (CNEP) and intermittent (INEP) negative expiratory pressure have been developed for use in infants. These provide more physiologically normal respiratory support[5,7]

In addition, there was need for trained personnel to deal with the pediatric emergencies that necessitate ICU admission.[6] Organized team approach to these conditions was adopted and has lead to on-site, continuous high quality care.

There was also the formation of organized medical care teams that eventually developed programs specifically directed at Pediatric Intensive Care[2]. By end of 1970s, Pediatric Intensivists and neonatologists emerged in the developed world. All these developments have been keystone to the high standards of pediatric care seen today. Most hospitals in developed world have adopted as standard care a pediatric intensive care unit (PICU).

COMMON CONDITONS REQUIRING PICU ADMISSION

Pediatric patients who may require PICU admission can be grouped into either of the following categories:

a) Major organ/ system failure. This category includes patients with;
   - Respiratory impairment or failure
   - Acute (and acute on chronic) renal failure
   - Cardiovascular compromise
   - Acute neurological deterioration

b) Post surgical patients

c) Sepsis

d) Trauma

Overview of the medico-surgical cases requiring PICU admission

1) Injuries

Injuries/ accidents are a common cause of childhood morbidity and mortality. The age group most affected is 1 – 4 years. In some developed countries, up to 40% of deaths in children in this age bracket have been attributed to injuries[3, 8].

In urban Kenya, it has been shown that the age group 0 – 14 years is most affected by accidents with an upward trend in incidence of domestic accidents. In a study on childhood accidents in an urban community in Kenya, burns have contributed to 37 % of total childhood morbidity in the city of Nairobi. Other common causes of injuries include road traffic accidents and fall from heights like buildings and trees[9]. Other pediatric trauma or injuries admitted to the ICU include those following near drowning situations, choking and suicide attempts.

Pediatric trauma presents in several unique ways;

a) There is increased frequency of multisystem involvement
b) There may be significant underlying damage to organs even without overt features. For instance in cases of fractures due to the resilience of the pediatric skeleton.
c) Heat is lost more rapidly and this may complicate management of hypotension as hypothermia causes resistance to fluid resuscitation.
d) Children tend to compensate well to hypovolemia. Hypovolemic shock therefore occurs late and is a poor prognostic sign[10].

Management of injuries in ICU is determined by the system(s) affected and the severity of the injuries. Respiratory, cardiovascular and central nervous systems take priority[10]. Airway management is frequently sited as the key to successful pediatric resuscitation and this is combined with early spinal immobilization for those with suspected spinal injuries.

Breathing and ventilation is also affected by airway obstruction, tension and open pneumothorax, flail chest, cardiac tamponade and massive hemothorax. Early recognition and management of these life threatening chest injuries improves outcome[10, 11].

2. Respiratory distress and failure

Respiratory failure is the inability of the respiratory system to provide exchange of oxygen (O2) and carbon dioxide (CO2) between air and blood leading to impaired supply of O2 (type I respiratory failure) and excretion of CO2 (type II respiratory failure) to meet the body's metabolic need or demands[12].

Respiratory failure is most common cause of emergency PICU admission[2]. It is the primary diagnosis in about 50% of PICU admissions[8]. The causes of respiratory failure in children include;

- Upper airway obstruction due to epiglottitis, foreign body, croup, subglottic stenosis or laryngomalacia.
- Lower airway obstruction and interstitial lung disease usually due to broncholitis, infective pneumonia/ pneumonitis, asthma and ARDS from any cause.
- Pleural and chest wall abnormalities caused by trauma, emphysema or congenital kyphoscoliosis
- Neuromuscular diseases like spinal muscular atrophy and Gullian Barrie Syndrome (GBS) as well as spinal injury.
- Central hypoventilatory syndrome such as Ondine's curse[13].

Patients presenting in PICU with respiratory failure may have other underlying conditions like immunosupression, cardiopulmonary disease or pulmonary hypertension Respiratory failure presents in the form of tachypnoea, dyspnoea, apnea and Cheyne-Stokes respiration depending on the cause[8]. It may also present in the form of respiratory arrest.

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Gas exchange is determined by lung surfaces, ventilation and perfusion of pulmonary vasculature. Optimum gas exchange occurs if they are distributed in the same optimal proportions to each other through out the lungs, that is, the V/Q ratio. Respiratory diseases may lead to V/Q mismatch. Compensatory mechanisms by the lungs for V/Q mismatch may not be adequate, leading to ventilated but not perfused alveoli. The latter leads to an intra pulmonary shunt leading to increase in PaCO2, which is suffered rapidly, and significant drop in PaO2, hence severe hypoxemia. Conditions leading to this include ARDS, pneumonia, hemorrhage and pulmonary edema[14, 15].

Severity of respiratory failure in pediatric intensive care can be quantified by use of physiological indices of oxygenation such as arteriolar/alveolar ratio (paO2/PAO2), alveolar – arterial oxygen tension difference, PaO2/FiO2 ratio and oxygen index. PaO2/FiO2 ratio and oxygen index relates PaO2 to both oxygen requirement and mean airway pressure[14, 16].

The management of respiratory failure in PICU includes ventilatory support, physiotherapy, proper nutrition, infection control and meticulous attention to fluid balance[2, 17].

3. Sepsis and multiple organ dysfunction syndrome (MODS)

Sepsis syndrome also called the systemic inflammatory response syndrome (SIRS) involves the clinical diagnosis of sepsis with altered organ perfusion, hypoxia, oliguria or elevated blood lactate levels[12].

In pediatric age group, criteria for defining sepsis have been adapted. In sepsis / SIRS, there is clinical evidence of infection presenting as hyperthermia (temperature >38degrees Celsius) or hypothermia (temperature <35 degrees Celsius), tachycardia, tachypnoea and an elevated or decreased white blood cell count. Early septic shock is sepsis syndrome with hypotension or poor capillary refill and responds well to intravenous fluids and/or drugs. Mortality rate of patients with septic shock is 40 – 70%[4,12].

Common causes of severe sepsis in children include Neisseria meningitidis, Haemophilus influenzae type B and Streptococcus pneumoniae[4, 12].

SIRS precipitates multiple organ failure by systemic release of mediators of inflammation. There is organ damage through impairment of tissue perfusion, microcirculatory abnormalities and defective oxygen utilization. The associated sepsis and fever are due to inflammatory response to systemic endotoxins and bacteria from gut lumen. Lungs are affected most times, with patient presenting with Acute Respiratory Distress Syndrome (ARDS) and respiratory failure. Other organs/systems affected include cardiovascular instability, shock, Disseminated Intravascular Disease (DIC), meningitis, acute tubular necrosis in the kidneys with consequent renal failure, and hepatic dysfunction[18]. In multiple organ –system failure, mortality rate approaches 90 – 100%[1, 19]. These pediatric patients would be admitted into PICU for close monitoring, inotropic support, mechanical ventilation and oxygenation and other supportive care.

4. Diarrhoea / Gastroenteritis

Diarrhoeal diseases are some of the leading causes of mortality in children worldwide, causing one billion episodes of illness, and 3 – 5 million deaths annually[8]. These diseases are more common in the developing countries where poverty, poor weaning habits and malnutrition are the major predisposing factors.

Acute gastroenteritis has been described as a clinical syndrome of diarrhoea and/or vomiting of acute onset, often accompanied by fever and constitutional disturbance and of infectious origin. Pathogens associated are mainly viruses such as echoviruses, adenoviruses and enteroviruses. Bacterial pathogens may also be encountered[20, 21]

Diarrhoeal diseases are mostly self-limiting. With supportive care, most children recover without any complications. However, they may lead to fluid and electrolyte loss which if not checked may result in shock and severe electrolyte imbalance, metabolic acidosis and eventually coma and death.

Replacement fluids commonly used are crystalloids like sodium chloride (NaCl), 5% dextrose, ringers lactate and plasmalyte depending on the fluid and electrolyte state of the patient. Colloids such as 5% albumin, 25% albumin, dextran and hydroxy ethyl starch may be used when there is superimposed 3rd space or intracellular fluid losses as they remain in the intravascular system[17]. Fluid therapy in PICU aims at restoring and preserving the microcirculation or tissue perfusion by restoring the extracellular fluid volume.

PICU care is recommended for close monitoring of patients and for fluid and electrolyte resuscitation in order to prevent and when necessary to manage any resultant cardiopulmonary or renal failure. Meticulous and timely intervention to restore fluid and electrolyte levels is the key to better outcome[22].

