

**7EVALUATING THE PERFORMANCE OF PEDIATRIC RISK OF MORTALITY
(PRISM) SCORE AS A TOOL TO PREDICT MORTALITY IN CHILDREN ADMITTED
TO PAEDIATRIC MEDICAL WARDS OF KENYATTA NATIONAL HOSPITAL.**

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DECLARATION

This proposal is my original work and has not been presented elsewhere. References to work done by others have been clearly indicated.

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DEDICATION

This work is dedicated to my dear husband Gibson Waichari, parents Mr and Mrs Kiniu, brother Jimmy and sister Nduta; who have been a true inspiration, source of encouragement and great support throughout this project. You are truly appreciated

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LIST OF ABBREVIATIONS:

µmol/L- micromoles/ litre

AHA-American Heart Association

AUC-Area under the Curve

BP-Blood Pressure

CCU- Critical Care Unit

CM-centimeters

ERC- Ethics and Review Committee

EXP-exponential function

FiO₂- Fraction of Inspired Oxygen

GCS-Glasgow Coma Scale

HDU- High Dependency Unit

KNH- Kenyatta National Hospital

KNH/UON ERC-Kenyatta National Hospital/University of Nairobi Ethics and Review
Committee

Kpa- Kilopascal

Mmhg-millimeters of mercury

Mmol/L- millimoles per litre

PaO₂-Partial Pressure of Oxygen

PaCO₂- Partial Pressure of Carbon Dioxide

PCCU-Pediatric critical care unit

PELOD- Pediatric Logistic Organ Dysfunction

PEU- Pediatric Emergency Unit

PICU- Pediatric Intensive Care Unit

PIM-Pediatric Index of Mortality

PRISM- Pediatric Risk of Mortality

PSI- Physiologic Stability index

ROC- Receiver Operating Curve

ABSTRACT:

Background: With the growth in paediatric critical care, there is need to have a standard way of assessing severity of illness and the risk of mortality. PRISM score is based on physiological derangement by the disease process and is determined within 24 hours of admission. It has 14 variables both clinical and laboratory measures and has been used in several paediatric critical units and has been found to have good assessment of the risk of mortality. Mortality is affected by many factors other than the disease severity. Therefore it is necessary to assess the ability of this scoring system to predict mortality in a setting that is different from the original population it was developed from.

Objective: To determine the prediction of probability of death at various PRISM scores

Methodology: A longitudinal survey carried out in Kenyatta National Hospital targeting children aged 1 month to 12 years admitted in acute rooms within the paediatric medical wards. A focused physical examination was done and blood samples drawn within 24 hours of admission to assess the PRISM score variables. The PRISM score was tabulated and the risk of mortality calculated using a logistic regression equation

Results: A total of 210 patients were enrolled for the study with a median age of 10 months with 55% being males. 61 (29%) patients died during the study. There was a 3% mortality in PRISM score between 0-9 and 80% in >29 PRISM score. The probability of death increased with increase in the PRISM score with it being 76% in PRISM score of 30 compared to 2.2% at a PRISM score of 5.

Conclusion: There is increasing probability of death with increasing PRISM score with the rise being exponential from a score of 15.

BACKGROUND

The main purpose of the paediatric critical care units is to reduce in hospital mortality by intensively monitoring and treating critically ill children who are considered at high risk of mortality. The capability to indentify these children is of paramount importance in running these paediatric critical care units. The lack of consistency, reliability and accuracy in physician's subjective opinions concerning patient mortality risk necessitates use of a standard objective and reproducible clinical prognostic scoring system ⁽¹⁾.

Scoring systems essentially consist of two parts: a severity score, which is a number (generally the higher this is the more severe the condition) and the calculated probability of outcome. Most commonly this is the risk of in-hospital mortality though other outcomes measures such as survival to 28 days post hospital discharge can also be modeled ⁽²⁾

An ideal scoring system is one that is institution and population independent, well calibrated with a high level of discrimination, uses easily recorded variables and has the ability to predict the quality of life after critical care discharge. It is important to note that no scoring system currently incorporates all these features ⁽³⁾.

HOW TO ASSESS A SCORING SYSTEM

Once a scoring system has been produced, its performance should be validated. This involves the ability to predict mortality in a different population from which it was assembled from ⁽⁴⁾. This is done by either splitting the original population into two groups one to produce the score and other to validate it or by using a completely separate population ⁽²⁾. The model calibration and discrimination are assessed.

Model Calibration.

Calibration assesses the degree of correspondence between the estimated probability of mortality and that actually observed. This is tested using a goodness of fit test; the most commonly used being the Hosmer-lemeshow c statistic.

Over a range of probabilities the expected and observed mortality are compared and a p-value derived. Calibration is considered to be good if the predicted mortality is close to the observed mortality⁽⁵⁾

Model discrimination.

This reviews the ability of the scoring system to discriminate between patients who die from those who survive, based on the predicted mortalities. This is done by calculating the area under the receiver operating characteristic (ROC) curve or by using a classification matrix. The two most important parts of the classification matrix are the specificity and sensitivity. A pair of the sensitivity-specificity values produces the ROC curve across a range of mortality prediction scores. The area under the resultant curve (AUC) represents the number of patients who die; the curve is analyzed using statistical processes to assess discrimination⁽⁵⁾. Typically an AUC of the ROC curve of >0.70 is required (2). Published c-index criteria suggest that ≥ 0.7 is acceptable, ≥ 0.8 is good, and ≥ 0.9 is excellent⁽⁶⁾

The field of paediatric critical care has made great steps in this area and several bedside clinical prognostic scoring systems have been developed and validated.

1.0 LITERATURE REVIEW

1.1 PEDIATRIC RISK OF MORTALITY (PRISM) SCORE:

The Pediatric Risk of mortality (PRISM) score is a third generation physiologic-based prognostic scoring system commonly used in the pediatric critical care unit. It was obtained and validated from the Physiologic Stability Index (PSI)⁽⁷⁾ with 1415 patients with a median age of 33 months evaluated from nine U.S. PICU environments between 1984 and 1985. Statistical analysis eliminated the insignificant PSI categories, thus reducing the number of physiological parameters, creating and validating the PRISM. It uses 14 parameters (physiological and laboratory data) and for each the highest severity value recorded in the first 24 hours⁽⁸⁾.

This scoring system was developed to assess severity illness-related mortality irrespective of the diagnosis. It presents an excellent discriminatory performance and prediction thus being used in many PICUs as a prognostic score to assess gravity of disease. The PRISM score variables and scores are shown in the table 1 below.

An updated version of this scoring system- PRISM III, published in 1996⁽⁹⁾ according to its authors, offers better predictive capability. However a considerable fee is charged for using it routinely, which has limited its use, even in developed countries^{(10) (11) (12)} and for this reason it was not used in this study.

Table 1: Prism Variables and Score.

