COMPARATIVE STUDY BETWEEN PAEDIATRIC RISK OF MORTALITY III SCORE AND PAEDIATRIC INDEX OF MORTALITY 2 SCORE AS PREDICTORS OF MORTALITY IN PAEDIATRIC INTENSIVE CARE UNIT

By

Dr.PUNEET VARMA

DISSERTATION SUBMITTED TO THE SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, KOLAR, KARNATAKA

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF MEDICINE

IN

PEDIATRICS

Under the guidance of

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Dr. PUNEET VARMA

ABSTRACT

Background

Scoring systems such as the Paediatric Risk of Mortality (PRISM) score and Paediatric Index of Mortality (PIM) are widely used in paediatric intensive care. These are third generation scoring systems that allow assessment of the severity of illness and mortality risk adjustment in heterogeneous groups of patients in an objective manner, enabling conversion of these numbers into a numerical mortality risk based on logistic regression analysis. The purpose of their usage varies, and may include comparison of severity of illness between different treatment arms in clinical trials and comparison of quality of care between paediatric intensive care units (PICUs) using standardized (that is, severity of illness adjusted) mortality rates. Both the PRISM and PIM scoring system have been developed and carefully validated in tertiary PICUs. In some centers that were closely involved in developing these scoring systems, preliminary data have indicated that the degree of inter-observer reliability was acceptable. To make use of these scores, both at a clinical and policy level, it is important to know if the score is relevant and valid in a patient population, which is different from the population in whom it was derived. There are very few studies which evaluate the performance of severity of illness scoring systems in Indian PICUs.

Objective

The objective of present study is to determine the performance of the PRISM and PIM scores in our PICU, to compare the predicted mortality with the observed mortality and to determine the suitability of each score for application in our paediatric intensive care unit.

Method

The study was conducted at R.L.Jallapa Hospital affiliated to Sri Devraj Urs Medical College, Kolar. Patients getting admitted to PICU under AAP protocol of admission to PICU, from February 2013 to January 2014were included. Minimal sample size of 73 was estimated after usage of appropriate sample size calculation method and finally 77 samples were analyzed. PIM 2 score was applied within one hour of admission and PRISM III-24 scoring was done with 24 hours of admission with a predesigned proforma which included a consent form. A comparative study was done to compare the predicted and observed mortality, to find out which of the scoring methods predicted accurate outcomes and to know which amongst the two was more suitable for application in our PICU.

Results

The study included 77 patients PIM 2 and PRISM III-24 score was applied as per protocol. The outcomes were as follows the mean predicted death rate was nearer to observed death rate in PRISM when compared to PIM, i.e. 25.94% to 34.40% over 12.48% to 34.40%. Hosmer and Lemeshow test results showed that both PRISM and PIM scores were good and satisfied the test, as p value in both the studies for the analytical test was >0.05, hence both were significant at 5% significance level. PRISM had the better prediction over PIM score as the classification accuracy was better in PRISM. PRISM had classification accuracy of 89.6 over 84.4 of PIM. This indicated that PRISM is better in predicting deaths and survival over PIM score. ROC curve showed that area under ROC curve was >0.8 for both PRISM and PIM scores which offered a good discriminative power for both the scores. Discriminative power

for PRISM was better over PIM as area under ROC curve was more for PRISM when compared to PIM, i.e. 9.30 over 9.22. In the calibration table both the studies showed good calibrations ($p>0.05$). Better calibration indicates better prediction and PRISM showed better calibration in predicting the outcome when compared to PIM. Estimates of Binary Logistic model showed that both PRISM and PIM were accurate but PRISM was better over PIM, with a standard error of 2.318 over 13.539.

Conclusion

This study shows that both PRISM III-24 and PIM 2 are good predictors of mortality and both have good calibration and both can be applied in our PICU setup but PRISM is relatively better over PIM when compared.

ABBREVATIONS

AAP	American Academy of Pediatrics
ALT	Alanine Amminotransferase
APACHE	Acute Physiology and Chronic Health Evaluation
APTT	Activated Partial Thromboplastin Time
AST	Aspartate Amminotransferase
BUN	Blood Urea Nitrogen
CNS	Central Nervous System
CPAP	Continuous Positive Airway Pressure
CVS	Cardio Vascular System
DBP	Diastolic Blood Pressure
ECMO	Extra Corporeal Membrane Oxygenation
FiO2	Fractional Inspiratory Oxygen
GCS	Glasgow Coma Scale
GI	Gastro Intestinal
HCO3-	Bicorbonate
ICU	Intensive Care Unit
MODS	Multi Organ Dysfunction Syndrome
PaCO2	Partial Pressure of Carbon dioxide
PaO2	Partial Pressure of Oxygen
PCWP	Pulmonary Capilllary Wedge Pressure
PELOD	Pediatric Logistic Organ Dysfunction
PGCS	Paediatric Glasgow Coma Scale
PHDU	Paediatric High Dependency Unit
PIC	Paediatric Intensive Care
PICU	Paediatric Intensive Care Unit

PIM	Paediatric Index of Mortality
PRISM	Paediatric Risk of Mortality
PSI	Physiologic Stability Index
PT	Prothrombin Time
ROC	Receiver Operator Characteristic
RS	Respiratory System
SAPS	Simplified Acute Physiology Score
SBP	Systolic Blood Pressure
SCCM	Society of Critical Care Medicine
SOFA	Sequential Organ Failure Assessment
TISS	Therapeutic Intervention Scoring System
WBC	White Blood Cell

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Introduction

INTRODUCTION

The main purpose of the paediatric intensive care unit (PICU) is to prevent mortality by intensively monitoring and treating critically ill children who are considered at high risk of mortality. The capability to estimate patient risk of death is extremely important because such estimate would be useful in achieving many different goals such as assessing patient's prognosis, ICU performance, ICU resource utilization and also evaluating therapies, controlling and matching severity of illness in clinical studies.

PRISM, PIM, and PELOD scores are composite scores (aggregate scales) that are made up of a group of variables. Many types of variables can be used in constructing such scores, including clinical data like heart rate, physiologic data like cardiac index, laboratory data like creatinine or PaO2, and other scores like the Glasgow coma score that is integrated into the PRISM score. Points that estimate severity of illness are given to each variable in proportion to its predictive weight. The number of points of each variable should be proportional to its capacity to predict a given outcome.

Initially scoring systems were developed for trauma patients and were either specific anatomical methods (abbreviated injury scale 1969, burn score 1971, injury severity score 1974) or specific physiological methods (trauma index 1971, Glasgow coma scale 1974, trauma score 1981 and sepsis score 1983)[1].

Scoring systems such as the Paediatric Risk of Mortality (PRISM) score and Paediatric Index of Mortality (PIM) are widely used in paediatric intensive care. These are third generation scoring systems that allow assessment of the severity of illness and mortality risk adjustment in heterogeneous groups of patients in an

objective manner, enabling conversion of these numbers into a numerical mortality risk based on logistic regression analysis. The purpose of their usage varies, and may include comparison of illness between different treatment arms in clinical trials and comparison of quality of care between paediatric intensive care units (PICUs) using standardized (that is, severity of illness adjusted) mortality rates.[3-5] Both the PRISM and PIM scoring system have been developed and carefully validated in tertiary PICUs. In some centers that were closely involved in developing these scoring systems, preliminary data have indicated that the degree of inter-observer reliability was acceptable[2,6,7].

To make use of these scores, both at a clinical and policy level, it is important to know if the score is relevant and valid in a patient population, which is different from the population in whom it was derived. There are very few studies which evaluate the performance of severity of illness scoring systems in Indian PICUs. The objective of present study is to determine the performance of the PRISM and PIM scores in our PICU, to compare the predicted mortality with the observed mortality and to determine the suitability of each score for application in our intensive care unit.

1. PRISM III Score: Paediatric Risk of Mortality score: A prognostic scoring system derived from 17 physiologic variables assessed during the first 24 hrs of care in an ICU for paediatric populations that derives from the PSI– physiology stability index.
2. PIM2 Score: Paediatric Index of Mortality score: A prognostic scoring system derived from 10 physiologic variables assessed during the first contact of a patient with a doctor in an ICU or emergency wing for paediatric populations.

Our hospital being the only tertiary centre in Kolar district, we do have many admissions in our PICU. In this study PRISM III and PIM 2 scores were

applied to all patients getting admitted to our PICU and falling under AAP criteria for admission to PICU. Mortality risks were predicted by both the scores at the earliest i.e. within 24 hours by PRISM III and 1 hour by PIM2 and were compared to the actual outcomes.

Objectives

AIMS AND OBJECTIVES

1. To compare PRISM and PIM score in predicting mortality of patients admitted to PICU under AAP protocol for admission to PICU.
2. To determine the suitability of each score for application in our intensive care in our unit.

Review of Literature

REVIEW OF LITERATURE

HISTORY OF PICU[34]

The development of Paediatric Critical Care followed the development of adult and neonatal intensive care. Florence Nightingale established the concept of Critical Care in 1863, who grouped postoperative patients into a common area, which reported significant reduction in the postoperative morbidity and mortality. During the epidemic of poliomyelitis in Copenhagen, it was recognised that children had higher mortality than adults in these poliomyelitis cases; so, the Paediatric Intensive Care was first established in 1950s in Sweden and Stockholm. In United States the first PICU was established in 1967 with the help of Mr.Downes. The Society of Critical Care medicine was established in 1968, and the Paediatric section of the SCCM was established in 1984. Then slowly the paediatric critical care developed in other parts of the world, like Europe and Australia.