5. Guillain Barre Syndrome 'GBS'

GBS is also known as 'Acute post-infective neuritis' or 'acute inflammatory polyradiculoneuropathy'. It is of unknown aetiology though it has been associated with respiratory or gastro-intestinal infections that occur about 2 weeks before neurological symptomatology. A cell – mediated immunological response of peripheral nerves has been shown to be responsible for the clinical presentation[23, 24].

GBS affects both adults and pediatric age groups. There is progressive symmetrical muscle weakness over a few hours to several days. Distal and proximal muscle groups are involved, usually beginning in the lower extremities and then ascending. Total motor paralysis, bulbar involvement with inability to swallow or control airway, disturbances of autonomic function with fluctuating hypertension and hypotension and respiratory involvement are indications for PICU care[25]. Management of GBS is symptomatic and thus the main indication for admission is in anticipation that ventilatory support will be required to ensure adequate alveolar ventilation and oxygenation and to avoid atelectasis and pneumonia.

In a PICU environment, majority of patients recover spontaneously and fully but for a mortality of 2%[24].

6. Post Operative ICU care

The surgical patient in the PICU usually has an acute or chronic debilitating disease with a superimposed physical insult. The insult is followed by a stress response responsible for numerous postoperative endocrine and electrolyte problems[26, 27].

Postoperative pain management is of utmost importance in patients undergoing major surgery especially when the surgery involves the central nervous system, the chest, abdomen or cardiovascular system. Adequate pain relief may require high doses of opioid analgesics that may interfere with respiration/ breathing of the patients[23].

Electrolyte imbalances are common in the postoperative critically ill patient. There is significant movement of fluid and essential ions in different body compartments in the immediate postoperative period. Electrolyte imbalances may be compounded by renal failure, cirrhosis of liver, use of drugs like diuretics and GIT malfunction[27]. Electrolyte abnormalities involving sodium and potassium pose immediate danger to vital organs like heart and brain[26]. The syndrome of inappropriate ADH secretion is common in head injury and neurosurgical patients leading to fluid retention and hyponatremia. On the other hand, closed head injury and craniotomy for excision of craniopharyngioma are the commonest causes of diabetes insipidus (DI) where there is free water loss resulting in hypernatremia[26, 28].

Patients undergoing complex surgical procedures require intensive care at least in the first 24 hours. One of the main reasons being for close observation and monitoring of patients. Open-heart surgery has seen tremendous growth in KNH since 1975 when the first open heart surgery was undertaken for closure of an ASD[29]. Common heart conditions requiring open-heart surgery include; mitral and aortic valvular diseases, ASD, VSD, TOF, PDA, constrictive pericarditis and coarctation of the aorta. Standard monitoring consists of continuous EEG recording, invasive blood pressure monitoring, central venous catheter and urethral catheterization to monitor urine output.

Common problems encountered postoperatively include arrythmias like atrial fibrillation or ventricular tachycardia, pyrexia, electrolyte imbalance, hypotension, postoperative bleeding and cardiac tamponade. Poor outcome has been attributed to advanced/complex heart pathology at time of surgery, technical difficulties, delayed operations and perfusion pump malfunctions. Some of these have been addressed adequately[29, 30].

Pediatric patients with tracheo-esophageal fistula (TEF) usually have complications that necessitate PICU admission. These include aspiration pneumonia, respiratory distress syndrome (RDS), prematurity and dehydration. Postoperative positive pressure ventilation will therefore be required till there's improvement of the condition[31].

Other patients who may require postoperative intensive care include those who have undergone neurosurgical procedures like craniotomy for excision of intracranial tumours or drainage/evacuation of intracranial haematomas or hygromas. These patients are predisposed to respiratory arrest or cardiovascular collapse due to increased intracranial pressure, which may precipitate tonsillar herniation or conning. Cerebral edema may occur post operatively depending on the extent of the surgery and therefore ventilation with the aim of hypocapnoea is required for such patients[31].

7. **Heart failure**

Heart disease and failure in the pediatric age group is a common indication for PICU admission. Majority of children who have congenital heart diseases do not require intensive care except when there is associated congestive cardiac failure or show deteriorating pulmonary function. In addition, those who have undergone open-heart surgery also require postoperative care in the intensive unit. This is due to the unique problems encountered such as cardiac dysrrhythmias, heart block, congestive cardiac failure, renal compromise and respiratory failure[10, 15].

PREDICTORS OF MORTALITY & SCORING SYSTEMS

Though there are no validated pediatric scoring systems for severity of illness in many countries, and no information on long-term outcome, in the recent years, risk adjustment

methods in the form of scoring system have been developed.[32] These scoring systems allow predicted mortality of pediatric cases to be compared with actual mortality[5].

However, they are only useful for assessing the performance of the PICU and for making triage decisions but of limited use in predicting progress in individual pediatrics cases[2, 3, 33].

The scoring systems in intensive care have been classified depending on:

(a) Mechanism of injury into:
- Pediatric trauma score
- Injury specific score

(b) Organ involved: e.g Glasgow coma scale

(c) Age group: for example
- APACHE scores are used in predicting outcome in adults population
- Pediatric Risk Index (PRI) – used in pediatric population
- PIM: Pediatric Index of Mortality

The commonly used outcome predictors in pediatric age group are PRISM and PIM. PRISM is a modification of the Physiologic Stability Index (PSI) and it assesses the severity of illness in a pediatric population. It compares and evaluates the performance and resource use among various PICUs[5, 34]. Mortality risk is calculated according to the degree of physiologic derangement, age and operator stability.

PRISM score requires a large amount of data, including vital signs, acid base status, chemistry and haematology, all collected within the first 24 hours of admission. It is unreliable in predicting short-term survival of cardiac surgery pediatric patients[34]. Other drawback in PRISM score includes the overestimation of mortality in critically ill patients. It also requires a reliable collection of data and that it does not adjust for comorbidity[35].

The PIM score is more amplified and gives more accurate score on first presentation of a critically ill patient. It gives better and more reliable comparisons in information required to calculate the score:

- Mechanical ventilation in the first hour in ICU.
- Arterial partial pressure of Oxygen (PaO2).
- Inspired fraction of Oxygen (FiO
- Base excess
- Response of pupils to bright light
- Systolic arterial blood pressure
- Booked or elective admissions
- Specific underlying conditions e.g. HIV and AIDS

The PRISM and PIM scores are not widely used in developing countries due the inaccessibility of the algorithms used for the calculations[36].

STUDY RATIONALE / JUSTIFICATION:

Children require intensive care in different situations. A child may be critically ill due to an acute medical condition like severe pneumonia, following surgery for a life threatening surgical condition like TOF or may require intensive care after complex surgical procedures[5]. This may occur in a previously healthy child or be superimposed on a congenital anomaly or chronic condition. Amongst the neonates and infants, the major causes of morbidity and mortality are immaturity, respiratory distress, infections, perinatal asphyxia, neonatal apnea and hypothermia. The primary aim of intensive care is to restore a child to normal health and give them a chance to live a potentially productive life.

Many children in Kenya seek emergency care at health centers, sub district and district hospitals. These public institutions are ill equipped to offer the care needed due to lack of required facilities and trained personnel. A great number succumb to their illness before care can be instituted but others are received early enough and are then referred to Provincial hospitals or the Kenyatta National Hospital. Unfortunately, the mechanisms for referral are also inadequate. The time it takes to source finances and organize transportation is costly to the health of the patient. In addition, most ambulances are not equipped for continuous monitoring and care of the patients in the usually long and tedious journey. This makes the work more difficult for the receiving centers since they receive patients in poor condition.

In the year 2003, a total of 35, 866 pediatric cases were admitted to the Pediatric wards at Kenyatta National Hospital alone. This formed 34.3% of total number of patients admitted to the hospital. Intensive care unit pediatrics admissions within the same year formed 35% of the number of patients admitted into the ICU. The outcome of ICU pediatric admission was very poor, with a mortality rate of 91.3%, which translated to170 deaths out of the 186 admitted[37].

Timely, effective pediatric emergency care and outcome depends on a network of pre hospital and hospital medical and administrative resources. There is a great demand for Pediatric Intensive Care in Kenya and other developing countries. This is to try and reduce the high mortality rates of the very critically ill pediatric patients admitted into the hospital. This study aims at determining the general outcome of PICU case, in so doing will enable health providers to focus their attention on more specific clinical areas.

For a pediatric emergency care facility to be developed, the special needs of this age group must be addressed and the current outcome in the existing intensive care unit is one of the major guidelines towards this goal. A literature search has not revealed a similar study done in our local environment.

AIMS AND OBJECTIVES

Main objective

To outline patterns and outcomes of pediatric admissions to the KNH ICU.