Variables	Infants²	children³	scores
Systolic Blood pressure (mmHg)	130-160	150-200	2
	55-65	65-75	2
	>160	>200	6
	40-54	50-64	6
	<40	<50	7
Diastolic Blood pressure (mmHg)	>110	>110	
Heart rate (beats/min)	>160	>150	4
	<90	<80	4
Respiratory rate (beats/ min)	61-90	51-70	1
	>90	>70	5
	Apnea	Apnea	5
Arterial Oxygen tension: Fraction of Inspired oxygen ratio ¹		200-300	2
		<200	3
Carbon dioxide Tension (KPa) ¹	6.8-8.66	6.8-8.66	1
	>8.66	>8.66	5
Glasgow Coma Scale (GCS) ¹	<8	<8	6
Pupillary reactions ¹	unequal and Dilated		4
	Fixed and Dilated		10
Prothrombin time/Partial thromboplastin time ratio ¹	>1.5*Control	>1.5*control	2
Total bilirubin (µmol/L) ¹	>60	>60	6
Potassium (mmol/L) ¹	3.0-3.5	3.0-3.5	1
	6.5-7.5	6.5-7.5	1
	<3.0	<3.0	5
	>7.5	>7.5	5
Calcium (mmol/L) ¹	1.75-2.00	1.75-2.00	2
	3.00-3.74	3.00-3.74	2
	<1.75	<1.75	6
	>3.74	>3.74	6
Glucose (mmol/L) ¹	2.2-3.3	2.2-3.3	4
	13.9-22.2	13.9-22.2	4
	<2.2	<2.2	8
	>22.2	>22.2	8
Bicarbonate (mmol/L) ¹	<16	<16	3
	>32	>32	3

1-All ages, 2- 1 to 12 months of age, 3- more than 12 months of age

PRISM SCORE=(systolic blood pressure points)+(diastolic blood pressure points)+(heart rate points)+(respiratory rate points)+(Oxygenation points)+(Glasgow coma scale points)+(Pupillary reaction points)+(Coagulation points)+(Bilirubin points)+(Potassium points)+(Calcium points)+(glucose points)+(Bicarbonate points)

The total score is then obtained, the Minimum Score is 0 and is seen to have an excellent prognosis, and a Maximum Score of 76 is almost invariably associated with death. The risk of death is calculated by a logistic regression equation as shown below which uses the total score of the PRISM, patient age and need of surgery on admission to the PCCU (5)but performance was not significantly influenced by the post operative status of the patients. The operative status is indicated by 1 if post operative or 0 if non-Operative

$$R = \{0.207 * (\text{PRISM SCORE})\} - \{0.005 * (\text{age in months})\} - \{0.433 * (\text{operative status})\} - 4.782$$

$$\text{Probability of Mortality} = \text{EXP}(R) / \{1 + \text{EXP}(R)\}$$

$$\text{Probability of Survival} = 1 - \text{probability of mortality}$$

The assessment of this scoring system includes sensitivity which is correct prediction of non survival and specificity which is correct prediction of survival.

Several studies have been done and show that PRISM is able to assess and predict mortality⁽¹³⁾⁽¹⁴⁾ while other studies show that it overestimates mortality⁽¹⁵⁾⁽¹⁶⁾. It is institution independent and can be used within limits to compare different critical care units⁽¹⁷⁾.

Below is a table summarizing different studies that have been done to assess the performance of the PRISM score in different populations and institutions.

Table 2: Performance of Prism Score.

Author/year	Title	Discrimination	Calibration.
Antony et al 2006 United kingdom	Assessment and optimization of mortality prediction tools for admission to PICU in united kingdom	C index-0.82	P=0.01
Graziela et al 2010 Brasil	Application of the PRISM score and determination of mortality risk factors in a tertiary PICU	0.76(0.69-0.83)	P=>0.05
Martha et al 2005 Brazil	Comparison of two prognostic scores(PRISM and PIM) at PICU	0.87(0.81-0.93)	P=0.10
Qureshi et al 2007 Pakistan	Comparison of three prognostic scores(PRISM, PIM2, PELOD) at PICU under Pakistan circumstances	0.78(0.67-0.89)	P=0.49
Wells et al 1996 South Africa	Poor discriminatory performance of PRISM score in south African ICU	0.73=-/ 0.01	

Several studies have been done to validate the PRISM score in different populations. One of the largest study was done in United Kingdom (UK) by Antony et al and involved 69% of the PICUs in UK. 10,197 patients with a median age of 1.4 years were enrolled in the study and its main objective was to assess the calibration and discriminatory power of the PRISM score alongside

other scoring systems. The PRISM score was found to have a good discriminatory power with an ROC of 0.82(0.80-0.84) but with poor calibration in the study population. The authors of this study further recommend that risk adjusted methods that are developed primarily in other countries require validation before being used to provide risk adjusted outcome mortality within a different health care setting. Calibration of these tools should be reassessed periodically to ensure their continued validity⁽¹⁸⁾

In Brasil 359 patients with a median age of 31 months were enrolled in a study done by Graziela et al. The study population had a median length of stay (LOS) in the PICU of 5 days and a mortality rate of 15%. The median mortality associated PRISM score was 15 points whereas that of the patients who survived was 7 points which was significantly lower. Other findings included that each additional day in the unit carried a mortality odds ratio of 4.38. The PRISM score was found to have adequate discriminatory capacity and calibration with a ROC of 0.76(0.69-0.83)⁽¹⁹⁾.

A study to compare the performance of the PRISM score and the PIM score done in Brazil by Martha et al enrolled 421 patients. The median age was 44 months with a median LOS of 11.6 days and a mortality rate was 7.83%. This study concluded that both these scores offer a good capacity to discriminate between survivors and moribund patients and that the PRISM score is better calibrated compared to the PIM score⁽¹³⁾.

Other comparison studies included one done in Pakistan by Qureshi et al and it compared the performance of PRISM, PIM and pediatric logistic organ dysfunction (PELOD) scores. It included 101 patients, mean age of 18 months and LOS of 12.6 days. The PRISM score was better calibrated compared to the other scores. The discriminatory power of the PRISM was good with an ROC of 0.78(0.67-0.89) which was comparable to PIM which had a ROC curve of

0.88(0.81-0.94) PELOD had poor performance compared to the PRISM and PIM scores. Of key note is that malnutrition was a major issue in this study with 55.4% of the patients below the 5th centile on weight for age analysis and 34.7% below the 5th centile on weight for height analysis⁽²⁰⁾. Malnutrition was not established as an independent prognostic factor and similar results have been documented in a study in India⁽²¹⁾.

A study done in India that included a total of 100 patients concluded that PRISM score is a good predictor of risk of mortality in PICU and it also helps to concentrate efforts to those who can benefit from PICU and finally can help in selecting sick children for PICU admission and thus optimally utilize the limited PICU resources⁽²²⁾.

There is limited use and number of studies done in Africa concerning the PRISM score but in a study from South Africa, there was discrepancy between observed and the predicted mortality rates. There was under prediction of mortality at lower PRISM scores and over prediction at higher scores. The authors suggested that this might be related to their “lead time bias”. Late presentation to the hospital and delay in admission to the PICU might be responsible. The PRISM, score at admission to the PICU may have been masked by their initial treatment causing a falsely low PRISM score and under estimation of mortality⁽²³⁾.

In Egypt in a tertiary care hospital a study done by Ahmed El-Nawawy et al over a period of 13 months found a mortality of 50% and a Length of stay of 4.67 ± 5.4 days. The PRISM scores of the non survivors were high compared to survivors (36 and 17 respectively) and had significant correlation to the number of organ failure on admission ($p < 0.001$)⁽²⁴⁾. There were discrepancies between observed and expected mortalities and this may have been influenced by the underlying chronic illness and local differences among the practising critical care team⁽²⁵⁾.

PRISM score has also been used with good discriminatory ability in specific disease entities: for example meningococcal disease ⁽²⁶⁾ and hepatic failure ⁽²⁷⁾ thus reducing the number of scoring systems to be used in a critical care setting. PRISM score is comparable to other scoring systems used in critical care units including Pediatric Index of Mortality 2 (PIM 2) and Pediatric Logistic Organ Dysfunction (PELOD) scores ⁽²⁰⁾.