History of paediatric critical care in India Though there were many centres taking care of the critically ill children, these children were treated in adult intensive care unit. Though one accepts the principle thatthe common denominator is not the age of the patient or which service he or she originates from, but rather the round the clock availability of paediatric oriented intensive care specialists. There are two specific objections to combine adults and children. The first is that children come in all different size and shapes and are not small people but different people. The second objection is that of potential of psychological trauma to a small child in a busy unit managing adults and children. So, with that in the mind the first organized paediatric Intensive Care Unit was established in 1991 at Kanchi Kamakoti Childs Trust

Hospital, with seven beds with separate team of doctors and nurses, with the paediatric anaesthesiologist as the in charge of the Unit. The first organized paediatric Advanced Life Support course recognized by the American Heart Association, American Academy of Paediatrics and the Indian Academy of Paediatrics was conducted at Chennai by Dr.N.Janakiraman, Past Chairman and Director, Division of paediatric critical care, Cook county Children's hospital, Chicago, USA. Thereafter, the PALS course is being conducted regularly in India, which has created lot of awareness and enthusiasm among the paediatricians in the concept 'Critically ill children can be saved'. In 1997 the intensive care group of Indian Academy of Paediatrics was formed. The first national congress of paediatric critical care was held at Nagpur lead by Dr.Deopujari in 1998. In 1999, the paediatric section of the Indian Society of Critical care medicine was established. The Journal, Indian Journal of Critical Care medicine, is a peer reviewed journal which has articles published regularly on subjects related to paediatric critical care. The paediatric Intensive Care group of Indian Academy of Paediatrics publishes regularly the half yearly newsletter **'THE INTENSIVIST'**. The Paediatric section of Indian Society of Critical care Medicine has given some guidelines for the organization of paediatric critical care in India.

Patients receiving medical care in intensive care units (ICUs) account for nearly 30% of acute care hospital costs, yet these patients occupy only 10% of inpatient beds[8,9].

PAEDIATRIC CRITICAL CARE[10]

Paediatric Critical Care services look after children and young people whose conditions are life-threatening and need constant, close monitoring and support from equipment and medication restore and/or maintain normal body functions. Care is

provided in specialist areas (Intensive Care Units (PICUs) or High Dependency Units (PHDU)) that have high levels of highly trained staff, monitoring and treatment equipment.

UK statistics from 2008 to Dec 2010 for the 0–15 age group, indicate the following national averages:

1. 40.9% of admissions (52,337 in total) to PICU are planned - 34.2% (17,891) following surgery, and 6.7% (3,513) for non-surgical reasons.
2. 59.1% (30,933) of admissions are for unplanned emergency care.
3. The top three indications for admission to a paediatric intensive care unit are:
    i. cardiovascular (28.6%);
    ii. respiratory (26.0%);
    iii. neurological (11.0%).
4. 65.7% require invasive mechanical ventilation (i.e. via an endotracheal tube) during their stay; •14.9% will require non-invasive ventilation.
5. These averages conceal substantial inter-unit variation, with the percentage of children on PICU requiring invasive ventilation varying from 6 to 85%.

PICU should be planned on an annualized overall average occupancy of around 80%. However, there is considerable seasonal variation in demand, and PICU are especially susceptible to "winter pressures" due to the increase in severe respiratory infections (especially bronchiolitis) during the winter months.

THE AIM OF THE PICU[10]

The aim of the PICU service is to provide care for the critically ill or injured child, including those recovering from elective surgery and that care is delivered "within PICUs conforming to agreed guidelines and standards". These national

standards set out the optimal requirements for the care of critically ill children and their families and identify specific medical, nursing, technical and emotional needs that are best provided by a specialist Paediatric Intensive Care multidisciplinary team in a PICU.

The PICU Service will deliver the aim to provide critical care to national standards:

1. Paediatric Intensive Care (PIC) is provided as part of a pathway of care and co- located with other specialist children's services and facilities.
2. All PIC will be provided in PICUs and only in other facilities until the arrival of the PIC Retrieval team with exception of short term care which may be provided in Adult ICUs as part of a local agreement with the lead center and the network
3. A PICU must provide or have access to a 24 hour Retrieval Service.
4. PIC must be provided by appropriately trained staff in equipped facilities.
5. Families should be able to participate fully in decisions about the care of their child and wherever possible, in giving this care.
6. Appropriate support services to children and families during the child's critical illness and, if necessary, through bereavement must be provided
7. There must be active support to the care of critically ill children in referring hospitals, including through advice, training and audit delivered through a network

PICU provides care for children requiring intensive care and monitoring, including medically unstable patients requiring intubation or ventilation, single or multi-organ support, and continuous or intensive medical or nursing supervision. PICU also provides routine planned post-operative care for surgical procedures, or during some planned medical admissions.

Children may access the critical care pathway to PICU through a number of routes:

- Inpatient children's services within the same hospital
- Operating theatres
- Neonatal units and occasionally, labour wards.
- Emergency Department

PICU Retrieval Service will facilitate many of the admissions to PICU from secondary care.

The service must ensure that comprehensive referral pathways and mechanisms are in place, and that similar pathways are in place to support egress from the service. This will include:

- Escalation to highly specialized services.
- Step-down facilities such as paediatric High Dependency Unit.
- Transfer to inpatient children's service (acute paediatric wards)
- Palliative care.
- Community care, as appropriate to patient's needs

Inpatient paediatric critical care services must be available and fully operational 24 hours per day, 365 days per year.

The service are delivered by appropriately trained and skilled staff, including consultant- level cover on the PICU at all times and must be able to act co-operatively with other PICUs and paediatric intensive care retrieval services. PICUs are unlikely to be able to meet demand from their catchment area 100% of the time, and PICUs must be seen as part of a cooperative system to meet national demand.

Paediatric intensive care is delivered in 3 types of hospital within a network model:

- Lead centres, providing most of the intensive care needed in the area and supporting the whole service for the area through provision of advice and training.
- Major acute general hospitals with large adult intensive care units, which already provide a considerable amount of paediatric intensive care.
- Specialist hospitals providing some intensive care in support of specific specialties (e.g. cardiac surgery, neurosurgery, burn care).

Paediatric intensive care is split into four care levels[10]:

- **Level 1: high dependency care**: Children requiring closer observation and monitoring than is usually available on an ordinary children's ward, with higher than usual staffing levels.
- **Level 2: intensive care (simple):**Children requiring continuous nursing supervision, and may need ventilatory support (including CPAP) or support of two or more organs systems. Usually children at level 2 are intubated to assist breathing.
- **Level 3: intensive care (complex):**Children requiring intensive nursing supervision at all times, undergoing complex monitoring and/or therapeutic procedures, including advanced respiratory support.
- **Level 4: highly specialized intensive care:** Children receiving treatment by extra-corporeal membrane oxygenisation (ECMO) provided at a very small number of hospitals are sometimes described as requiring level 4 intensive care.

ADMISSIONS TO PICU[10]

Paediatric intensive care admission is mandatory for children likely to require advanced respiratory support (i.e. acute or medium term mechanical ventilation), but children should also be referred to PICU if they:

- Are highly likely to require an intensive care dependent procedure.
- Have symptoms or evidence of shock, respiratory distress or respiratory depression.
- Have the potential to develop airway compromise.
- Have an unexplained deteriorating level of consciousness
- Have required resuscitation or who are requiring some form of continuous resuscitation
- Have received a significant injury
- Have had prolonged surgery or any surgical procedure that is medium or high risk, or of a specialist nature – even if elective
- Have potential or actual severe metabolic derangement, fluid or electrolyte imbalance
- Have acute organ (or organ system) failure.
- Have established chronic disease (or organ system failure) and who experience a severe acute clinical deterioration, or secondary failure in another organ system
- require one-to-one nursing due to the severity of an acute or acute-on-chronic illness.

Patients should be retrieved to a PICU if the expected length of intubation is more than 24 hours

EXCLUSION CRITERIA

- Neonates that have not already been discharged home are not usually cared for in a PICU. However, arrangements may be agreed locally relating to the management of neonates requiring intensive care following surgery – for example, cardiac and gastrointestinal surgery. Any neonate cared for in a PICU will be classified as receiving paediatric critical care.
- Adult patients should not be treated in a PICU, though patients aged 16-18 years (or occasionally, up to 24 years) may be treated in a PICU if this is deemed to be the most appropriate location care based on individual needs.
- Children with a PICU stay of ≤4 hours are not classified as having a chargeable PICU stay.
- Only a limited number of centres nationally have the facilities to provide respiratory ECMO and other highly specialised paediatric intensive care, for example, Burns Care, though some PICUs providing Level 3 and 4 care have the ability to „step-up" their care level on a short-term basis.

AMERICAN ACADEMY OF PEDIATRICS (AAP) RECOMMENDS FOLLOWING CRITERIA FOR ADMISSION TO PICU[11]:

Respiratory System

Patients with severe or potentially life-threatening pulmonary or airway disease. Conditions include, but are not limited to:

1. Endotracheal intubation or potential need for emergency endotracheal intubation and mechanical ventilation, regardless of etiology;
2. Rapidly progressive pulmonary, lower or upper airway, disease of high severity with risk of progression to respiratory failure and/or total obstruction;

3. High supplemental oxygen requirement (Fio2 >0.5), regardless of etiology;
4. Newly placed tracheostomy with or without the need for mechanical ventilation;
5. Acute barotrauma compromising the upper or lower airway;
6. Requirement for more frequent or continuous in- haled or nebulized medications than can be administered safely on the general pediatric patient care unit (according to institution guidelines).