Specific objectives

1) To determine the main pediatric conditions/diagnosis requiring admission to the ICU.

2) To correlate the outcomes of pediatric ICU admission to age, sex and organ system involvement.

3) To correlate duration of stay of pediatric ICU patients to general outcome.

STUDY METHODOLOGY

STUDY DESIGN

This was a prospective cross sectional descriptive study.

STUDY SITE

The site of study was the Intensive Care Unit (ICU) of Kenyatta National Hospital in Nairobi, Kenya.

STUDY POPULATION

The targeted population was all children from zero to 12years of age admitted into the ICU within the study period.

INCLUSION CRITERIA

Children 0 – 12 years admitted into the ICU within the study period whose parents have consented to their inclusion into the study.

EXCLUSION CRITERIA

- Children already admitted into the ICU by the time the study commenced. Study period was November 2005 – June 2006.
- Children whose stay extends beyond the study period

DATA COLLECTION

A questionnaire was used to collect data from both the patients and their files after an informed consent.

SAMPLE SIZE AND SAMPLING TECHNIQUE

The sample size (n), was calculated from the formula below[38];

$$n = \frac{(Z\alpha/2)^2 P (1-P)}{d^2}$$

Where,

d = Margin of error (absolute precision) which is 5%.

P = The proportion/ percentage of the most common pediatric condition that necessitate pediatric ICU admission. In this case, the commonest condition is respiratory failure, which accounts for 93% of admissions.

$(Z\alpha/2)^2$ = Standard errors from the mean corresponding to 95% confidence level (1.96).

Therefore,

$$n = \frac{1.96^2 \times 0.93\ (1-0.93)}{0.05^2} = 99 \text{patients}$$

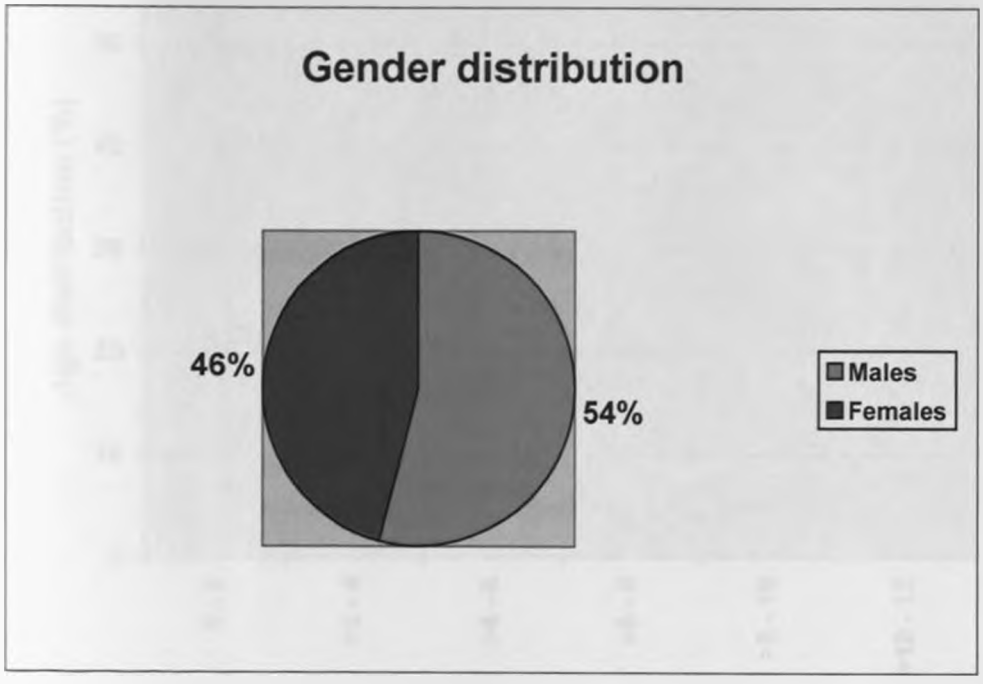
DATA ANALYSIS

Data collected was cleaned and verified then entered into a computer hard copy before analysis using the statistical package for social science programs. Comparison of different variables was made. Descriptive statistics namely mean, median, mode, standard deviation, correlation statistics and point estimates with 95% confidence interval around them were determined. Specific patterns where applicable were deduced from tables, bar charts, histograms, pie charts and simple graphs.

RESULTS

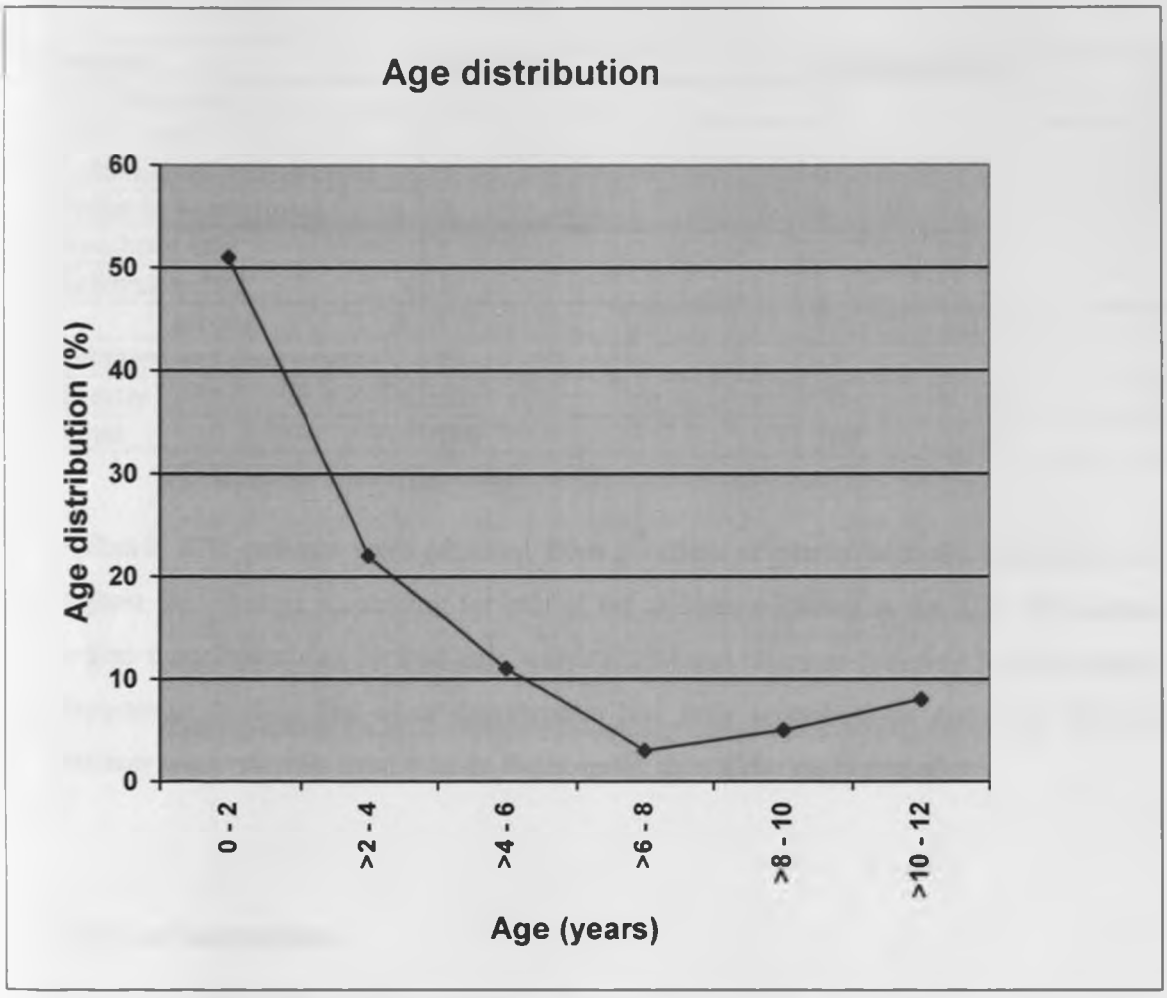
In the study period, a total of 100 pediatric patients who fulfilled the requirements were reviewed. This represented 17.5% of patients admitted into the intensive care unit during this period.

Figure 1: Gender distribution



54% of the patients included in the study were males while 46% were females with the male to female ratio being 1.17 : 1.

Figure 2: Age distribution



The majority of patients were aged between 0- 2 years. Neonates formed 13% of the cases while those above 10years contributed only 8% of the study population. In total 80% of the study population was made up of children aged five years and below.