A recent study done in Egypt by Hanan and John et al that assessed the accuracy of the PRISM score and pneumonia severity index score in predicting outcome in children under 5 years showed that PRISM score is superior to the Pneumonia severity index in predicting survival of pneumonia patients. At a cut off level of PRISM score of ≥ 12.5 the sensitivity was 75% and specificity was 84% (28).

Patients' mortality is affected by many factors such as: demographic and characteristics of the population, infrastructure, case mix, admission practices unit performance and non-medical factors (management and organization) (29).

Therefore there is need for field testing of these scoring systems in settings different from the one in which they were originally developed.

2.0 STUDY JUSTIFICATION AND OBJECTIVES

2.1 Problem Statement

Kenyatta National Hospital is a national referral facility in our country that receives very sick children. There is no standard way to evaluate the severity of illness and risk of mortality in these children making it difficult to prioritize care or even assess their improvement or even compare the overall performance of the hospital in relation to other facilities.

2.2 Justification

There needs to be an objective and reproducible way of assessing the severity of illness and risk of mortality in the paediatric population admitted in the critical care units in Kenyatta National Hospital. This can be achieved by the use of severity of illness scoring systems. These systems are developed and validated in a different population from the one in Kenya in terms of genetic variability, case mix and admission procedures among others .It is therefore important to evaluate their performance in our population before they are used in our setting. If the PRISM score as a severity of illness score and tool to assess risk of mortality is found to have good performance in our setting then it can be adopted as the standard severity of illness scoring system.

2.3 Utility

By using the PRISM score as a standard prognostic scoring system in our critical care units, we will be able to:

- Prioritize specialized care as needed
- Evaluate different management protocols in relation to the outcomes

- Obtain severity of illness adjusted mortality ratio and compare our performance with other institutions
- Can be used as entry criteria into studies that incorporate severity of illness.

2.4 Research Question.

Can PRISM score be used a prognostic scoring system in Kenyatta National Hospital paediatric acute rooms?

2.5 Study Objectives.

2.5.1 Broad Objective

- To evaluate the performance of PRISM score in predicting mortality in children admitted at the paediatric ward medical acute rooms in Kenyatta National Hospital.

2.5.2 Specific Objectives

- To determine the prediction of probability of death at various PRISM scores

3.0 METHODOLOGY.

3.1 Study Design

This study was a prospective longitudinal survey carried out in Kenyatta National Hospital, a tertiary level care hospital in Nairobi Kenya.

3.2 Study Site.

This study was conducted in Kenyatta National hospital (KNH) which is a national referral and teaching hospital. KNH has four paediatric medical wards and in each ward there is an acute room in which critically ill children are admitted.

The acute rooms have an average capacity of 6 beds in each room and it is here that the critically ill children in the wards are nursed. Any child requiring mechanical respiratory support is admitted in the Critical care unit. Critical care unit was not used in this study

About 20-30 children are admitted everyday through the paediatric emergency unit (PEU). The admitted children are reviewed by the on call paediatric resident doctor and if they are very sick they are admitted into the acute rooms within that specific ward. This is estimated at about 10-20% of the admitted children.

3.3 Study Population

The study population included children aged 1 month to 12 years admitted in the Kenyatta National Hospital -paediatric medical wards acute rooms.

3.4 Sample Size Estimation

Total number of 210 children was included in the study. This sample size was arrived at by using the Buderer⁽¹⁾ formula as shown below.

$$n = \frac{Z_{1-\alpha/2}^2 \times S_N \times (1-S_N)}{L^2 \times \text{Prevalence}}$$

S_N , = specificity set at 89.76%- study done in Egypt⁽²²⁾

α = size of the critical region ($1 - \alpha$ is the confidence level),

$Z_{1-\alpha/2}$ = standard normal deviate corresponding to the specified size of the critical region (α), set at 1.96

L = absolute precision of specificity set at 0.06.

P = mortality rate from the Egypt study⁽²²⁾ set at 50.49%.

$$= \frac{1.96^2 \times 0.8976 \times 1 - 0.8976}{0.06^2 \times 0.5049}$$

$$= \frac{3.8416 \times 0.0991424}{0.00181764}$$

$n = 209.5$

The sample size was obtained at 210 children.

3.5 Sampling

Consecutive screening and enrollment of the children meeting the inclusion criteria and admitted in the paediatric medical ward acute rooms was done till the desired sample size of 210 was reached. This took a period of approximately three months.

3.6 Inclusion Criteria

This study included children aged 1 month to 12 years admitted at the paediatric ward acute rooms in Kenyatta National Hospital.

3.7 Exclusion Criteria

Among the children who were excluded from this study were:

- Those with congenital malformations.
- Children who died within 8 hours of admission.
- Children who were discharged from the unit within 24 hours of admission.

Children who died within 8 hours of admission or were discharged from the critical care units within 24 hours were excluded in the initial development and validation of the PRISM score by Pollack et al⁽⁸⁾ therefore the score was not developed or validated for them.

3.8 Equipment

To measure the blood pressure we used an aneroid Sphygmomanometer machine from the Reister Company that had three different paediatric veelo cuffs for the different paediatric age groups. It included the neonatal, infant and child cuff sizes.

3.9 Study Procedure

I. Screening and enrollment

All the children aged 1 month to 12 years admitted in the paediatric medical ward acute room were enrolled in the study within 24 hours of admission.

During enrollment:

- The study and its benefits and risk were explained to the caregivers. This was followed by signing of an informed consent (Appendix 5).
- A detailed questionnaire was filled by the researcher in a one to one interview with the caregivers. The questionnaire captured the demographic data, the primary system affected by the disease among other parameters (Appendix 4).

II. Focused Physical Examination

A focused physical Examination was done targeting the variables in the PRISM score which include:

- a) **Blood pressure:** The American Heart Association (AHA) guidelines 2005 for measuring blood pressure was used. The correct cuff size was chosen as indicated in table 3 shown below. The cuff was inflated to at least 30 mm Hg above the point at which the radial pulse disappeared. The cuff was then deflated at a rate of 2 to 3 mm Hg per second. Two

readings were taken, with a one-minute interval between them, and the average of the measurements recorded.

Table 3: Recommended Cuff sizes

Age	Recommended Cuff size
Infants	6*12 cm
Children	9*18cm

- b) **Heart Rate:** the heart rate was counted over one minute and the obtained value recorded in beats per minute.
- c) **Respiratory Rate:** The respiratory rate was counted over one minute and recorded as breaths/minute.
- d) **Glasgow Coma Scale (GCS):** The GCS include three components that are verbal, eye opening and motor response. All these three components were assessed and observed response recorded as per modified GCS as shown in Appendix 3 and each variable was given a score the total score obtained and recorded as the GCS.
- e) **Pupillary Light Reaction:** light was shone into the pupils and the reaction observed in both pupils and recorded as equal, unequal fixed and nonresponsive.
- f) **Fraction of inspired oxygen (Fio₂):** For children who were on oxygen, the mode of oxygen delivery was recorded and the Fio₂ was estimated as is done in the Kenya paediatric protocol book July 2013(Table 4).For this particular study we used the minimum value of Fio₂ for the deferent modes of oxygen delivery. For children not on oxygen Fio₂ was estimated at 21%.

Table 4: Estimation of the Fraction of inspired oxygen (Fio2)

Mode of Oxygen delivery	% of oxygen delivered	Minimal value used as Fio2
Nasal prong or short nasal catheter	30-35%	30%
Naso-pharyngeal (long) catheter	45%	45%
Plain, good fitting oxygen face mask	40-60%	40%
Oxygen face mask with reservoir bag	80-90%	80%

All these variables were recorded in the PRISM score forms which were part of the questionnaire.