Cardiovascular System

Patients with severe, life-threatening, or unstable cardiovascular disease. Conditions include, but are not limited to:

1. Shock;
2. Postcardiopulmonary resuscitation;
3. Life-threatening dysrhythmias;
4. Unstable congestive heart failure, with or without need for mechanical ventilation;
5. Congenital heart disease with unstable cardio- respiratory status;
6. After high-risk cardiovascular and intrathoracic procedures;
7. Need for monitoring of arterial, central venous, or pulmonary artery pressures;
8. Need for temporary cardiac pacing;

Neurologic

Patients with actual or potential life-threatening or unstable neurologic disease. Conditions include, but are not limited to:

1. Seizures, unresponsive to therapy or requiring continuous infusion of anticonvulsive agents;

2. Acutely and severely altered sensorium where neurologic deterioration or depression is likely or unpredictable, or coma with the potential for air- way compromise;
3. After neurosurgical procedures requiring invasive monitoring or close observation;
4. Acute inflammation or infections of the spinal cord, meninges, or brain with neurologic depression, metabolic and hormonal abnormalities, and respiratory or hemodynamic compromise or the possibility of increased intracranial pressure;
5. Head trauma with increased intracranial pressure;
6. Preoperative neurosurgical conditions with neurologic deterioration;
7. Progressive neuromuscular dysfunction with or without altered sensorium requiring cardiovascular monitoring and/or respiratory support;
8. Spinal cord compression or impending compression;
9. Placement of external ventricular drainage device.

Hematology/Oncology

Patients with life-threatening or unstable hematologic or oncologic disease or active lifethreatening bleeding. Conditions include, but are not limited to:

1. Exchange transfusions;
2. Plasmapheresis or leukopheresis with unstable clinical condition;
3. Severe coagulopathy;
4. Severe anemia resulting in hemodynamic and/or respiratory compromise;
5. Severe complications of sickle cell crisis, such as neurologic changes, acute chest syndrome, or aplastic anemia with hemodynamic instability;

6. Initiation of chemotherapy with anticipated tumor lysis syndrome;
7. Tumors or masses compressing or threatening to compress vital vessels, organs, or airway.

Endocrine/Metabolic

Patients with life-threatening or unstable endocrine or metabolic disease. Conditions include, but are not limited to:

1. Severe diabetic ketoacidosis requiring therapy exceeding institutional patient care unit guidelines. (If hemodynamic or neurologic compromise, see specific section);
2. Other severe electrolyte abnormalities, such as:
    a. Hyperkalemia, requiring cardiac monitoring and acute therapeutic intervention
    b. Severe hypo- or hypernatremia
    c. Hypo- or hypercalcemia
    d. Hypo- or hyperglycemia requiring intensive monitoring
    e. Severe metabolic acidosis requiring bicarbonate infusion, intensive monitoring, or complex intervention
    f. Complex intervention required to maintain fluid balance
3. Inborn errors of metabolism with acute deterioration requiring respiratory support, acute dialysis, hemoperfusion, management of intracranial hypertension, or inotropic support.

Gastrointestinal

Patients with life-threatening or unstable gastrointestinal disease. Conditions include, but are not limited to:

1. Severe acute gastrointestinal bleeding leading to hemodynamic or respiratory instability; 2. After emergency endoscopy for removal of foreign bodies;
2. Acute hepatic failure leading to coma, hemodynamic, or respiratory instability.

Surgical

Postoperative patients requiring frequent monitoring and potentially requiring intensive intervention. Conditions include, but are not limited to:

1. Cardiovascular surgery;
2. Thoracic surgery;
3. Neurosurgical procedures;
4. Otolaryngologic surgery;
5. Craniofacial surgery;
6. Orthopedic and spine surgery;
7. General surgery with hemodynamic or respiratory instability;
8. Organ transplantation;
9. Multiple trauma with or without cardiovascular instability;
10. Major blood loss, either during surgery or during the postoperative period.

Renal System

Patients with life-threatening or unstable renal disease. Conditions include, but are not limited to:

1. Renal failure;
2. Requirement for acute hemodialysis, peritoneal dialysis, or other continuous renal replacement therapies in the unstable patient;
3. Acute rhabdomyolysis with renal insufficiency.

Multisystem and Other

Patients with life-threatening or unstable multisystem disease. Conditions include, but are not limited to:

1. Toxic ingestions and drug overdose with potential acute decompensation of major organ systems;
2. Multiple organ dysfunction syndrome;
3. Suspected or documented malignant hyperthermia;
4. Electrical or other household or environmental (eg, lightning) injuries;
5. Burns covering .10% of body surface (institutions with burn units only; institutions without such units will have transfer policy to cover such patients).

Special Intensive Technologic Needs

Conditions that necessitate the application of special technologic needs, monitoring, complex intervention, or treatment including medications associated with the disease that exceed individual patient care unit policy limitations.

DISCHARGE/TRANSFER CRITERIA

Patients in the PICU will be evaluated and considered for discharge based on the reversal of the disease process or resolution of the unstable physiologic condition that prompted admission to the unit, and it is determined that the need for complex intervention exceeding general patient care unit capabilities is no longer needed.

Transfer/discharge will be based on the following criteria:

1. Stable hemodynamic parameters;
2. Stable respiratory status (patient extubated with stable arterial blood gases) and airway patency;
3. Minimal oxygen requirements that do not exceed patient care unit guidelines;
4. Intravenous inotropic support, vasodilators, and antiarrhythmic drugs are no longer required or, when applicable, low doses of these medications can be administered safely in otherwise stable patients in a designated patient care unit;
5. Cardiac dysrhythmias are controlled;
6. Intracranial pressure monitoring equipment has been removed;
7. Neurologic stability with control of seizures;
8. Removal of all hemodynamic monitoring catheters;
9. Chronically mechanically ventilated patients whose critical illness has been reversed or resolved and who are otherwise stable may be discharged to a designated patient care unit that routinely manages chronically ventilated patients, when applicable, or to home;
10. Routine peritoneal or hemodialysis with resolution of critical illness not exceeding general patient care unit guidelines;
11. Patients with mature artificial airways (tracheostomies) who no longer require excessive suctioning;
12. The health care team and the patient's family, after careful assessment, determine that there is no benefit in keeping the child in the PICU or that the course of treatment is medically futile.

Scoring Systems in PICU

The main purpose of the paediatric intensive care unit (PICU) is to prevent mortality by intensively monitoring and treating critically ill children who are considered at high risk of mortality. The capability to estimate patient risk of death is extremely important because such estimate would be useful in achieving many different goals such as assessing patient's prognosis, ICU performance, ICU resource utilization and also evaluating therapies, controlling and matching severity of illness in clinical studies[12].

The lack of consistency, reliability, and accuracy in physician's subjective opinions concerning patient status necessitates quantitative clinical scores. Physicians are in general poor prognosticators. In fact more accurate predictions result from actuarial methods than from clinical methods. Besides scoring systems have been developed in response to increasing emphasis on the evaluation and monitoring of health services.

Scoring systems are arrived at evaluation of the patient's mortality risk in the ICU by assigning a score to patient and predicting the outcome. However, patient's mortality is not only affected by ICU performance but also depends on many other factors such as demographic and clinical characteristic of population, infrastructure and non-medical factors (management and organization), case mix and admission practice.[13]

Therefore there is need for field testing of these scoring system in setting different from the one in which they were originally developed. The ideal probability model / scoring system would be institution independent and population independent. Initially scoring systems were developed for trauma patients and were either specific anatomical methods (abbreviated injury scale 1969, burn score 1971, injury severity

score 1974) or specific physiological methods (trauma index 1971, Glasgow coma scale 1974, trauma score 1981 and sepsis score 1983).[12]

Different scoring methods are followed in different PICU's for assessment of risks. Among them the most commonly used ones are:

Therapeutic Intervention Scoring System (TISS)

In 1974 Therapeutic intervention scoring system (TISS) was introduced by Cullen D J et al to quantitate severity of illness according to the therapeutic interventions received by the patients. 8 Each intervention had a value of 1-4 points based upon the complexity and invasiveness of intervention with a total score of 70 interventions. TISS has been utilized for many purposes which include:-

1. Determining the severity of illness
2. Establishing nurse patient ratio in ICU.
3. Assessing current utilization of hospital intensive care beds.
4. Establishing future need and numbers of ICU beds particularly in response to request for certification of need.

TISS was found to be a useful tool for obtaining comparable data which could be utilized for administrative, management and clinical purposes, within and between hospital settings.[14] Unfortunately, TISS score is heavily influenced by diagnosis, indicating the TISS score depends on the monitoring and therapeutic philosophies of the physicians and institutions using it.[15]

Compared with other predictors, it cannot quantify mortality risk. Efforts to evolve the TISS score by com- bining physiological dysfunction with therapies has been relatively unsuccessful.[16]

The Acute Physiology and Chronic Health Evaluation (APACHE) system

The acute physiology and chronic health evaluation (APACHE) system was introduced (for adult patients) in 1981 by an expert panel of physicians who selected and weighed 34 laboratory and clinical measurements based on perceived impact on mortality. It consisted of 2 parts: An acute physiology score that reflected the degree of physiologic derangements and a chronic health evaluation that reflected patient's status before the acute illness.