Table 1: Source of admission

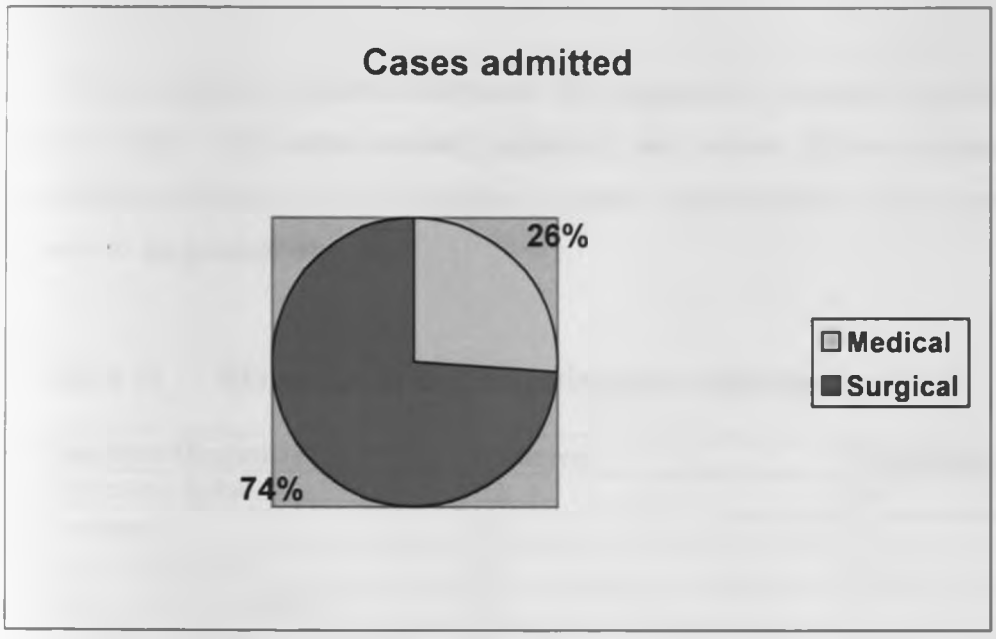
Source	Numbers	Percentage (%)
Pediatric ward	22	22
Labor ward	1	1
Pediatric out patient clinic	0	0
Pediatric filter clinic	5	5
New born unit	5	5
Referral; public	1	1
private	1	1
Accident and emergency	15	15
Theatre	50	50
Total	**100**	**100**

Pediatric ICU patients were admitted from a variety of places with the theatres as the highest contributors accounting for half of the children admitted to the ICU. The second largest contributor was the pediatric wards (22%) and this was followed by the casualty department (15%). The other departments had little contributions and only (2%) of patients were referrals from outside the hospital, during the study period.

Type of admission

From the study, 74% of all the admissions into the unit were surgical cases and only 26% were patients with medical conditions. As a whole, 99% of patients admitted into the ICU within the period of study were being admitted into the unit for the first time. In addition, there were just as many elective cases as there were emergency cases admitted into the unit with a ratio of 1 : 1.

Figure 3: Medical Vs Surgical admissions



The main pediatric conditions/diagnoses that required ICU admission were found to be quite varied. The cardiovascular, respiratory and central nervous systems were the greatest contributors with the respiratory system contributing not only more varied cases but also the greatest numbers.

Table 2: Main conditions affecting the respiratory system

Condition/Diagnosis	Numbers	Percentage
Respiratory failure	22	30
Pnuemonia	15	21
Inhalational burns	9	13
Foreign body bronchus	5	7
Pulmonary edema	5	7
Aspiration pneumonitis	4	5
Tracheo-esophageal fistulae	4	5
Adenoid/tonsillar hypertrophy	2	3
Pulmonary tuberculosis	2	3
Recurrent laryngeal papilloma	2	3
Pulmonary hypertension	1	1
Laryngeo-tracheo-bronchitis	1	1
Laryngomalacia	1	1
Total	**73**	**100**

Respiratory diseases had the majority of patients admitted into the unit within the study period. A total of 73 children with the 15 different conditions/diagnoses as outlined above were noted. Of these, respiratory failure which is a sequelae of many conditions accounted for 22 of the patients admitted. The second commonest condition was pneumonia contributing a further 15 children with inhalational burns contributing 9 children.

Table 3: Main conditions affecting the cardiovascular system

Condition/diagnosis	Numbers	Percentage
Atrial septal defect	6	21
Patent ductus arteriosus	4	14
Ventricular septal defect	3	10
Congestive cardiac failure	2	7
Tricuspid atresia	2	7
Mitral valve regurgitation	2	7
Tetralogy of fallot	2	7
Single ventricle	2	7
Hypovolemic shock	1	4
Constrictive pericarditis	1	4
Right ventricular failure	1	4
Coarctation of aorta	1	4
Pulmonary stenosis	1	4
Total	**28**	**100**

Within the study period, 28 patients with the 14 different cardiovascular conditions outlined above were admitted into the ICU. Of these, 21 patients were postoperative patients who had had correction of congenital anomalies, with the commonest anomaly being an atrial septal defect.

Table 4: Main conditions affecting the Central Nervous System

Condition/diagnosis	Numbers	Percentage
Brain tumours	12	45
Severe head injury	5	19
Meningitis	3	11
Hypoxic brain damage	3	11
Hydrocephalus	2	7
Severe birth asphyxia	2	7
Total	**27**	**100**

Diseases of the central nervous system(CNS) contributed the 3rd largest group of patients admitted into the unit. A total of 27 patients had CNS problems with 11 different conditions noted. CNS tumours were the commonest conditions noted (12 cases) with posterior cranial fossa tumours in 50% of these. Severe head injury was also common

contributing a further 5 patients. Brain hypoxia (hypoxic brain damage and severe birth asphyxia) contributed another 5 children.

Urogenital System

The genito – urinary system was not found to be commonly affected in the patients admitted into the intensive care unit within this study period. Only 3 children had conditions affecting this system and they all had acute renal failure.

Table 5: Main conditions affecting the Gastro Intestinal System

Condition/diagnosis	Numbers	Percentage
Gastroenteritis	2	25
Peritonitis	1	12.5
Anorectal malformation	1	12.5
Hirschsprung	1	12.5
Intestinal obstruction	1	12.5
Intussussception	1	12.5
Umbilical hernia	1	12.5
Total	**8**	**100**

The gastro- intestinal system was also not a commonly affected system within the period of study. There were only 8 cases but with 7 different conditions. Gastroenteritis (GE) was seen in 2 of the cases with all the other conditions having only one patient each. Those with congenital malformations were admitted postoperatively for stabilization and monitoring.

Table 6: Other conditions admitted into the ICU

Condition/diagnosis	Numbers	Percentage
Burns	5	50
Cleft lip/palate	2	20
Neonatal sepsis	2	20
Septicaemia	1	10
Total	**10**	**100**

The other conditions that were not included into the major body systems are outlined above. These contributed a further 10 children admitted into the unit.

The commonest condition was burns accounting for 5 of these patients. The other conditions noted were cleft lip/palate (admitted from theatre for post resuscitation management) and sepsis contributing 2 and 3 patients respectively.

Table 7: Investigation findings on admission

	Discharge		Death	
Investigation	**Normal**	**Abnormal**	**Normal**	**Abnormal**
Urea	57	5	28	10
Electrolytes	51	11	15	23
Creatinine	55	7	29	9
Blood sugar	46	16	25	13
Chest radiograph	29	33	12	26

The investigation findings on admission were varied. The majority of patients, disregarding the outcome, had normal biochemical findings. From the data, of those discharged, (57%) had normal urea levels, (51%) had normal electrolytes, (55%) had normal creatinine levels and (46%) had normal blood sugar levels.

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Outcome of pediatric ICU admission compared to age.