III. Laboratory Work-up:

A 3 Millilitre (ml) arterial blood sample was obtained and put in two sampling bottles and one syringe.

- 1 ml was put in a citrated microvacutainer (blue top) bottle. The ACL 700 coagulation analyzer machine in the hematology laboratory Kenyatta National Hospital was used to measure Prothrombin time and Partial Prothrombin time.
- 1.5 mls was put in a plain red top bottle. The Mindray BS 400 machine in the renal Laboratory Kenyatta National Hospital was used to measure calcium, total bilirubin, potassium and random blood sugar.
- 0.5mls of the sample was put in a self heparinized 2 mls syringe. This sample was analyzed for PaO₂, PaCO₂ and bicarbonate using the rapidlab 348 machine at the Intensive Care unit Laboratory, Kenyatta National Hospital.

The above samples were taken to the appropriate laboratory within 30 minutes of collection.

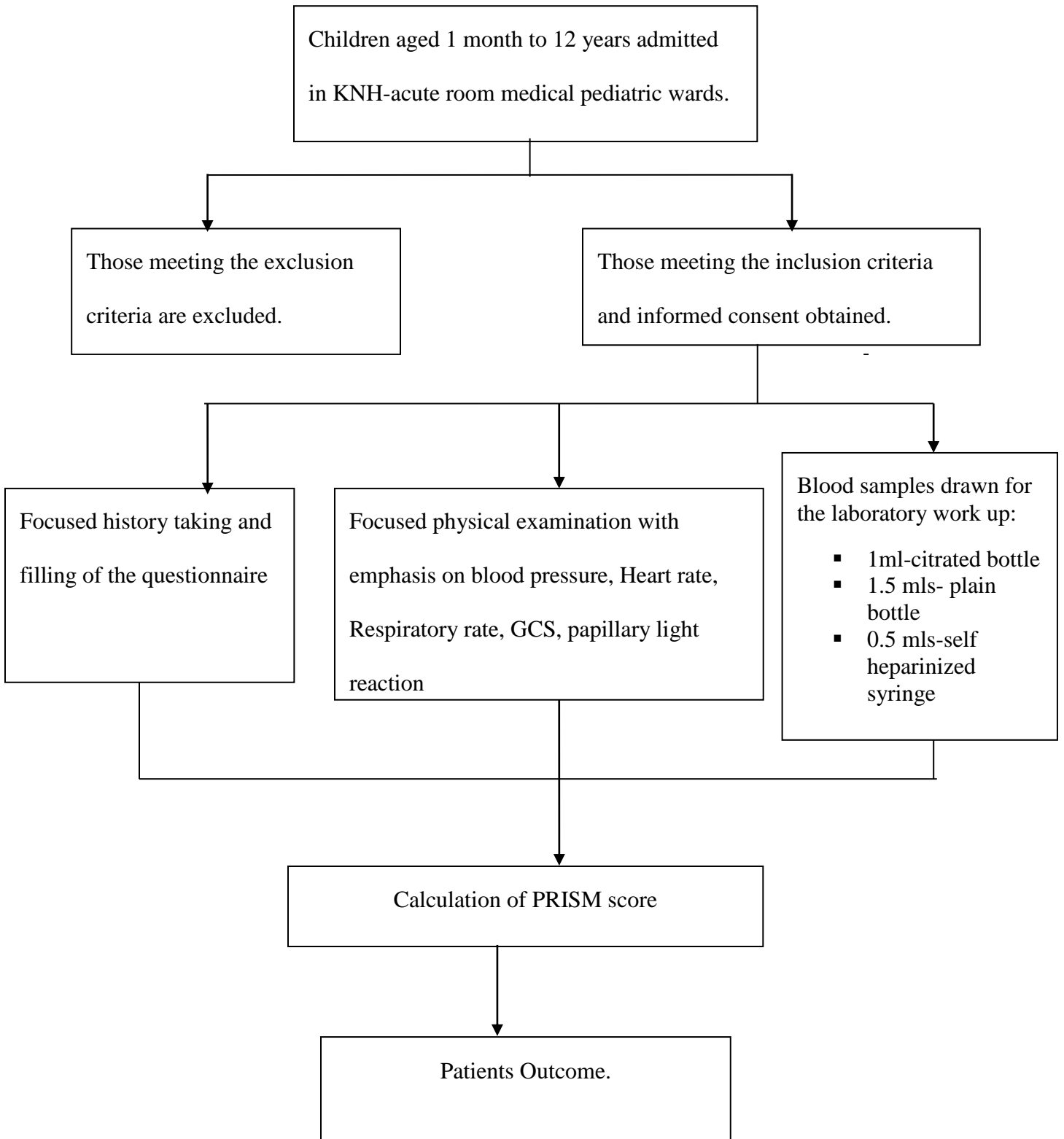
IV. PRISM score calculation

The results of the above tests were obtained within 12 hours of delivery of samples. The results were then recorded in the PRISM score forms. All the variables recorded were awarded a score as described by Pollack et al⁽⁸⁾ and tabulated to give the total PRISM score.

V. Patient follow up

The outcome at the point of discharge of the children from the acute room was recorded as died or survived.

Figure 1: Patient Flow Chart



3.10 Data Management:

A clinical officer trained in research methodology was recruited as the research assistant. The PRISM score was taught to him: its components, its importance and relevance, how to assess the different components and score them appropriately. The inclusion and exclusion criteria were explained to him. The data collection tool which was a structured questionnaire was explained and any concerns or questions on how to collect information indicated ironed out. Instructions on the blood drawing procedure were given and he was educated on the bottle types for the specific laboratory investigation. The research assistant was also educated on the research ethics and how to uphold them throughout the research period. A pre trial test was done to establish if the research tool was well understood and whether it was a good enough tool to answer the objectives of the study.

Data collected using the structured questionnaires were entered into Epi data for data entry (version 3.1). The entered data was then exported to SPSS version 20 for editing, cleaning and validation to arrive at a working dataset for analysis. The data was analyzed and descriptive statistics generated (frequencies, mean, median, and mode). Data was then presented in the form of tables and charts like Pie charts, bar graph, ROC to provide summaries about the sample. Cross-tabulations were done and Chi-square statistic used to establish if association existed between the categorical predictive variables (variables) and the risk (mortality). A Logistic regression model was plotted to establish the independent relationship and relative contribution of dependent variables (PRISM Score) towards mortality in children.

3.11 Ethical Considerations

The participants of this study included children aged between 1 month and 12 years. These are minors thus full explanation of the study was given to the parents/ guardian and a written consent (appendix 5) obtained.

The study was funded by the Kenyatta National Hospital Research and ethics department.

All patients' information was handled with strict confidentiality. The patients' paper records were kept in locked cabinets and electronic records within database were password protected with only the research assistant and principal investigator having access to the locked cabinets and the database.

Information necessary in management of the patients was duly communicated to the clinician overseeing the patients' management.

Approval for the study was sought from the ethics and review committee in Kenyatta National Hospital.

4.0 RESULTS

A total of 210 children aged between 6 to 142 months with a median of 10 (7, 16) months were enrolled into the study between the months of October to December 2013. It was noted that more than half 127(60.5%) of the children were aged less than 1year. More than half (55.2%; n=116) of the study population were male and a third of the children (30.5%; n=64) had severe malnutrition followed by 25.2% (53) who had moderate malnutrition while 22.9% (48) were well nourished. 73.8% (155) were referred from other facilities with most admissions being medical (99%; n=208) and non-operative (99.5%; n=209). The length of stay was between 1 and 18 days having a median of 3(2, 4) days. A mortality ratio of 29% in the study population was noted.