There are now three APACHE system i.e. I, II, III. An increasing APACHE II score reflects increased severity of disease and a higher risk of hospital death. But the system was neither designed nor intended to predict for individual patients and it has an error rate of approximately 15% for the prediction of hospital mortality using 0.50 decision point. APACHE III was introduced in 1991 to expand and improve the prognostic estimate provided by APACHE II.[17]

APACHE III system consists of points for physiologic abnormalities, age and chronic health status. Scoring is based on a degree of abnormality in 17 physiologic variables (APS), which reflects value for vital signs, laboratory tests and neurological status. In addition, points are added based on age and 7 co-morbid conditions shown to have a significant impact on short term mortality.[18] It can be used to measure the severity of disease and to risk stratify patients within a single diagnostic category or independently define patient group. It can also be used to compare patient outcomes but only for ICU admissions meeting diagnostic and selection criteria similar to those used in APACHE study.

The APACHE system is appropriate for adult ICUs. However the changing physiology with growth and development within the wide spectrum of ages of

paediatric patients prevents its direct application to PICUs.[19] The limited number of patients and diverse conditions make diagnostic subgroups difficult to study.[19]

Physiologic Stability Index (PSI).

Physiologic Stability index (PSI) was developed by a group of paediatric intensivists in 1984 from TISS.As TISS only indirectly reflects the severity of illness by assessing therapeutic needs. PSI assesses the severity of acute illness in the total population of paediatric intensive care unit patients by quantitating the degree of derangement in 34 variables from 7 major physiologic systems. Each variable was assigned a score of 1(abnormality worth concern but not to change therapy), 3 (need to change therapy), and 5 (life threatening). This reflected the clinical importance of derangements but not necessarily the amount of deviation from the normal value. The most abnormal value of a variable recorded within 24 hours was used.[20]

PSI however, is time consuming; requiring the use of 34 variables from 7 physiologic systems and also it is a subjective score. A total of 294 clinical classification system (CCS) class III and IV patients in a PICU were evaluated by using PSI / TISS ratio. Non survivors had significantly higher ($p < 0.01$) PSI and TISS scores than survivors. Medical patients had the highest PSI / TISS ratio scores while, cardiovascular patients had lowest PSI / TISS ratio scores.[19]

To reduce the number of physiologic variables required for severity of illness assessment and to obtain an objective weighting of remaining variables, a second generation score called pediatric risk of mortality (PRISM) has been devised by Pollack MM et al in 1988.[21]

Table 1: Physiologic stability Index:

Physiologic Systems (7) and Variables (34)

1. Cardiovascular: systolic blood pressure, diastolic blood pressure, heart rate, cardiac index, C(a-v)O2, CVP, PCWP
2. Respiratory: respiratory rate, PaO2, PaO2/FIO2, PaCO2
3. Neurologic: Glasgow coma score, intracranial pressure, seizures, pupils
4. Hematologic: hemoglobin, WBC count, platelet count, PT/PTT, FSP
5. Renal: BUN, creatinine, urine output
6. Gastrointestinal: AST/ALT, amylase, total bilirubin and albumin.
7. Metabolic: sodium, potassium, calcium, glucose, osmolality, pH, HCO_3

Points for each variable:0, 1, 3, 5reflect clinical importance of derangement, with more abnormal having higher point valuenot intended to reflect magnitude of deviation from the normal value

Variable	**0 Points**	**1 Points**	**3 Points**	**5 Points**
Systolic blood pressure in mm Hg				
Infant	66-129	55-65, or 130-160	40-54, or > 160	< 40
Children	66-149	65-75,	50-74, or >	< 50

		or 150-200	200	
Diastolic blood pressure, in mm Hg	< 90	90-110	> 110	
Heart rate, in beats per minute				
Infant	91-159	75-90, or 160-180	50-74, or 181-220	< 50, or > 220
Children	81-149	60-80, or 150-170	40-59, or 171-200	< 40 or > 200
Cardiac index, in L per min per square meter	> 3.0	2.0-3.0	1.0-1.9	< 1.0
Arterial to mixed venous oxygen content difference, C(a-v)O2, in ml O2 per dL (vol%)	3.0-5.4	< 3.0, or 5.5-6.5	> 6.5	
CVP, in mm Hg	0-15	< 0, or >		

		15		
Wedge pressure, or left atrial pressure, in mm Hg	5-14	< 5, or 15-25	> 25	
Respiratory rate, in breaths per minute				
• nfants	< 50	< 30	61-90	> 90, apnea
• hildren	<50	51-60	61-70	> 70
PaO2, in mm Hg	> 50	50-60	40-49	<40
PaO2/FIO2	> 300	200-300	< 200	
PaCO2 in mm Hg	30-44	< 30, or 45-50	51-65	< 65
pH	7.31-7.54	7.20-7.30, or 7.55-7.65	7.10-7.19, or > 7.65	< 7.10

Glasgow Coma Score	> 11	8-11	5-7	<5
Intracranial pressure, in mm Hg	< 15	15-20	21-40	>40
Seizures		focal	grand mal or status epilepticus	
Pupils	Equal and responsive	equal and sluggish	unequal and sluggish	fixed and dilated
Hemoglobin, in g/dL	7.1-17.9	5.0-7.0, or 18.0-22.0	3.0-5.0, or 22.1-25.0	<3.0
WBC count, per µL	5,001 - 19,999	3,000-5,000, or 20,000 -	< 3,000, or > 40,000	

		40,000		
Platelet count, per µL	51,000 - 999,999	20,000-50,000, or > 1 M	< 20,000	
PT/PTT ratio, relative to normal control PT/PT	<= 1.5	> 1.5		
Fibrin split products in µg/mL	<= 40	> 40		
BUN, in mg/dL	< 40	40-100	> 100	
Creatinine, in mg/dL	< 2.0	2.0-10.0	> 10.0	
Urine output, in mL per kg per hour	> 1.0	0.5-1.0	< 0.5	
AST / ALT, in IU/L	<= 100	> 100		
Amylase, in U/L	<= 500	> 500		
Total bilirubin, in mg/dL	<= 3.5	> 3.5		
Serum albumin, in g/dL	> 2.0	1.2-2.0	< 1.2	
Sodium, in mEq/L	126-	115-	< 115,	

	149	125, or 150-160	or > 160	
Potassium, in mEq/L	3.6-6.4	3.0-3.5, or 6.5-7.5	2.5-2.9, or 7.6-8.0	< 2.5, or > 8.0
Calcium, in mg/dL	8.1-11.9	7.0-8.0, or 12.0-15.0	5.0=6.9, or > 15.0	< 5.0
Glucose, in mg/dL	61-249	40-60, or 250-400	20-39, or > 400	< 20
Osmolality, in mOsm/L	< 320	320-350	> 350	
Bicarbonate, in mEq/L	16-32	< 16 or > 32		

Where:

- Infants are all those under 1 year of age; children are all those older than 1 year of age
- AST/ALT is taken to be the ratio of the transaminases
- Hypoosmolality does not seem be included for evaluation

Physiologic stability index =SUM (points for each physiologic variable)

Interpretation : Index scores:

- Minimum score 0
- Maximum score 119

Higher scores indicate more severe disease

Scores compared:

- On day of admission

1. Maximum score
2. 4-day average
3. Trend over hospital course

Trends over hospital course:

1. Decreasing indicates improvement
2. Increasing indicates worsening
3. Unchanging

Probability of mortality = (EXP{[0.277 * (4 day average PSI)] - 5.241})

(1 + (EXP{[0.277 * (4 day average PSI)] - 5.241}))

<u>Pediatric Risk Of Mortality (PRISM)</u>

Pediatric risk of mortality (PRISM) score allows for mortality risk assessment in the paediatric ICU. PRISM was developed from PSI to reduce the number of variables from 34 to 14 and number of ranges from 75 to 23 without losing the predictive power. It is institution independent and can be used within limits to compare different intensive care units.[22]

The 14 Parameters:

1. Systolic blood pressure and age
2. Diastolic blood pressure
3. Heart rate
4. Respiratory rate
5. PaO2 to FIO2 ratio
6. PaCO2
7. Glasgow coma score
8. Pupillary reactions to light
9. PT and PTT
10. Total serum bilirubin
11. Serum potassium
12. Serum total calcium
13. Glucose
14. Bicarbonate

In 1996 physiological variables and their ranges as well as diagnostic and other risk variables reflective of mortality risk were reevaluated by Pollack MM et al to update and improve the performance of second generation PRISM score. Thus PRISM III was developed.[23]

PRISM III

This was based upon a sample of 11,165 consecutive admissions to 32 paediatric ICUs (10% of PICUs of USA) representing a wide diversity of organizational and structural characteristics.[23] The variables that were most predictive of mortality as indicated by the highest PRISM scores were minimum systolic BP, abnormal pupillary reflexes and stupor/coma were retained from PRISM score. Variables in the original PRISM that were not included in PRISM III are diastolic BP, respiratory rate, PaCO2/F1O2, serum bilirubin and calcium concentration.PRISM III has 17 physiologic variables subdivided into 26 ranges and is population independent.[23]

PRISM III is a widely accepted and is a standard against which other scores are compared. However there some problems with the use of PRISM III: - A lot of information is needed to calculate it and many units do not calculate it routinely. Worst reading of 12/ 24 hours is used and a lot of deaths occur (in one study over 40%) within first 24 hours, so the score may be diagnosing death rather predicting it. There may be blurring of differences of 2 units as patient in a good unit may recover rapidly and score may be lower and the same patient in a bad unit might have had higher score due to poor management and high mortality of bad unit may be interpreted as due to sicker patients. The time spent in the hospital before coming to ICU could improve the PRISM score and predict lower than actual mortality (lead time bias).[24]

Uses of models of mortality prediction including PRISM III: - These models including PRISM III are most applicable to groups of patients (e.g. to assess institutional performance). These models help us to investigate best ways of organizing PICU by comparing different units.[25] They also help us to monitor effect of change in practice by observing trends within the unit over a time.[24] They can also

be used for controlling severity of illness for various clinical trials.[23] They can be applied for resource utilization (rationing intensive care).PRISM III takes 24 hours to complete and can't be used in regulating admission to PICU.[26] They have been used to assess relation between severity of illness and length of stay or cost.