Out of the 100 pediatric patients admitted into the ICU within the study period, 38 of them accounting for (38%) died. From figure 4, the mortality represented as a percentage was high in children under 4 years and was low amongst children above 8 years. Within the analyzed age groups, neonates had the highest mortality rate (62%)with 8 out of the 13 neonates admitted succumbing to their illnesses

Figure 4: Percentage outcome in different age groups

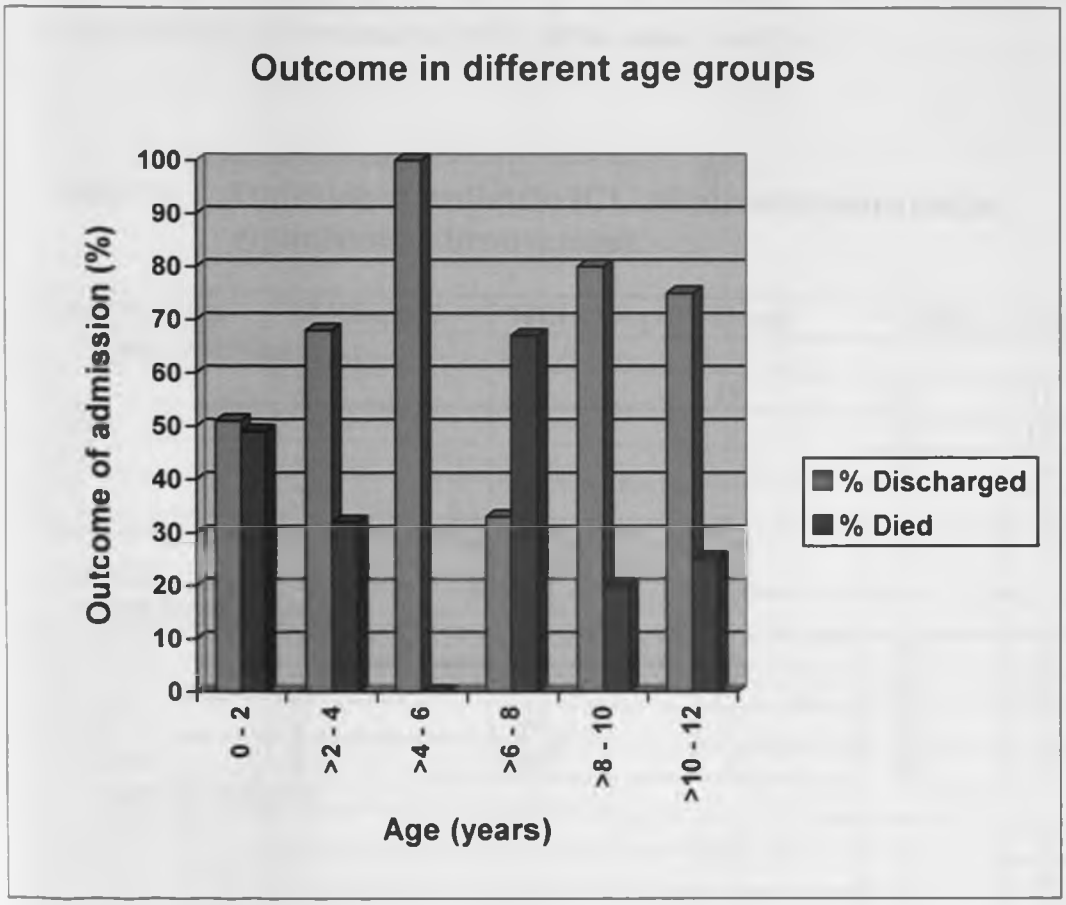


Table 8: Outcome of pediatric ICU admission compared to gender.

Sex	Discharged	%Discharged	Death	% Died	Total
Male	33	61	21	39	54
Female	29	63	17	37	46
Total	**62**		**38**		**100**

The table above shows the distribution of the patients in terms of gender. Although there were slightly more males (54) admitted into the ICU as compared to females (46), the outcome did not vary much. Females had a slightly better outcome with (63%) of them being discharged as compared to (61%) of the males ($p<0.05$).

Table 9: Outcome of pediatric ICU admission compared to organ/system involvement.

Organ/System	Discharged	%Discharged	Death	% Died	Total
1 - organ involvement					
RS	20	65	11	35	31
CVS	18	95	1	5	19
CNS	4	100	-	-	4
GIT	3	100	-	-	3
MSS(cleft lip/palate)	2	100	-	-	2
2 – organ involvement					
RS+CVS	2	67	1	33	3
RS+CNS	9	41	13	59	22
RS+GIT	2	40	3	60	5
RS+Burns	2	40	3	60	5
3 – organ involvement					
RS+CVS+GUT	-	-	2	-	2
RS+GUT+Burns	-	-	1	-	1
RS+CVS+Burns	-	-	1	-	1
RS+CVS+CNS	-	-	1	-	1
RS+CVS+GIT	-	-	1	-	1
Total	**62**		**38**		**100**

KEY

RS – Respiratory system

CVS – Cardiovascular system

GUT – Genitourinary system

GIT – Gastrointestinal system

CNS – Central Nervous system

MSS – Musculoskeletal system

The distribution of patients in terms of the organ/system(s) involvement varied as follows. The highest number of patients had single organ/system involved accounting for 59 of the patients (59%). Those with two system involvement were a further 35 patients (35%) and those with three system involvement were 6 patients (6%).

For the patients with single organ/system involvement, those with respiratory problems accounted for 31children, those with cardiovascular (CVS) problems contributing 19 children with central nervous system (CNS) and gastrointestinal system (GIT) contributing 4 and 3 patients respectively. Musculoskeletal system (MSS) contributed another 2 patients. Amongst these patients with single system involvement, the respiratory system had the highest mortality at 35% while the cardiovascular system had a mortality rate of only 5%. There was no mortality amongst the patients with CNS, GIT or MSS system involvement. All in all, out of the 59 patients admitted with single organ involvement, there were 12 mortalities translating to only 20% mortality rate.

Within the study period, 35 patients admitted into the intensive care had 2-organ/system involvement with each case involving the respiratory system. Of these, involvement of both the respiratory system (RS) and the CNS was the commonest finding with 22 patients. A combination of RS with either the GIT or burns each contributed another 5 patients while a combination of RS with CVS had another 3 children. As seen from table 9 and figure 5, the mortality rate rose significantly. A combination of (RS+CVS) had the lowest mortality at 33%, while the combinations of (RS+CNS), (RS+GIT) and (RS+Burns) had mortality rates of 59%, 60% and 60% respectively. Therefore, of the 35 children admitted with 2-system involvement, there were 20 mortalities giving a mortality rate of 57%.

In addition, a total of 6 children had three systems involved. All these combinations had involvement of the respiratory system. The other systems involved varied but included all the major systems as well as the integument system/skin. All in all, disregarding the actual systems involved, all the patients who had three organ systems involved succumbed to their illness putting the mortality rate at 100%.