Table 5: Characteristics of the Study Population.

Variables	Frequency	Percent (%)
	Median (IQR)	
Age(Year)		
≤ 1	127	60.5
>1 – 5	63	30.0
>5	20	9.5
Median age (months)	10(7,16)	
Gender		
Male	116	55.2
Female	94	44.8
WHO Z-score(weight for Height)		
Severe malnutrition (<-3)	64	30.5
Moderate malnutrition (-2 to -3)	53	25.2
At risk (-1 to -2)	45	21.4
Normal (>-1)	48	22.9

Readmission		
Yes	6	2.9
No	204	97.1
Referred		
Yes	155	73.8
No	55	26.2
Type of admission		
Medical	208	99
Surgical	2	1
Operative status		
Post operative	1	0.5
Non operative	209	99.5
Length of stay in days (LOS)		
0-3	120	57.1
4-7	74	35.3
>7	16	7.6
Median LOS	3(2,4)	
Outcome		
Dead	61	29
Alive	149	71

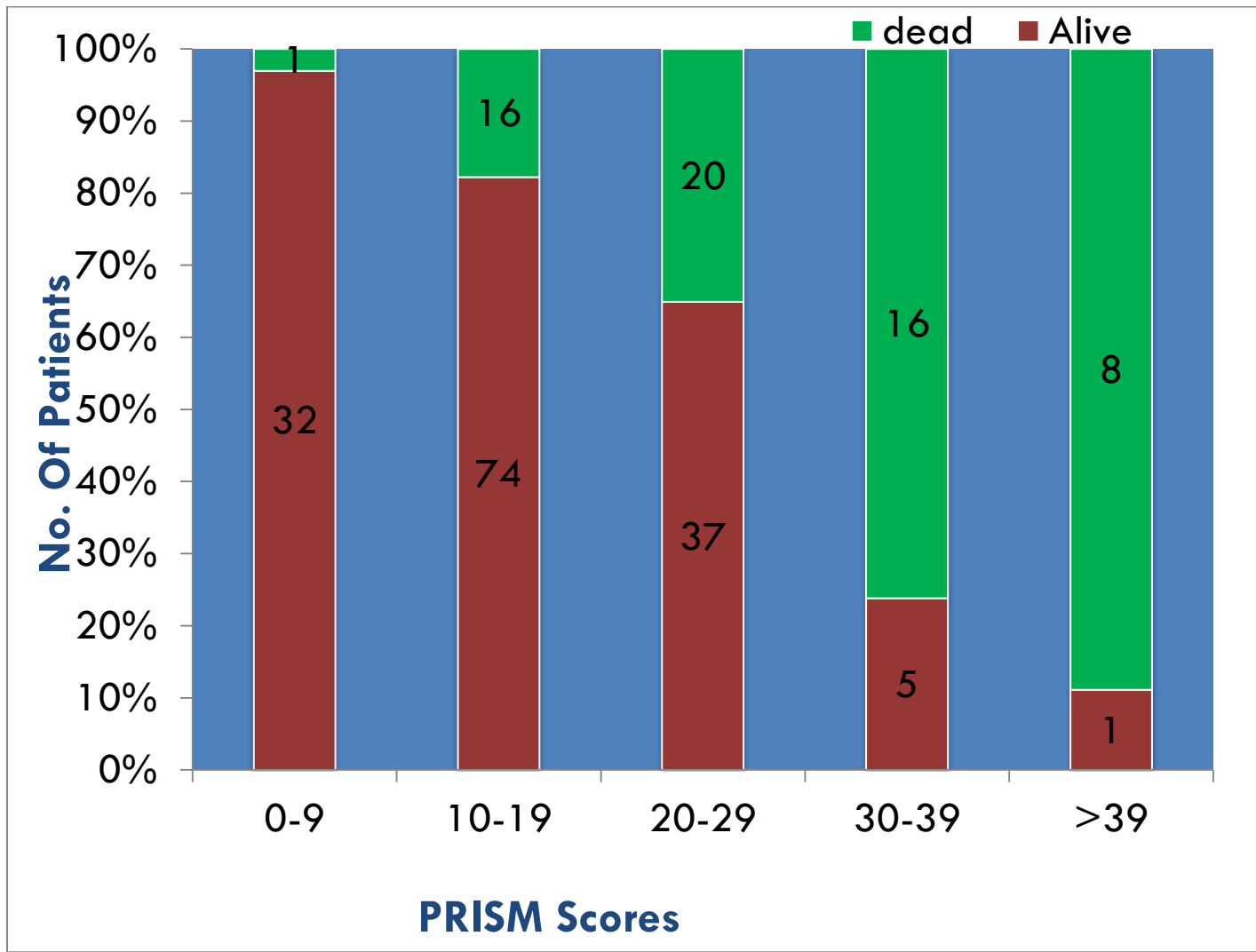


Figure 2: PRISM Score and corresponding proportion of deaths

Figure 2 above shows that an increase in the PRISM score had corresponding increase in proportion of deaths. It was noted that 89% of the children with PRISM score greater than 39 died compared to 35% with a PRISM score of 20-29.

Table 6: Univariate analysis: Risk factors of Mortality

Predictors	Outcome		χ^2	P value
	Alive	Dead		
Gender				
Male	72(62.1%)	44(37.9%)	9.72	0.002**
Female	77(81.9%)	17(18.1%)		
Type of admission				
Medical	148(71.1%)	60(28.9%)	0.43	0.512
Surgical	1(50%)	1(50)		
Readmission				
Yes	5(83.3%)	1(16.7%)	0.46	0.498
No	144(70.6%)	60(29.4%)		
Operative status				
Post operative	0	1(100%)	2.45	0.117
Non operative	149(71.3%)	60(28.7%)		
Patient on oxygen therapy				
Yes	136(69.7%)	59(30.3%)	1.94	0.164
No	12(86.7%)	2(13.3%)		
Patient referred				
Yes	102(65.8%)	53(34.2%)	7.60	0.006**
No	47(85.5%)	8(14.5%)		
WHO Z-score-(Weight for Height)				
Malnutrition	78(66.7%)	39(33.3%)	2.35	0.125
No malnutrition	71(76.3%)	22(23.7%)		
Length of stay in days (LOS)				
0-3	73(60.8%)	47(39.2%)	14.0	0.001**
4-7	62(83.8%)	12(16.2%)		
>7	14(87.5%)	2(12.5%)		
PRISM score				
0-9	32(97%)	1(3%)	55.18	0.0001**
10-19	74(82.2%)	16(17.8%)		
20-29	37(64.9%)	20(35.1%)		
>29	6(20%)	24(80%)		

** Significant at P=0.05

Table 6 gives the association of predictors of mortality and the outcome on univariate analysis. There existed a difference in the gender of the children and the patients outcome at discharge ($p < 0.002$). There were more male children 44(37.9%) compared to female 17(18.1%) who died. In contrast, there were more children admitted for medical 148(71.1%) than surgical 1(50%) type

of admission but this was not significantly different in predicting the outcome at discharge ($P>0.05$). Similarly, patient readmission was not significantly different. The results show that referred patients were significantly associated with poor outcome at discharge. Higher proportion of patients referred died (33.6%; 48) compared to 9.8 % (5) of those not referred ($P=0.006$). The lengths of stay as well as PRISM score were statistically significant in predicting outcome at discharge.

Table 7: Multiple logistic regression analysis of the mortality risk factors.