In 1997 MM Pollack et at developed a physiology based measure of physiologic instability for use in pediatric patients that has an expanded scale compared with the prism III score and called as the Pediatric risk of mortality Ill-acute physiology score (prismIll-APS) . It has 59 ranges of 21 physiologic variables. It was designed to have a broad severity scale from 0- 356, with the higher values indicating higher instability. Data were collected from consecutive admissions to 32 Pediatric ICU's (11165 admissions, 543 deaths).[27] Most patients who had PRISM Ill-APS score of greater than 80 had mortality greater than 97%. It concluded that the PRISM Ill-APS score is an expanded measure of physiologic instability that has been validated against mortality.

Compared with prism III, prism Ill-APS should be more sensitive to small changes in physiologic status even those that may not contribute significantly to mortality risk. Patient assessment for future studies for issues e.g. effectiveness of drugs or for other purposes might be more concerned with the physiologic status. However even this should not be used for quality assessments or calculating risk of individual patients.[27]

The following parameters are used in the calculation of PRISM III score and the most deranged value over first 24 hours after admission to PICU is taken for calculation of PRISM III-24 score:

Table 2: PRISM III SCORE

Variables	**Age restrictions and range**				**Score**
SBP	Neonate	Infant	Child	Adolescent	
	40-55	45-65	55-75	65-85	3
	<40	<45	<55	<65	7
Temperature	All ages <33’ C or >40’C				3
Mental status	All ages: stupor or coma (GCS <8)				5
Heart Rate	Neonate	Infant	Child	Adolescent	
	215-225	215-225	185-205	145-155	3
	>225	>225	>205	>155	4
Pupillary reflexes	All ages = One pupil fixed, pupil >3mm				7
	All ages = Both fixed, pupil >3mm				11
Acidosis (pH) or total CO2 (mmol/L)	All ages = pH 7.0-7.28 or total CO2 5-16.9				2
	All ages = pH <7.0 or total CO2 <5				6

pH	All ages = 7.48-7.55				2
	All ages >7.55				3
PCO2 (mmHg)	All ages = 50.0-75.0				1
	All ages >75.0				3
Total CO2(mmol/L)	All ages >34.0				4
Arterial PaO2 (mmHg)	All ages = 42.0-49.9				3
	All ages <42.0				6
Glucose	All ages >11.0 mmol/L				2
Potassium	All ages >6.9 mmol/L				3
Creatinine (µmol/L)	Neonate	Infant	Child	Adolescent	
	>75	>80	>80	>115	2
Urea (mmol/L)	Neonate		Other age group		
	>4.3		>5.4		3
White blood cells	All ages < 3000 cells/mm3				4
Prothrombin time (PT) or	Neonate		All other ages		

partial thromboplastin time(PTT)	PT >22.0 sec or PTT >85.0 sec	PT >22.0 sec or PTT >57.0 sec	3
Platelets (cells/mm3)	All ages = 100,000 to 200,000		2
	All ages = 50,000 to 99,999		4
	<50,000		5

Risk of death is calculated as

Calculate risk of death(r)

r = (0.207×PRISM) - [0.005×(age in months)] – 0.433×1 (if post-operative) – 4.782

Predicted death rate = $e^r/(1+e^r)$

Pediatric Index of Mortality (PIM) score

The Pediatric Index of Mortality 2 (PIM-2) score uses a logistic regression model to obtain an equation that describes the relationship between a limited set of predictor variables measured at the time of admission to intensive care and the probability of death. Originally developed in Australia in the mid-1980's[24], the score was revised to version 2 in late 1990's[28] to account for the changes in intensive care

organization and outcomes over time. Since then, PIM-2 has been widely adopted as a tool for adjusting mortality rate by patients' case mix[29-30].

The following parameters are taken into consideration while calculating PIM 2 score and each variable measured within the period from the time of first contact (anywhere by an ICU doctor) to 1hour after arrival to the ICU:

Table 3: PIM 2 Score

Sl No.	**Variable**	**Score**
A	Systolic Blood Pressure, mmHg	MV0 If unknown=120 Cardiac arrest=0 Shock with unmeasurable SBP=30
B	Pupillary reaction to bright light	>3mm and both fixed=1 Other or unknoun=0
C	$(FiO_2 \times 100)/PaO_2$,mmHg	MV If unknown=0
D	Base Excess in arterial or capillary blood, mmol/L	MV If unknown=0
E	Mechanical Ventilation at any time during the first hour of admission	NO=0, YES=1.
F	Elective admission to ICU	NO=0, YES=1.

G	Recovery from Surgery or a Procedure is the main reason for ICU admission	NO=0, YES=1.
H	Admitted following Cardiac Bypass	NO=0, YES=1.
I	High risk diagnosis is the main reason • Cardiac arrest preceding ICU admission • Severe Combined Immune Deficiency • Leukemia or lymphoma following first induction • Spontaneous Cerebral Haemorrhage • Cardiomyopathy or Myocarditis • Hypoplastic Left Heart Syndrome • HIV Infection • Neurodegenerative disorders • Liver Failure is the main reason for ICU admission	NO=0, YES=1.
J	Low risk is the main reason for ICU admission • Asthma • Bronchiolitis • Croup • Obstructive Sleep Apnea • Diabetic Ketoacidosis	NO=0, YES=1.

Risk of death is calculated as follows:MV=Measured Value

Enter the value of each variable in the equation

PIM2 = {0.01395×[absolute(A-120)]} + (3.079×B) + (0.2888×C) + (0.104×absolute D) + (1.3352×E) – (0.9282×F) – (1.0244×G) + (0.7507×H) + (1.6289×I) – (1.5770×J) – 4.8841

Probability of death = $e^{PIM2}/(1+ e^{PIM2})$

Pediatric Logistic Organ Dysfunction (PELOD) score

In children, Pediatric Logistic Organ Dysfunction (PELOD) score was developed in prospective multicenter study by Leteurtre, et al. and validated by the same group in a multidisciplinary tertiary care pediatric intensive care unit of university affiliated hospitals[31-32].

Table 4: PELOD Score

Organ Systems and Variables	Points by Level of Severity for Each System			
	0	1	10	20
Respiratory system				
Pao_2 in mm Hg/FIo_2 ratio (kPa/%)[a]	>70 (9.3) *and*	—	≤70 (9.3) *or*	—
$Paco_2$ (mm Hg or kPa)[b]	≤90 (11.7) *and*	—	>90 (11.7)	—
Mechanical ventilation[c]	No ventilation	Ventilation	—	—
Cardiovascular system[d]				
Heart rate (beats/min)				
<12 yrs	≤195	—	>195	—
≥12 yrs	≤150	—	>150	—
Systolic blood pressure, mm Hg	*and*		*or*	
<1 month	>65	—	35–65	<35
1 month–1 yr	>75	—	35–75	<35
1–12 yrs	>85	—	45–85	<45
≥12 yrs	>95	—	55–95	<55
Neurologic system				
Glasgow coma score[e]	12–15 *and*	7–11	4–6 *or*	3
Pupillary reaction[f]	Both reactive	—	Both fixed	—
Hepatic system				
ALT or SGOT, UI/L	<950 *and*	≥950 *or*	—	—
Prothrombin time (% of standard), INR	>60 *or* <1.4	≤60 *or* <1.4	—	—
Renal system: creatinine, μmol/L (mg/dL):				
<7 days	<140 (1.59)	—	≥140 (1.59)	—
7 days–1 yr	<55 (0.62)	—	≥55 (0.62)	—
1–12 yrs	<100 (1.13)	—	≥100 (1.13)	—
≥12 yrs	<140 (1.59)	—	≥140 (1.59)	—
Hematologic system				
White blood cell count (10^9/L)	>4.5 *and*	1.5–4.4 *or*	<1.5	—
Platelet count (10^9/L)	≥35	<35	—	—

Glasgow Coma Scale (GCS)

Impairment of consciousness is one of the most consistent features of head injury. The Glasgow Coma Scale (GCS) was described by Teasdale and Jennett in 1974,[33] based on a theoretical model of level of consciousness. It was introduced as a simple tool, initially in the research setting, as a method of describing states of impairment within the consciousness continuum.[33]This GCS which was established in adult population was extrapolated to pediatric population and was found to be reliable. Pediatric GCS is as follows:

Table 5: Paediatric GCS

PAEDIATRIC GLASGOW COMA SCALE			
	> 1 Year	**< 1 Year**	**Score**
EYE OPENING	Spontaneously	Spontaneously	4
	To verbal command	To shout	3
	To pain	To pain	2
	No response	No response	1
MOTOR RESPONSE	Obeys	Spontaneous	6
	Localizes pain	Localizes pain	5
	Flexion-withdrawal	Flexion-withdrawal	4
	Flexion-abnormal (decorticate	Flexion-abnormal (decorticate	3

	rigidity)	rigidity)	
	Extension (decerebrate rigidity)	Extension (decerebrate rigidity)	2
	No response	No response	1

	> 5 Years	**2-5 Years**	**0-23 months**	
VERBAL RESPONSE	Oriented	Appropriate words/phrases	Smiles/coos appropriately	5
	Disoriented/confused	Inappropriate words	Cries and is consolable	4
	Inappropriate words	Persistent cries and screams	Persistent inappropriate crying and/or screaming	3
	Incomprehensible sounds	Grunts	Grunts, agitated, and restless	2
	No response	No response	No response	1
TOTAL PEDIATRIC GLASGOW COMA SCORE (3-15):				

Apart from the above mentioned scores there are many other scores like SOFA (Sequential Organ Failure Assessment) score, Pediatric Revised Trauma Score, Multiple Organ Dysfunction (MOD) score, Simplified Acute Physiology Score (SAPS) which are used in PICU's but these scores are not as much validated as PRISM, PIM or PELOD score.

Previous studies

Volakli et.al, from Greece concluded that PRISM III-24 performed well in their population showing high discrimination and calibration capabilities. Mortality was higher than in relevant studies, probably due to case mix, patient characteristics and the distinct PICU policy of that country. However, efficiency and effectiveness were met by an international standard[50].

Costa et.al, from Sao Polo concluded that pediatric risk of mortality score showed adequate discriminatory capacity and thus constitutes a useful tool for the assessment of prognosis for pediatric patients admitted to a tertiary pediatric intensive care units[51].

Keulen et.al, from a multicenter study concluded that in daily practice, severity of illness scoring using the PRISM and PIM risk adjustment systems is associated with wide variability. These differences could not be explained by the physician's level of experience. Reliable assessment of PRISM and PIM scores requires rigorous specific training and strict adherence to guidelines. Consequently, assessment should probably be performed by a limited number of well-trained professionals[42].

Atti et.al, from Italy in their study concluded that calibration with usage of PIM was less satisfactory the probable reason being overprediction of death in high risk group[52].

Shukla et.al, in an Indian study concluded that infectious disease being the commonest cause for admission into PICU, PIM2 scoring did not explain the outcome adequately, suggesting need for recalibration[53].

In another Indian study published in 2014 from PGIMER, Dr. R.M.L Hospital, New Delhi and All India Institute of Medical Sciences, New Delhi, India,[9] where in

the objective was to validate the Pediatric Index of Mortality (PIM) and PIM2 scores in a large cohort of children from a developing country. It was concluded that the calibration across different age and diagnostic subgroups was also good[54].

Methodology

MATERIALS AND METHODS

This was a one year study conducted on patients getting admitted to PICU and falling under the admission criteria to PICU as proposed in AAP protocol for admission to PICU. Sample size was estimated to be 75, (precisely 73).

Sample size estimation:

Our hospital's Paediatric unit is 90 bedded with around 80 outpatients, 15 inpatients and around 2 admission into PICU per day. A previous medical record survey was done for the past 2 years and it was found out that the total number of admission per year was 4322 and 3956 in 2011 and 2010 respectively. It was also seen that there were 556 and 492 admissions to PICU in 2011 and 2010 respectively of which 202 and 196 patients satisfied the criteria as per AAP guidelines for admission to PICU.

Considering the above fact in which around 5% of the total admissions per year in Paediatric unit satisfying AAP criteria for admission to PICU the average prevalence for the past 2 years was calculated as around 5%.

Sample size estimation was done by using the formula[46]:

$$N = \frac{Z_{1-\alpha/2}^2 \times p(1-p)}{d^2}$$

Where $\mathbf{Z_{1-\alpha/2}}$is the standard normal variate which at 5% type 1 error ($p<0.05$) is 1.96.

p is the prevalence rate or the expected proportion in population based on the previous studies.

d is theabsolute error or precision and in our study it was taken as 5%.

With the above mentioned formula when the sample size was calculated it was a minimum of 73. In the present study 77 samples (cases) were analyzed.

Study Period: The study was conducted over a period of one year from Feb2013 to Jan 2014.

Place of Study: Study was conducted at our PICU, which is 10 bedded with 3 Mechanical Ventilator beds. PICU is well equipped with multichannel monitors for all beds. There is ABG machine, portable X ray, portable Echo and Ultrasound which is available 24X7. PICU is also backed by biochemistry, pathology and microbiology lab which functions 24X7.

Sample Size Estimation: Sample size was estimated based on number of admissions to PICU in the past 2 years with admissions falling strictly under criteria for admissions as per AAP protocol of admission to PICU.

Source of Data: Patients getting admitted to PICU as per AAP protocol for admissions to PICU from Feb2013 to Jan 2014.

METHOD OF COLLECTION OF DATA:

Inclusion Criteria:

All patients getting admitted to PICU and falling under AAP protocol for admissions to PICU[11].

Exclusion Criteria:

1. Patients getting discharged within 24 hours of admission or getting discharged against medical advice.
2. Patients dying within 24 hours after admission.

METHODOLOGY

All patients getting admitted to PICU from February 2013 to January 2014 and falling under criteria for admissions were enrolled for the study. A total of 75 patients were included as per the requirement.

All parameters taken as follows:

PIM 2 score was applied at admission.

Parameters for PIM2

1. Manual BP was measured with sphygmomanometer with appropriate cuff size.
2. Pupillary reaction to bright light was assessed.
3. An ABG was done and Base Excess was noted down from the ABG report.
4. FiO_2 was calculated theoretically based on O_2 requirementand the O_2 delivery devicebeing used[55](high flow device or low flow device)

Delivery Devices:

i. Nasal Cannula
   a. 1 – 6 LPM
   b. FIO2 0.24 – 0.44 (approx 4% per liter flow)
   c. FIO2 decreases as Ve increases

ii. Simple Mask
   a. 5 – 8 LPM
   b. FIO2 0.35 – 0.55 (approx 4% per liter flow)
   c. Minimum flow 5 LPM to flush CO2 from mask

iii. Venturi Mask
   a. Variable LPM
   b. FIO2 0.24 – 0.50
   c. Flow and corresponding FIO2 varies by manufacturer

iv. Partial Rebreather

a. 6 – 10 LPM

b. FIO2 0.50 – 0.70

c. Flow must be sufficient to keep reservoir bag from deflating upon inspiration

v. Nonrebreather

a. 6 – 10 LPM

b. FIO2 0.70 – 1.0

c. Flow must be sufficient to keep reservoir bag from deflating upon inspiration

i. With the exception of the Venti mask, the above are all low flow oxygen delivery systems and therefore the exact FiO2 will be based on the patient's anatomic reservoir and minute ventilation.

When on ventilator FiO_2 was noted down as per the actual requirement.Patients were noted down if they required Mechanical Ventilation within 1 hour of admission.Patients were classified as having either a high risk or low risk diagnosis at admission as per PIM2 guidelines.Admissions were classified as elective or emergency admissions for application of PIM2 scores.It was noted down if recovery from Surgery or a Procedure is the main reason for ICU admission.It was noted down if patients were admitted following Cardiac Bypass.PIM2 proforma was filled at the end of 1hour after admission.

Parameters for PRISM III 24 Score: all parameters were estimated within first 24h after admission and the most deranged value estimated was considered for scoring.

1. Blood Pressure was monitored manually with sphygmomanometer every hourly and sos, the lowest reading over first 24h was taken for scoring.

2. Axillary Temperature was monitored every hourly and sos, core temperature was calculated by adding $1^0$to the axillary temperature value and the maximum temperature value over 24h was taken for scoring.
3. GCS was monitored every hour and sos, the lowest GCS in the first 24h was considered for scoring.
4. Heart rate monitoring was done by multichannel monitoring and the highest rate recorded in first 24h was considered for scoring.
5. Pupillary Reaction to bright light was assessed by a bright light every hourly and sos, anytime if pupils were non-reactive over first 24h was counted for scoring.
6. ABG was done at admission, 6^{th} hourly and sos, most abnormal PCO_2, pH, TCO_2 and PaO_2 were considered for scoring.
7. Glucose estimation was done at admission, 6^{th} hourly and sos, most abnormal value was considered for scoring.
8. Renal Function Tests, Serum Electrolytes were done at admission, 12^{th} hourly and sos, most deranged value of Serum creatinine, blood urea and Serum Potassium was considered for scoring.
9. Total Leukocyte Count, Platelet Count, Prothrombin Time and Activated partial thromboplastin time were estimated at admission, 12^{th} hourly and sos, the most deranged value estimated over first 24 hours was considered for scoring.