Figure 5: Mortality versus number of systems involved

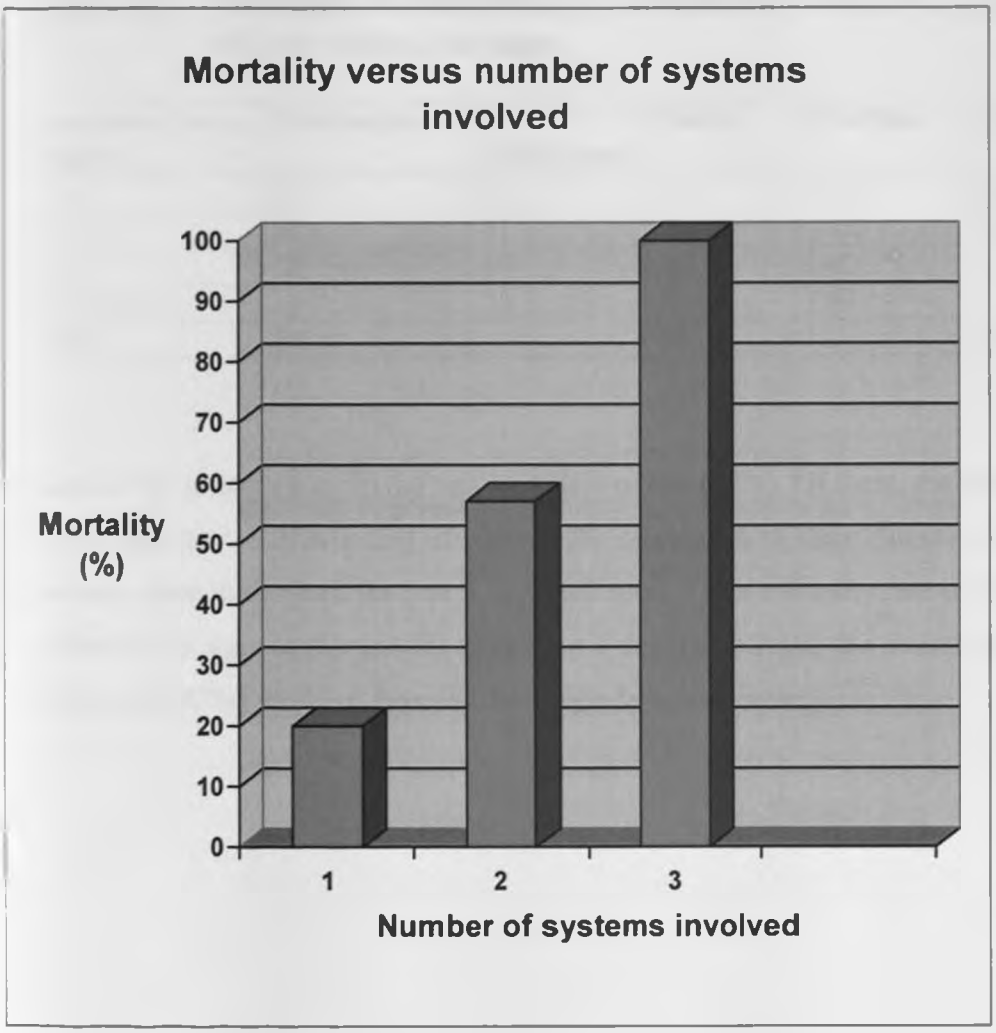
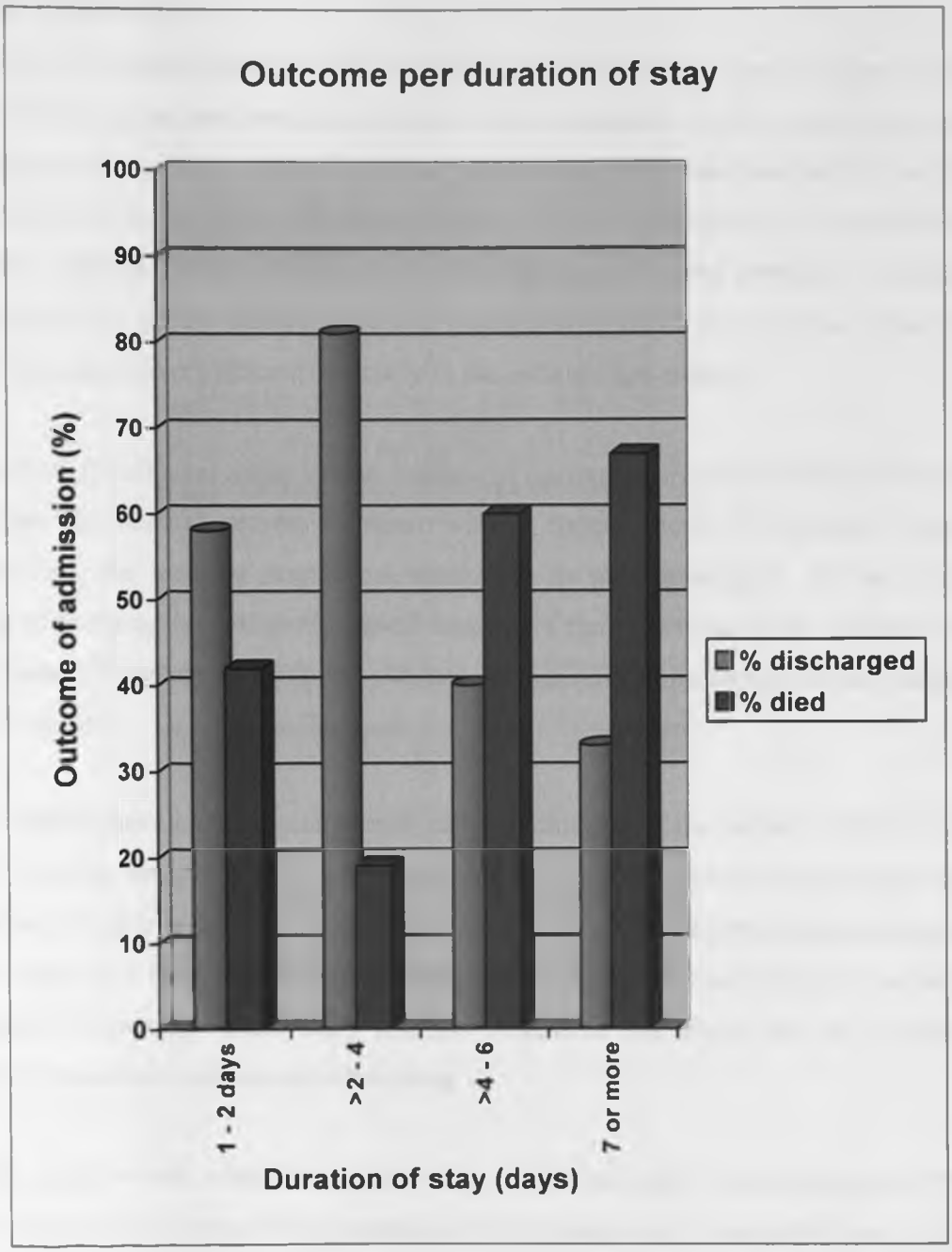


Table 10: Outcome of pediatric ICU admission compared to duration of stay within the unit.

Duration of stay (days)	Discharges	% Discharged	Death	% Died	Total
1 – 2	38	58	28	42	**66**
>2 – 4	21	81	5	19	**26**
>4 - 6	2	40	3	60	**5**
7 or more	1	33	2	67	**3**
Total	**62**		**38**		**100**

Most of the patients were in the unit for 4 days or less (92%). Of these, the majority were in the unit for 1 – 2 days (66) of whom 42% succumbed to their illnesses. A further 26 patients were in the unit for 3 to 4 days and these had a mortality rate of 19%. For the patients who were in the unit for more than 4 days (8 patients) the mortality rate rose to (60%) and (67%) for 5 – 6 days and 7 or more days respectively.

Figure 6: Outcome per duration of stay



DISCUSSION

Critically ill patients are those with major organ disease(s) that pose a danger to their lives. The major organs involved are those of the respiratory, cardiovascular and central nervous systems and the affected group of patients required focused treatment in the ICU. Disease involvement and surgical manipulation of any of these systems, or a combination of these systems have been associated with high morbidity and mortality[7]. Therefore, immediate and timely medical care and postoperative monitoring is often required to maximize on recovery process especially in the pediatric age groups.

Support of the affected major system needs to be instituted during the critical period so as to allow the healing process to occur without complications. This support may be mechanical, for instance mechanical ventilation, or pharmacological. All these being aimed at restoring normal physiological function of the systems involved. Intensive care units should therefore be equipped with not only specialized personnel but also facilities and equipment.

Some factors have been associated with different outcome of the patients admitted to the ICU. Pediatric age group is of special interest due to the fact that their physiology varies from that of adult population. Their immature body structures and physiological functions may limit, to a large degree, the extent of physical and pharmacological intervention necessary to restore normal body function[12]. Some of the factors that may influence outcome have been considered in this study.

In this study, it was noted that majority of patients were aged 5 years and below (77%) with the poorest outcome being associated with neonates with a mortality rate of 62%. This may be related to their low immunity. Congenital malformations and RDS may also contribute to this high mortality rate. Outcome improved significantly with age up to 5 years where it remained unchanged to 12 years at 25%. Elsewhere, preterm infants with birth weight of less than 750 grams have shown mortality rates of 66% while hospital mortality rates of 26% have been reported for adults undergoing intensive care. In addition, reported mortality rates for pediatric intensive care vary between 5 – 17%[39]. A local study showed a mortality rate of 92.5% in children below 5 years admitted in ICU[40].

Sa. Ferrar et al also showed a better outcome, short term and long term, survival in pediatric critical care patients compared to adults[41].

There were slightly more male patients admitted during the study period (54%). However, female patients had a slightly better outcome compared to males with 63% of them being discharged. This indicated that the gender of the patient did not influence their outcome significantly ($p<0.05$).

The ICU formed a significant link between the theatres and the surgical wards since 50% of the patients admitted came from theatre either as an emergency or elective admission. The main cases encountered were from the neurosurgical and cardiovascular wards. The elective cases were admitted mainly for close postoperative monitoring and care. Patients who have undergone major surgery such as open-heart surgery may require cardiovascular and/or ventilatory support. ICU admission for this category of patients ensures timely recognition and intervention of postoperative complications. Mortality rate for this group of patients was low at only 5%. Other centers elsewhere have shown comparable outcome with 100% of open-heart surgical patients being discharged to the ward[42].