Variable	SE (β)	OR	P-value	Lower 95% CI	Upper 95% CI
Male	0.22	0.561	0.138	0.26	1.20
Referred	0.18	0.370	0.045	0.14	0.98
Length of day					
0-3		1			
4-7	1.116	2.647	0.021	1.16	6.05
>7	3.498	4.098	0.098	0.77	21.83
PRISM Score	0.020	0.884	0.0001	0.85	0.92

Multiple regression was fitted to variables which were associated with the outcome at discharge (Table 7). It was noted that patient referral status, longer length of stay and PRISM score were associated with mortality while male gender was not significant in predicting mortality. A child who was referred was less likely to die than non-referred child (OR-0.370). If a patient stayed between 4-7 days was 2.6 times likely to die compared to a child who is discharged within 3 days ($P=0.021$). An increase in PRISM score increased the likelihood of the child to die ($p=0.0001$).

In figure 3 below, the PRISM score and the probability of death is given for each score. The probability of death was 2.2% with PRISM score of 5 and increased to 76% with a score of 30

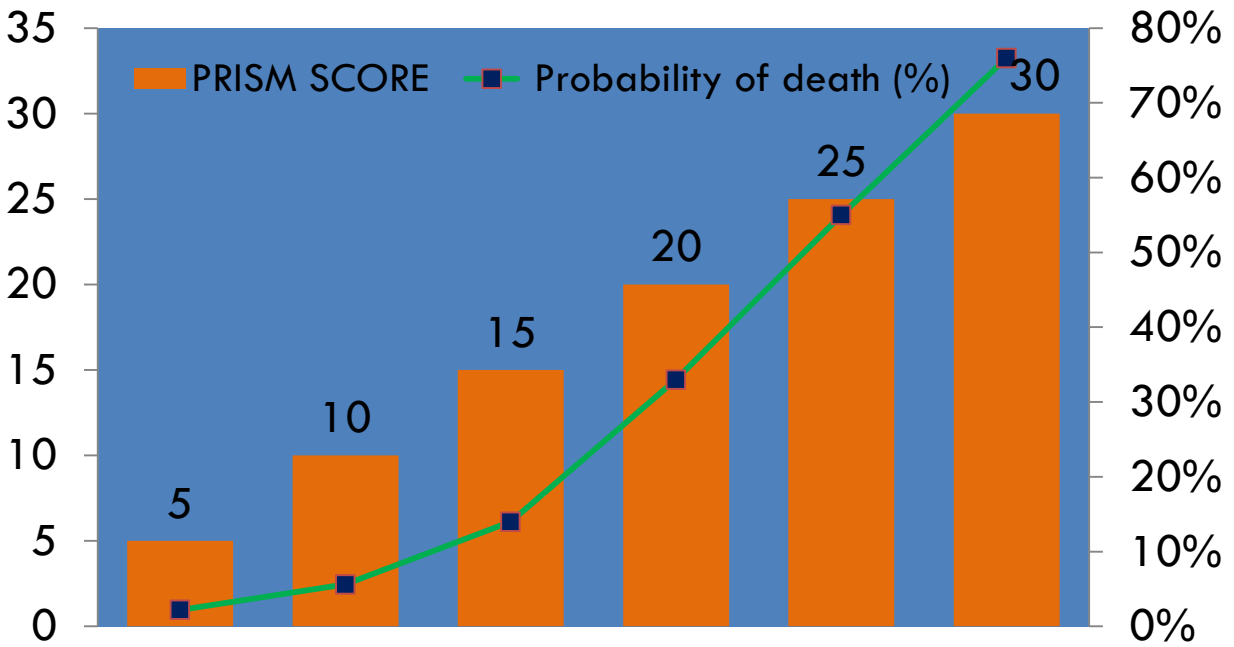


Figure 3: PRISM score in relation to probability of death

5.0 DISCUSSION.

In our study done over a period of 3 months in Kenyatta National hospital paediatric medical acute rooms we were able to enroll 210 patients and were all included in the data analysis. The median age of patients was 10 months which is much lower compared to the study population used in the validation of the PRISM score which was 33 months⁽⁸⁾. One study that had an almost similar median age was done in Egypt and focused on under 5 years who had pneumonia and the mean age was 14 months (28). Another study done in Iran by Kadivar et al in evaluating the PRISM score had 46% of the children (n=205) being under 1 year old⁽³⁰⁾. The largest percentage of the children included in our study was infants as they comprised of 60 % of the study population. This age difference is important as this means that most of the medical paediatric acute room admission are infants, and the diseases that commonly affect this age group are different from the older children. Being able to take care of this age group with best available services will also reduce the infant mortality rate significantly.

Of importance to note with our study population is that 55% of the children were malnourished. This is a finding that has been reported in other developing countries example in Pakistan a study done by Qureshi et al there were 35% of malnourished children by weight for height measurement⁽²⁰⁾. However, malnutrition could not be established as an independent prognostic factor. Similar results have been documented in a study from India⁽²¹⁾. It is clearly known and has been stated by the world health organization that malnutrition is a major cause of mortality in the developing countries.

The type of admission was largely biased as this study was conducted in paediatric wards, hence the low number of the surgical patients. The median length of stay (LOS) was 3 days which is

comparable to other countries ranging from 2-11^{(22) (23) (31)}. In our study the length of stay was short compared to other developing countries example in Alexandria-Egypt they found a LOS of 22 days in the survivors and 12 days in the non survivors. Due to limited facilities and the large number of patients needing the services I our setting this can also influence the LOS because as soon as the patients are stable they are moved to create room for other sicker children.

Our study population had a mortality rate of 29% which is notably high compared to other critical care units where most of the studies the mortality rate was less than 10% in the developed countries. Singhal et al in a study done in India found a mortality rate of 18%, El Nawawy in Egypt had a mortality rate of 50% and 38% adjusted mortality rate⁽²⁴⁾. The high mortality rate can be attributed to the fact that in the hospital that this study was conducted there is not a well equipped acute room. It is important to note that the children needing ventilator support are actually admitted in the critical care unit and the other critically ill children who in other well equipped centers would be in high dependency unit are actually put in the acute room where this study was done.

There was a mean PRISM score of 18.80 in our study population. In the lower PRISM scores observed lower numbers of deaths as is similar to many more studies^(22,23,31). And an increase in the score was associated to increase in mortalities as is outlined in other papers.

The probability of death was noted to increase with increase in the PRISM score as is graphically outlined in figure 2. This probability is very similar to the probabilities that were found by Singhal et al in the study done in India⁽²²⁾. At a prism score of 5 the probability of death was 2.2 while at a score of 20 it was 33% and it was 76% at a score of 30. For the lower PRISM score our study had lower probabilities of death compared to the other studies. In Iran a study by Ali

Khajeh et al⁽³²⁾ had probability of death at 11% at a PRISM score of 5 and in the same study by Singhal et al the probability of death at a score of 5 was 9%.

Other important factors that are contributory to the mortality include the length of stay, which was found to be directly proportionate to the risk of mortality. This has been echoed in many other studies with the LOS being a risk factor for mortality risk^(24,19). In our study there was a 2.7 higher likelihood for death if patient was in the unit for duration of 4-7 days. Referral was another established risk factor for mortality which was similar to the study done by Kadivar establishing the same⁽³⁰⁾. Kenyatta National hospital being a national referral hospital means that most of the patients presenting in the institution have been through other health facilities and have been referred for more specialized care because they are already considered at high risk of mortality.