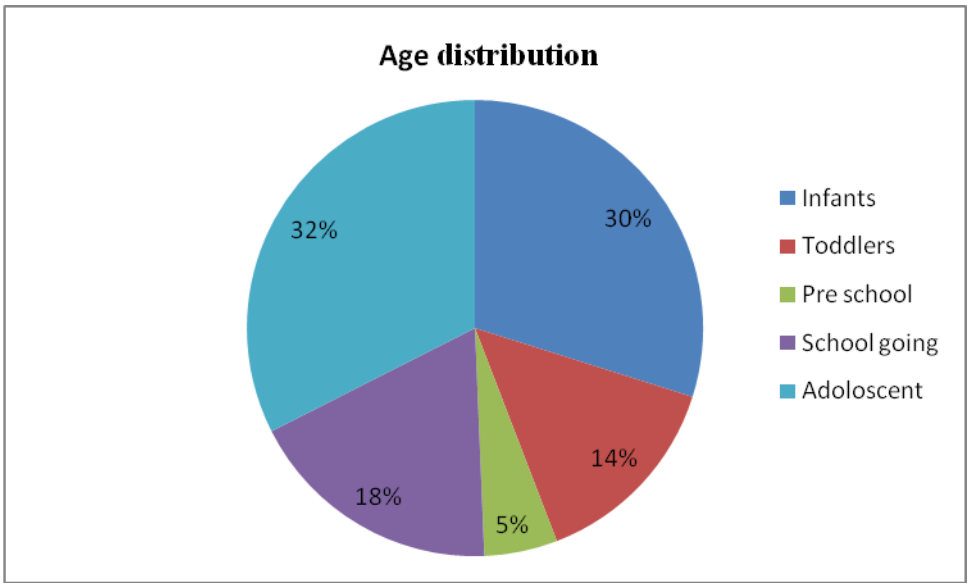
Results

RESULTS

Table 6: Shows age wise distribution of data, same is depicted in **Graph 1.**

Age categories	Number of patients	Average age	Maximum age	Minimum age	Standard deviation
Infants	23	0.41	0.92	0.17	0.23
Toddlers	11	2.00	3.00	1.00	0.89
Pre school	4	4.50	5.00	4.00	0.58
School going	14	7.29	9.00	6.00	1.20
Adolescent	25	14.44	18.00	11.00	2.16

Graph 1: age wise distribution of data

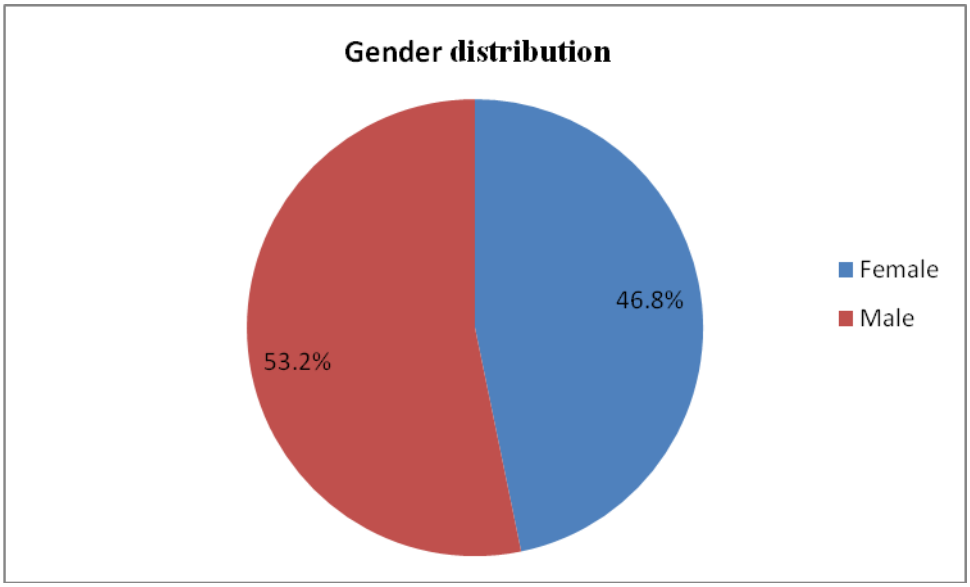


Adolescents constitute 32% of the sample and are followed by Infants which constitutes about 30% of the sample. Pre-school kids constitutes only for about 5% of the sample.

Table 7:Gender distribution:

Sex	% of patients
Female	46.8%
Male	53.2%

Graph 2: Gender distribution



53% of the patients are male and almost 47% of the patients are female patients.

Primary system involved by Age categories: This is the data showing the primary system involved and that system involvement being the reason for admission to PICU.

Table 8: Primary system involved by Age categories

Age categories	Primary system involved	Count of patients	% of patients
Infants	Hemodynamic	7	30.4%
	Hepatobilliary	1	4.3%
	Metabolic	1	4.3%
	Respiratory System	14	60.9%
Toddlers	Central Nervous System	3	27.3%
	Hemodynamic	1	9.1%
	Bites/poisonings	1	9.1%
	Renal System	1	9.1%
	Respiratory System	5	45.5%
Pre-school	Central Nervous System	1	25.0%
	Bites/poisonings	1	25.0%
	Respiratory System	2	50.0%
School going	Central Nervous System	1	7.1%
	Endocrine	3	21.4%
	Hematologic System	1	7.1%
	Hemodynamic	5	35.7%
	Renal System	1	7.1%
	Respiratory System	3	21.4%
Adolescent	Cardiovascular System	1	4.0%
	Central Nervous System	5	20.0%
	Endocrine	2	8.0%
	Hematologic System	1	4.0%
	Hemodynamic	5	20.0%
	Hepatobilliary	1	4.0%
	Bites/poisonings	5	20.0%
	Renal System	2	8.0%
	Respiratory System	3	12.0%

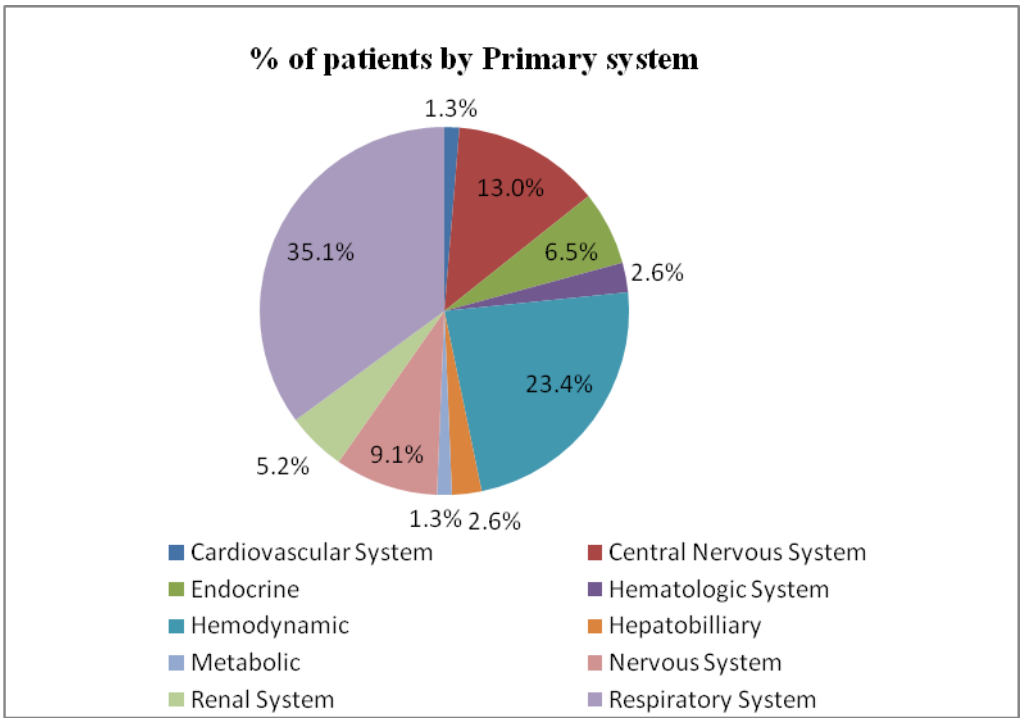
Primary system involved for majority of Infants (60.9%), Toddlers (45.5%) and Preschool (50%) patients is Respiratory system. Whereas, Primary system involved is spread across all the systems for School going and Adolescent patients.