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Respiratory system pathology or involvement has been shown to be the commonest reason for pediatric ICU admission. A recent demographic profile outcome analysis for pediatric intensive care in India showed that respiratory diseases contributed the most (19.7%) to PICU admissions[43]. Outcome of patients who had pulmonary pathology or respiratory involvement was generally poor. Respiratory involvement not only had the highest mortality (35%) in the category of single organ/system involvement but was also the commonest dysfunctional system in multiple organ failure. It was involved in all patients with multiple organ disease. Pneumonia was seen as the commonest primary pulmonary pathology accounting for 20.5% of all respiratory conditions and 15% of total number of patients admitted. Respiratory failure in this study group contributed 19 cases with the etiology being multi factorial. Type II respiratory failure was seen in patients with severe head injury and some of the patients who underwent surgery for excision of posterior cranial fossa tumors. Direct/local pressure to the respiratory center by

hematomas, local edema after surgery or even increased intracranial fossa pressure would lead to respiratory embarrassment mandating ventilatory support.

Patients with inhalational burns were admitted in relatively stable condition but required intubation to ensure patency of airway, for tracheobronchial toileting and chest physiotherapy. Outcome was favorable in this group of patients with all of them being discharged to the wards. Airway edema and obstruction occurs in patients with foreign bodies (FB) bronchus, laryngotracheobronchitis (LTB) and those who have undergone excision of recurrent laryngeal papilloma. Laryngoscopy and bronchoscopy in the management of patients with these airway emergencies may further worsen the edema necessitating ICU admission[44]. Two of the patients encountered in this study who had FB bronchus suffered severe brain hypoxia after cardiorespiratory arrest during bronchoscopy. Cardiopulmonary support was the main indication for ICU admission but both succumbed to their conditions within 24hours of admission.

Cardiovascular conditions, on the other hand, accounted for 28% of all cases admitted at the time of the study. Congenital heart diseases formed a large portion (75%) of these patients, with ASD diagnosis being the most frequently encountered pathology (6 patients). Other studies have also shown that congenital heart diseases (mainly VSD and ASD) form the commonest reason for open-heart surgery and postoperative cardiac intensive care[42]. In addition, good preoperative preparation, intra operative monitoring and planned postoperative intensive care have been shown to improve outcome[19]. Most of these patients with cardiovascular problems (24) were admitted post operatively following elective surgery. Only 2 patients were admitted with congestive cardiac failure (CCF).

ICU admission is usually necessitated by the fact that patients with cardiovascular disease, whether surgical or medical, are potentially unstable and their haemodynamic status is quite unpredictable. An example is surgical patients who have undergone open-heart surgery for correction of congenital cardiac abnormalities. Bradycardia and conductive block are common when a patient comes off cardio pulmonary bypass and may persist into the postoperative period. Early recognition and correction of causes of

arrhythmias such as electrolyte disturbances, hypoxia, hypercarbia, acidemia, tamponade and ischaemia have been associated with good outcome[42]. High pulmonary arterial pressures have been associated with correction of congenital anomalies like VSD and ASD and this may precipitate right-sided heart failure. In addition, coagulopathy in surgical patients may be due to massive blood transfusions or pharmacological agents used to facilitate surgery. Acute blood loss post operatively, arrhythmias and poor chronotropic and inotropic function are other major complications associated with surgery. As a result, intensive postoperative monitoring and care mandates ICU admission[29,30].

The third major system that contributed 27% of all pediatric patients admissions during the study involved the central nervous system and it had an average mortality of 51.8%. Neurosurgical conditions accounted for 70.1% (19 cases) of CNS related diseases with intracranial tumors being the commonest indication for elective ICU admission in this category. Patients who have undergone surgery in the posterior cranial fossa are at high risk of cardiovascular compromise. This is because there may be pressure on the vital centers in the brain stem caused by post surgical edema, hematoma, the surgery itself or increased posterior cranial fossa pressure[45, 46].

Neurosurgical patients who did not have cardiopulmonary compromise did well with 100% being discharged to the wards. Severe head injury accounted for 5% of all admissions and was the commonest indication for emergency admission for patients with CNS disease. Outcome was poor with 100% mortality. Another study on head injury indicated that higher rates are found amongst children aged 0 – 4 years. However, the overall morbidity and mortality rates were much lower compared to those in adults[45].

Hypoxic brain damage is seen in a variety of patients including those with severe birth asphyxia and head injury. These patients present with among other things, the inability to maintain their airway. Although the injury to the CNS may be permanent, early initiation of respiratory support, intensive physiotherapy, nursing and nutritional support in ICU have been associated with better outcome[18,19].

Diseases of the gastro intestinal and genito-urinary systems also contributed to the population under study but to a lesser extent. The conditions associated with these two systems may not be indicated for ICU admission but it is the co-morbidity and complications associated with them that require early recognition and management. These two systems play a major role in maintenance of fluid and electrolyte balance. Conditions associated with these two systems may lead to severe electrolyte imbalance like hyper/hypokalemia or hyper/hyponatremia and severe metabolic and physiological derangements including acidosis and pulmonary edema.

In this study, 3 patients presented in acute renal failure (ARF) which was all part of multiple organ failure in patients with sepsis and CCF. ARF is associated with significant morbidity and is a major cause of death during acute illness in the ICU[47].

Diseases affecting the GIT were mainly surgical and included conditions like anorectal malformations, intestinal obstruction, hernias and peritonitis. These patients were mostly critically ill postoperative patients with electrolyte imbalance. Gastrointestinal emergencies may also be complicated by hypovolemic shock or endotoxaemia/ bacteremia culminating in the development of systemic inflammatory response syndrome and multiple organ dysfunction. The mortality rate for elective intra abdominal procedures is up to 5%[48].

Other cases admitted included burns, which contributed 5% of cases. Their admission was based on high burn surface area, with mortality of 100% in those with >60% BSA. Close monitoring of central venous pressure, input/output fluid balance, electrolyte and renal function were required. A study done in the United Kingdom showed that 6% of all patients admitted with burns had severe burns and required fluid and electrolyte resuscitation. Of these, 50% of the patients were children. The mortality rate for those with 75% total burn surface area was 60%[49].

Outcome of patients with sepsis was quite poor with all 3 patients succumbing to the illness. These patients presented with multiple organ failure. Cytokines and other inflammatory mediators are released in response to activation of complement system in

sepsis[8, 50]. The result is loss of vascular tone, disturbed temperature regulation, coagulopathy, myocardial dysfunction and poor platelet aggregation. There is increased capillary permeability leading to hypovolemia and hypoperfusion[12]. The effect is then seen in all organs/systems as disseminated intravascular coagulopathy, respiratory failure, acute renal failure, cardiovascular collapse and dysfunction of the central nervous system. A study done in KNH reported mortality of 73.7% in neonates admitted to ICU with sepsis. However, better outcomes have been identified in other regions with mortality rate ranging between 10 – 30%in some tertiary PICU[50].

Two children with cleft lip/palate were admitted for postoperative monitoring after they developed arrhythmias in the perioperative period. Both patients responded well to ICU management and were discharged to the wards. Arrhythmias are common in the intra and postoperative period but most are benign and require no treatment. ICU care is indicated for persistent arrhythmias or those associated with cardiac arrest[51].

The outcomes of pediatric ICU admissions in this study were grouped into; death, discharge to the wards, transfer to other ICU and others. However, patients admitted into the ICU within the study period either died or were discharged to the wards. These two outcomes have thus been correlated to various factors namely; age, sex, organ/system involvement and duration of stay in the unit.

Mortality was noted to be 100% in those patients who had 3 or more organ/system diseases. The mortality dropped to 57% in the patients with only 2-organ/system involvement and was only 20% in patients with single organ involvement. The association of multiple organ failure by Wilkson et al revealed that the incidence of multiple organ system failure (MOSF) in pediatric ICU was 27% of the 831 consecutive PICU admissions. In addition, they noted that the mortality rate for these patients with MOSF was 54% with mortality for those without MOSF being 0.3%[50]. In my study, the mortality rate for patients with MOSF was comparatively higher at 63.4% and those without MOSF was at 20%. This reflects a poorer outcome at the KNH ICU for the pediatric admissions.

Duration of stay was grouped into 1-2 days, >2 – 4 days, >4 – 6 days and 7 or more days. From the study, majority of patients were in the unit for only 1 or 2 days (66%). Of these, the mortality rate was 42%. The average length of stay for pediatric patients in ICU elsewhere has been shown to be 4.52+/- 2.6 days[51]. The 1st 48 hours are a critical period for monitoring, evaluation and management of critically ill patients. It is also the period when patients who are too ill or are unable to stabilize their physiological functions succumb to their illnesses[7]. Patients who survive this critical period but are not well enough to be discharged to the wards also perform well in terms of outcome. The patients who remained in the unit for up to 4 days had a mortality rate of only 19%. Further to that, mortality rate rose significantly in patients who remained in the unit for up to 6 days to 60%. Continued stay in the unit for a week or more had a further increase in mortality rate to 67%. This may be due to irreversible damage to the organ/systems and this damage cannot be enhanced much by an increased stay in the unit.