6.0 CONCLUSIONS:

- Increase in PRISM score increases the probability of death.
- There is significant association with length of stay in the hospital

7.0 LIMITATIONS:

The PRISM score is developed and validated for use in critical care setting, my study was conducted in a tertiary hospital with limited paediatric critical care facilities thus warranting admission of the very sick children in acute rooms which are meant to act as high dependency units but are not well equipped for that.

The study was only conducted in the medical wards thus very limited number of surgical patients.

8.0 RECOMMENDATIONS:

The PRISM score be adopted and used routinely as a severity of illness scoring system in paediatric medical acute rooms- Kenyatta National Hospital.

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APPENDIXES

Appendix 1: Study Timelines:

Nov 2012 to Nov 2013													
ACTIVITY	Nov	Dec	Jan	Feb	Mar	Apr	may	Jun	Jul	Aug	Sep	Oct	Nov
Proposal development and approval													
Ethical clearance													
Training research assistants and pre-testing questionnaires													
Data collection and verification													
Data analysis													
Writing & presentation of the draft													
Correction, and final thesis presentation													

Appendix 2: Brief Budget with Justification:

Stationery	Cost per unit(Ksh)	No. of units	Total Cost(Ksh)
Pens	20	6	120
Document Folders and spring file	30 each	5 of each	300
Printing	Cost per page(Ksh)	No. of pages	Total Cost(Ksh)
Questionnaires	10	8	80
PRISM Score Forms	10	3	30
Poster printing	2000	1	2,000
Final Thesis	10	100(estimate)	1,000
Photocopying	Cost per page(Ksh)	No. of pages	Total Cost(Ksh)
Questionnaires	3	8(*215)	5,160
PRISM Score forms	3	3(*215)	1,935
Final thesis	3	100(*6)	1,800
Thesis book binding	200/book	6	1,200
Laboratory Cost	Cost per sample(Ksh)	No. of samples	Total Cost(Ksh)
Blood Gas Analysis	600	195	117,000
Random blood sugar	100	195	19,500
Prothrombin time/prothrombin time test	400	195	78,000
Total Bilirubin	200	195	39,000
Serum Calcium	100	195	19,500
Potassium	100	195	19,500
Personnel	Cost per person(Ksh)	No. of people	Total Cost(Ksh)
Research Assistant	600/day	90 days	54,000
Statistician	30000	1	30,000
TOTAL COST(Ksh)			390,125

Assumption: sample vacutainer bottles, syringes and needles, to be provided by KNH

Appendix 3: Modified Glasgow Coma Scale for Infants and Children

Area Assessed	Infant	Children	Score
Eye opening	Open spontaneously		4
	Open in response to verbal stimuli		3
	Open in response to pain		2
	No Response		1
Verbal response	Coos and babbles	Oriented, appropriate	5
	Irritable cries	Confused	4
	Cries in response to pain	Inappropriate words	3
	Moans in response to pain	Incomprehensible words or nonspecific sounds	2
	No response		1
Motor response	Moves spontaneously and purposefully	Obeys commands	6
	Withdraws to touch	Localizes painful stimulus	5
	Withdraws in response to pain	Withdraws in response to pain	4
	Responds to pain with decorticate posturing (abnormal flexion)	Responds to pain with flexion	3
	Responds to pain with decerebrate posturing (abnormal extension)	Responds to pain with extension	2
	No response		1

Appendix 4: Questionnaire

STUDY:

Evaluating the performance of pediatric risk of mortality (PRISM) score as a tool to predict mortality in children admitted in Kenyatta national hospital.

PRINCIPAL INVESTIGATOR:

Dr. Kiniu Naomi Mukuhi -Masters in Medicine: Pediatric and child Health, University of Nairobi. Phone number: 0727635509

STUDY SITE:

Kenyatta National Hospital Pediatric wards in acute rooms and critical care unit.

Inclusion Criteria:

Admitted Cases in the critical care unit and the acute rooms in the wards aged 1 month to 12 years.

Exclusion criteria:

Among the children to be excluded from the study will include:

- Those with congenital malformations.
- Children who died within 8 hours or discharged from the unit within 24 hours.

BIODATA

Study number:-.....

Age: (in months).....

Gender:-

- Female
- Male

Weight (Kgs).....

Height (Cm).....

WHO Z score (height for Weight):

<-3 Z score (severe malnutrition)

-3 to <-2 Z score (moderate Malnutrition)

-2 to <-1 Z score (At risk)

\geq -1 Z score (normal)

DATA COLLECTED WITHIN 24 HOURS OF ADMISSION

In which unit is this patient admitted?

- Acute room
- Critical care unit

Is the patient a readmission (another admission into the unit within 48 hours?)

- Yes
- No

What type of admission is it?

- Medical
- Surgical

Which system is mainly affected by the primary disease?

- | | |
|--|---------------------------------------|
| <input type="radio"/> meningitis | <input type="radio"/> Malaria |
| <input type="radio"/> pneumonia | <input type="radio"/> Malignancies |
| <input type="radio"/> Diarrhea disease | <input type="radio"/> sepsis |
| <input type="radio"/> Acute kidney injury | <input type="radio"/> Malnutrition |
| <input type="radio"/> Trauma | |
| <input type="radio"/> Congestive cardiac failure | <input type="radio"/> Others(specify) |

What is the operative status of the patient?

- Post operative
- Non operative

Is the patient on mechanical ventilation?

- Yes
- No

If yes, what is the FiO2 on the machine?

Is the patient on inotropic support?

- Yes
- No

If yes, how many drugs are being used? -----

Is the patient on oxygen therapy?

- Yes
- No

If yes, tick the mode of oxygen delivery being used (estimated Fio₂)

- Nasal prong or nasal catheter (30%)
- Nasopharyngeal catheter (45%)
- Simple face mask (40%)
- Face mask with reservoir (80%)

What is the length of stay in this unit? (In days).....

What is the patient's outcome at the point of discharge from this unit?

- Alive
- Dead

A. PRISM SCORE TABLE

	PARAMETER	VALUE	SCORE
1.	SBP(mmHg)		
2.	DBP(mmHg)		
3.	HR(beats per minute)		
4.	RR(breath per minute)		
5.	GCS		
6.	Pupillary reaction		
7.	PaO ₂ :FiO ₂ ratio		
8.	PaCO ₂ (mmHg)		
9.	PT/PTT		
10.	Bilirubin(mg/dL)		
11.	Potassium(mEq/L)		
12.	Calcium(mg/dL)		
13.	Glucose(mg/dL)		
14.	Bicarbonate(mEq/L)		
15.	TOTAL SCORE		

Appendix 5: Client Information and Consent Form

DATE: _____ (day/month/year) SERIAL No:

Evaluating the performance of pediatric risk of mortality (prism) score as a tool to predict mortality in children admitted in Kenyatta national hospital.

Investigator:

Dr kiniu Naomi Mukuhi

University Of Nairobi: Pediatrics and Child Health department.

Emergency contacts:

Dr Kiniu Naomi - 0727635509

Email address: kiniunaomi@yahoo.com, PO Box-751-00618 Nairobi.

Sponsor: KNH- Department of Programs and Research

This Informed Consent Form has two parts:

- Information Sheet (to share information about the study with you)
- Certificate of Consent (for signatures if you choose to participate)

Part 1: Information Sheet.

Investigators Statement: We are asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether to be in the study. Please read this form carefully. You may ask questions about what we will ask you to do, the risks, the benefits and your rights as a volunteer, or anything about the research or in this form that is not clear. When all your questions have been answered, you can decide if you want to be in this study or not. This process is called “informed consent”.

Purpose and benefits: The aim of this study is to assess if the PRISM score can be used to establish how sick your child is and if he/she is at high risk of death and appropriate action taken accordingly. PRISM score is attained by combining examination findings and laboratory results obtained.

Through this study if the score is found to be a good assessment of how sick a child is and if there is high risk of death, then it will be routinely used to prioritize patients care in the pediatric acute rooms.

Procedure: This is what will happen if you decide to participate in this study. A study assistant will ask you questions about your Child's age and illness and fill them in a questionnaire. Your child will then be examined and the findings recorded. Then blood amounting to 5 mls will be drawn from your baby and taken to lab for testing to find out how the different body organs are working. The results obtained from the laboratory will then be communicated to your Child's doctor for necessary action to be taken. The study assistant will keep on checking on your Child's progress till discharge or transfer from the acute room.

This interview is expected to last about 20 minutes. The information recorded is confidential, your name or your child's name will not be included on the forms, only a serial number will identify you and no one else except the research investigators has access to your details.

Risks, Stress, Discomfort: We are asking you to share with us some very personal and confidential information, and you may feel uncomfortable answering some of the questions. You do not have to answer any question if you don't wish to do so. You do not have to give us any reason for not responding to any question.

The blood drawing can cause discomfort and pain at the puncture site. There is also a risk of fainting after blood is drawn.

Participation in the study will require you to commit your time to answer the questions asked by the study assistant and allow time for examination and blood drawing.

Confidentiality: We will not be sharing information about you to anyone outside of the research team. The information that we collect from this research project will be kept private. Any information about you will have a number on it instead of your name. Only the researchers will know what your number is and we will lock that information up under lock and key. It will not be shared with or given to anyone except the research team who will have access to the information

Although we will make every effort to keep your Child's information confidential, no system for protecting your confidentiality can be completely secure. It is still possible that someone could find out your child were in this study and could find out information about him/her

Sharing Results: Nothing that you tell us today will be shared with anybody outside the research team, and nothing will be attributed to you by name. The knowledge that we get from this research will be shared with you and other parents of children in pediatric wards acute room before it is made widely available to the public. Each participant will receive a summary of the results. There will also be small meetings and these will be announced. Following the meetings, we will publish the results so that other interested people may learn from the research.

Compensation: Participation in this study is on voluntary basis and no monetary token or any other form of reward will be given for participation or for any loss or expense incurred during this study.

You may withdraw from the study; refuse to answer any of the questions asked or to have any of the tests described above at any time without loss of benefit or penalty.

In event of any complains the investigator can be contacted on the emergency contacts listed above. The same complains can also be channeled to the Ethics review Committee (ERC) using the contacts shown below.

If you have any questions regarding the study you can contact the investigator listed above. You are free to refuse to participate in the study, if you decide not to participate in the study your child will receive similar care to that provided to other children participating in the study.

This proposal has been reviewed by the Kenyatta National Hospital/University of Nairobi Ethics and Review Committee (KNH/UON ERC) which is a committee whose task it is to make sure that research participants are protected from harm. If you wish to find about more about the ERC, contact

The Chairman,

Kenyatta National Hospital/University of Nairobi Ethics and Review Committee

P.O.BOX 20723 Nairobi, Kenya.

Part 2: Certificate of Consent

Subject's statement:

This study has been explained to me. I volunteer my child to take part in this research. I have had a chance to ask questions. If I have questions later on about the research I can ask the investigator listed above. If I have questions about my Childs rights as a research subject, I can call the University of Nairobi Ethics and research Committee at 2726300.

Signature of parent/guardian _____ Date _____ (day/month/year)

Or

Left thumbprint of parent/guardian _____ Date _____ (day/month/year)

Name of parent/guardian _____

Signature of witness (If thumbprint used) _____

Name of Witness _____

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands that a questionnaire will be administered to the participant. I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Print Name of Researcher/person taking the consent _____

Signature of Researcher /person taking the consent _____

Date _____ (Day/month/year)

FOMU YA KUPATA KIBALI CHA WAZAZI / WALEZI WA WASHIRIKI

Mimi ni Dkt Kiniu Naomi, mwanafunzi katika Chuo Kikuu cha Nairobi kutafuta masomo ya utaalumu katika afya ya watoto. Mimi ninafanya utafiti kuona kama tunaweza kutumia Score ya PRISM kuwajua watoto walio wagonjwa zaidi na wanaweza kufa kwa haraka ili wapate kuhudumiwa ipasavyo. Nitakupa taarifa na kukukaribisha kwa utafiti huu.

Kunaweza kuwa na baadhi ya maneno ambayo huelewi, tafadhali uliza nami nitachukua muda kueleza. Kama una maswali baadaye, waweza kuuliza na utajibiwa.

Score ya PRISM ni vipimo tofauti tofauti ambavyo vimekusanywa pamoja. Na kutumiwa kueleza kiwango cha ugojwa na athari ya kifo.

Sababu ya utafiti: Kwa kufanya utafiti huu tutaweza kujua au tunaweza kutumia vipimo tutakavyo fanywa kubainisha kiwango cha ugojwa kwa mtoto wako na matibabu yanayopaswa kuanzishwa kwa muda unaofaa.

Maandalizi ya utafiti: : Utafiti utafanywa kwa njia ya kupitia mahojiano ya moja kwa moja. Na baadaye mtoto wako atapimwa na kiwango kidogo cha damu kitatolewa ili kuweza kupata kiwango cha ugojwa. Msaidizi wa utafiti huu ataweza kuwajulia hali mpaka wakati wa kwenda nyumbani au chumba kingine.

Kushiriki katika utafiti huu ni wa hiari. Ni uamuzi wako kama utashiriki au la. Usipochagua kushiriki bado utapokea huduma zote katika hospitali hii. Unaweza kubadilisha mawazo yako baadaye na kuacha kushiriki hata kama ulikubali hapo awali. Unaweza kujiondoa katika utafiti huu wakati wowote.

Utafiti utafanyika kwa kipindi ambacho mtoto wako atakuwa amelazwa kwenye chumba cha “acute room” Wakati huo, tutathamini afya ya mtoto wako kila siku.

Maadhara: Utafiti wetu hautamdhuru mtoto wako kwa njia yoyote. Wakati tunamtoa mtoto wako damu atahisi uchungu kidogo kwa muda mfupi .Habari kukuhusu ambazo tutakusanya kutoka mradi wa utafiti huu itakuwa siri.

Mawasiliano: Kama una maswali yoyote unaweza kuuliza hivi sasa au baadaye, hata pia baada ya utafiti kuanza. Kama unataka kuuliza maswali baadaye, unaweza kuwasiliana nami kupitia nambari hii: 0727635509.

Nimesoma/ Nimesomewa maelezo haya na nimepewa nafasi ya kuuliza maswali kuhusu hayo maelezo. Nimeidhini kwa hiari mtoto wangu kuwa katika utafiti huu.

Jina la lako _____

Sahihi ya Mshiriki _____

Tarehe _____

Nina uhakika kuwa nimemsomea mwakilishi fomu hii, na kwa kadri ya uwezo wangu nilihakikisha kwamba mshiriki ameelewa. Nimethibitisha kuwa mshiriki alipewa nafasi ya kuuliza maswali kuhusu utafiti nakuyajibu vema kwa kadri ya uwezo wangu. Mimi nathibitisha kwamba mwakilishi hakulazimishwa kutoa kibali

Jina la Mtafiti / Mtu kuchukua kibali_____

Sahihi ya Mtafiti / mtu kuchukua kibali_____

Tarehe _____