There are no validated pediatric scoring systems for severity of illness in KNH ICU as is the case in many pediatric ICUs in other countries. Scoring systems were developed to compare actual mortality to predicted mortality[5, 32]. PRISM and PIM could not be used in this study due to inaccessibility of the algorithms used for this calculations[36]. Cost of the investigations is an inhibitory factor in many cases and thus only the tests that are absolutely necessary for the management of the patients are done. And this has impact on the outcome of pediatric ICU patients. Although some of the routine tests done on admission were mentioned in this study, they were not related to outcome as would have been the case if the scoring systems (PRISM and PIM) were used to gauge the severity of illness. Majority of patients had normal biochemical finding on admission but more patients had chest radiograph abnormalities though this was not necessarily associated with a poorer outcome.

CONCLUSION

As far as the pediatric population is concerned, the KNH ICU is more of a surgical ICU since 74% of all children aged 12 years and below were surgical cases. The numbers of elective and emergency cases were equal and the ICU was seen to be a very important link between the theatres and the surgical wards. Majority of the patients were being admitted for the 1st time (99%) and the highest mortality was within the first 48 hours.

Gender of the patient was not seen to be a major determinant of the outcome of pediatric patients. The male population was slightly higher than the females but there was no significant difference in their outcome noted.

On the other hand, age is a very important determinant of outcome of ICU patients. The most frequent age group was between zero to 2 years and this had a mortality rate of 49%. Neonates had the worst mortality rate of 62%. Therefore, younger patients have a higher likelihood of being admitted into the intensive care and yet have a worse outcome while in the unit.

The indications for admission varied greatly and were based on the patients' needs and requirements. These included a need to resuscitate the seriously ill patients, monitor specific therapy like inotropic and ventilatory support for patients in respiratory failure and cardiovascular collapse and the need to reverse reversible biochemical and physiological abnormalities to preserve important/vital organ functions.

The main pediatric conditions/diagnoses that required ICU admissions were diseases affecting the respiratory, cardiovascular and central nervous systems. Respiratory conditions are associated with higher morbidity and mortality with patients requiring ventilatory support in ICU. Congenital abnormalities are associated with significant morbidity but surgical intervention with immediate postoperative intensive care and monitoring are associated with a good outcome.

Patients with single organ/system failure have better prognosis. Outcome becomes poorer with every extra system involvement with an almost zero chance of survival when three or more systems are involved. The respiratory system on its own had the highest mortality rate and it was also involved in all cases of MOSF and thus its involvement is indicative of a likelihood of poorer outcome.

Finally, outcome of pediatric ICU admissions in this study was found to be unpredictable in the 1st 24 – 48 hours of admission. This is the critical period for stabilizing patients by correcting the reversible physiological and biochemical abnormalities encountered at admission. Patients who respond well to this management are discharged within 4 days of admission. A longer stay in the intensive care has a poorer outcome due to irreversible body changes.

The general outcome of pediatric ICU admission at KNH during the study period was an average mortality rate of 38%.

RECOMMENDATIONS

The KNH ICU is a multidisciplinary unit catering for adult and pediatric population and medical and surgical cases. It has a bed capacity of 20 serving a hospital with a bed capacity of 2000. This puts the ratio at 1:100 whereas the international recommendation is 1:50. There is thus need for extra ICU space to cater for extra beds.

Critically ill pediatric patients have special needs in view of their different physiology. They also have more congenital abnormalities, which are associated with a higher morbidity. This study showed the highest mortality rate to be in the neonates at 62%. A specialized unit in the form of pediatric intensive care unit would improve the outcome of critically ill pediatric patients. Investment in training of more personnel in pediatric intensive care and procurement of facilities that cater specifically for pediatric needs would go a long way in improving management and outcome of these patients.

Although the long-term outcome of cardiovascular correction surgery has not yet been documented, the short term (ICU) outcome is quite encouraging even with the limited resources. Although teamwork has been shown to contribute to this, a lack of funding for open-heart surgery has limited the number of corrective surgeries that can be done. A system of funding or subsidizing such expensive surgical procedures would take more advantage of the trained personnel and facilities already available.

In order to improve outcome, predictors of outcome should be identified. PRISM and PIM have been used in developed countries but the algorithms for their calculation are not available. A scoring system for severely ill pediatric patients should therefore be developed for the hospital to apply to all patients for ICU admission. This will enable clinicians to stratify accurately ill patients and evaluate the use of hospital resources and compare efficacy of the ICU at different times.

In addition, referral systems from primary and secondary health facilities should be streamlined. This would ensure timely intervention for life threatening conditions.

APPENDICES

APPENDIX 1: QUESTIONNAIRE

1. Name: _____
2. IP No: _____
3. Sex: Male ☐ Female ☐
4. Age: _____
5. Admission

   a. Source of admission: - (Tick where appropriate)

   - Pediatrics ward ☐
   - Labour ward ☐
   - POPC ☐
   - PFC ☐
   - NBU ☐
   - Referral ☐
   - Transfer (from other hospital)
     - Private ☐
     - Public ☐
   - Home / OPD / A& E (Casualty) ☐
   - Theatre ☐

   b. 1st admission ☐ Readmission ☐
   c. Emergency admission ☐ Elective ☐
   d. Medical case: Yes ☐ No ☐
   e. Surgical case: Yes ☐ No ☐
   f. Others: _____
   g. Duration of stay in unit: _____ days.

6. Diagnosis/Disease

   ☐ Cardiovascular system

   - (Specify)_____

☐ Respiratory system

- (Specify)_____

☐ Nervous system

- (Specify)_____

☐ Post surgical

- (Specify) _____

☐ Genitourinary

- (Specify)_____

☐ Gastrointestinal

- (Specify)_____

7. Number of systems affected (Above)_____
8. Other data on admission:

	Normal	Abnormal
- U/E/C:		
• Urea_____	☐	☐
• Electrolytes_____	☐	☐
• Creatinine_____	☐	☐
- Blood sugar_____	☐	☐
- Chest X-ray _____	☐	☐

9. Outcome: -

Death ☐

Discharge to ward ☐

Transfer to other ICU ☐

Others: Specify_____

APPENDIX 2: CONSENT EXPLANATION

I, Dr. Mwendwa Nyalita, am a postgraduate student in Anaesthesia at the University of Nairobi and attached to the Kenyatta National Hospital. I am the principal investigator in this study.

THE PURPOSE OF STUDY

This study aims at identifying the patterns of admission into the ICU KNH then will relate this to the outcome. All children aged 12years and below will be included in the study. Data will be collected from the patients' file. The child's guardian/next of kin may be interviewed for any clarifications on history and presentation. No other invasive procedures will be performed on the patient other than those already prescribed in their treatment. No harm will befall the patient.

CONFIDENTIALITY

Confidentiality will be maintained at all stages of this study. No names will be included in the final document.

PARTICIPATION IN THE STUDY

You are at liberty to withdraw your child/ward from the study at any stage. This will in no way affect the quality of care to the patient. There will be no extra cost incurred to you as the data sort for is already available from the files.

RISKS

This study involves no risks to the patient as the data will be drawn from the patient's file. There are no other procedures that will be carried out on the patient other than those already prescribed for their management in the intensive care unit.

BENEFITS

The benefits of this study will be realized in the long term. Recommendations will be made at the end of the study to offer suggestions that may assist in the management of pediatric ICU patients in the future to minimize morbidity and mortality.

APPENDIX 3: CONSENT FORM

I, ..., the parent/guardian/next of kin of ..... hereby give consent for my child/ward to participate in the study; 'A review of pediatric admissions and outcomes at the ICU, KNH.' I am aware that the study is non invasive and will have no adverse effects on my child/ward.

I have the freedom to withdraw my child/ward from the study at any time.

Signature..... **Date.....**

I confirm that I have explained to the parent/guardian of the patient, the nature of this study.

Signature..... **Date.....**

Mimi....., mzazi wa..... nakubali mtoto wangu kushiriki katika uchunguzi wa matibabu ya watoto katika chumba cha wagonjwa mahututi katika hospitali kuu ya Kenyatta. Naelewa ya kwamba utafiti huu hauusi kufanyiwa kitu chochote mwilini au kupewa madawa yoyote.

Niko na uhuru wa kumtoa mtoto wangu kutoka kwa utafiti huu wakati wowote.

Sahihi..... **Tarehe.....**

Ninathibitisha ya kwamba nimemwelezea mzazi wa monjwa kikamilifu kuhusu utafiti huu.

Sahihi..... **Tarehe.....**

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