Primary system involved:

Table 9:Primary system involved

Primary system involved	Count of patients	% of patients
Cardiovascular System	1	1.30%
Central Nervous System	10	12.99%
Endocrine	5	6.49%
Hematologic System	2	2.60%
Hemodynamic	18	23.38%
Hepatobilliary	2	2.60%
Metabolic	1	1.30%
Bites/poisonings	7	9.09%
Renal System	4	5.19%
Respiratory System	27	35.06%

Graph 3:Primary system involved



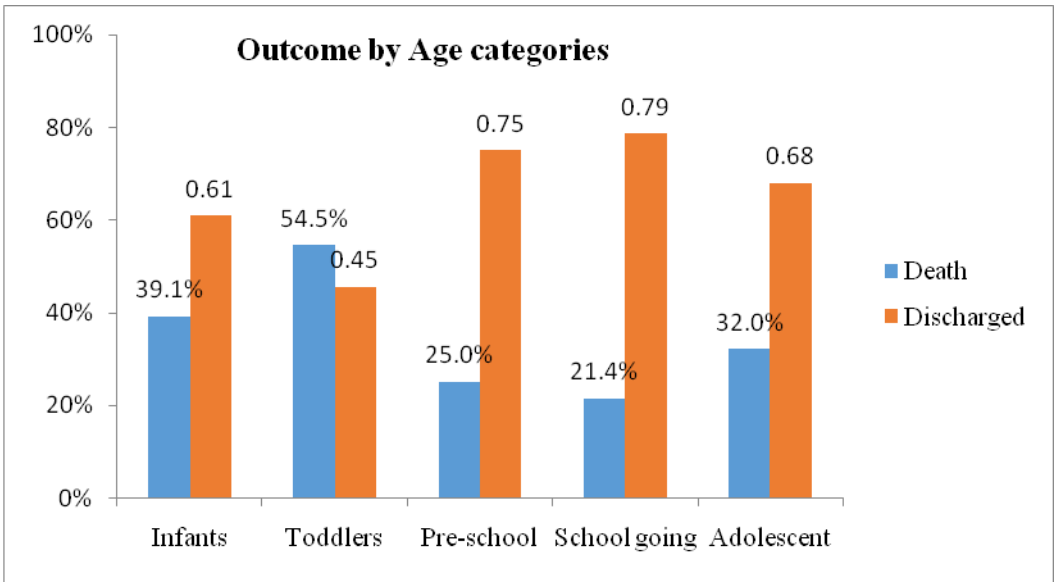
35.1% of patients had respiratory system as primary system followed by hemodynamic (23.38%)

Outcome by Age categories: Outcomes were categorized as death and survival (discharged out) and this is the data showing the same.

Table 10:Outcome by Age categories

Age categories	Outcome	Count of patients	% of patients
Infants	Death	9	39.1%
	Discharged	14	60.9%
Toddlers	Death	6	54.5%
	Discharged	5	45.5%
Pre-school	Death	1	25.0%
	Discharged	3	75.0%
School going	Death	3	21.4%
	Discharged	11	78.6%
Adolescent	Death	8	32.0%
	Discharged	17	68.0%

Graph 4: Outcome by Age categories



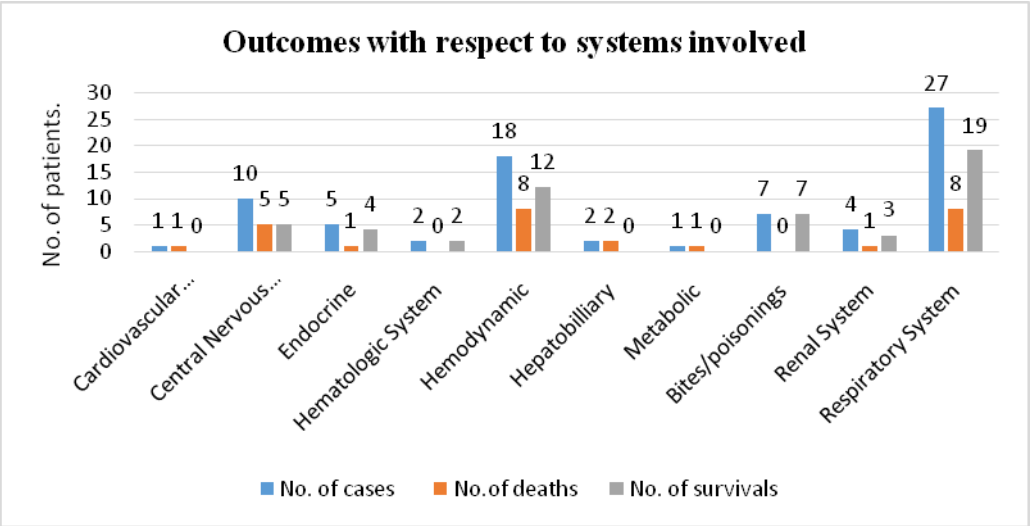
Death rate is very high among Infants (39.1%) and Toddlers (54.5%). It is comparatively lower among Pre-school, School-going and Adolescent patients.

Outcomes with respect to systems involved

Table 11: Outcomes with respect to systems involved

Primary system involved	No. of cases	No. of deaths	No. of survivals
Cardiovascular System	1	1	0
Central Nervous System	10	5	5
Endocrine	5	1	4
Hematologic System	2	0	2
Hemodynamic	18	8	12
Hepatobilliary	2	2	0
Metabolic	1	1	0
Bites/poisonings	7	O	7
Renal System	4	1	3
Respiratory System	27	8	19

Graph 5: Outcomes with respect to systems involved

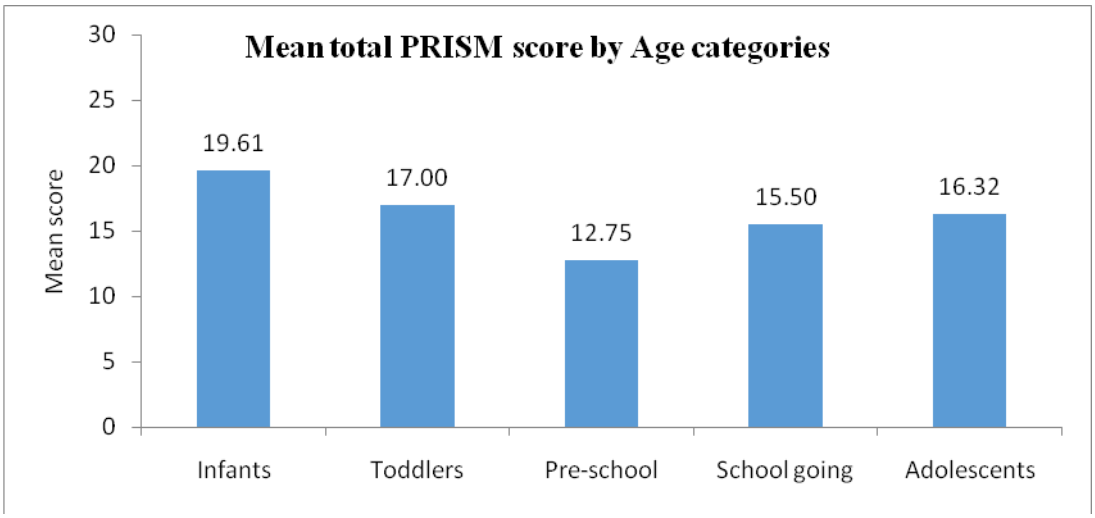


Taking atleast 10% of total admissions as significant number, 50% mortality was seen in disease involving Central Nervous System, followed by 44% in patients with hemodynamic involvement and 30% in patients with disease involving respiratory system.

Table 12:Total PRISM score by Age categories:

Age categories	Number of patients	Mean total PRISM score	Maximum total PRISM score	Minimum total PRISM score	Standard deviation of total PRISM score
Infants	23	19.61	42	8	10.01
Toddlers	11	17.00	28	3	9.54
Pre-school	4	12.75	24	3	9.91
School going	14	15.50	31	5	8.51
Adolescents	25	16.32	38	3	10.45

Graph 6



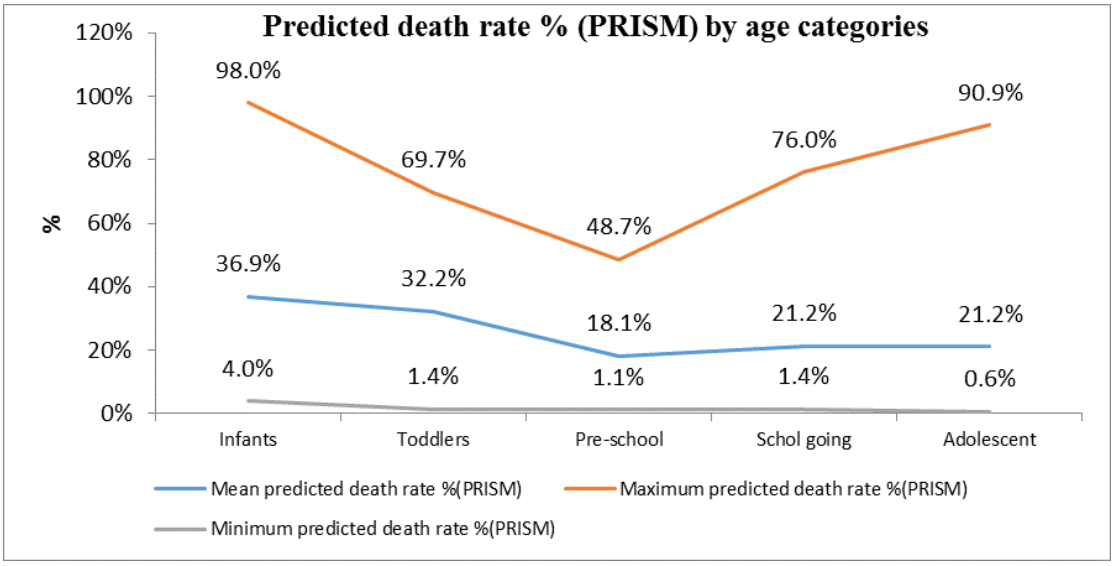
Mean total PRSM score is very high in Infants (19.61) and Toddlers (17.0). It is least in Pre-school patients (12.75).

Analysis of variance to measure the between subject effects suggests that there is no statistical difference in the mean total PRISM score across all the age categories. Analysis of variance is conducted to test whether the groups in the sample differ or not. P-value 0.594 which is not significant at 5% significance level suggests that mean of total PRISM score is statistically same across all the age groups. Turkey HSD test is conducted for multiple comparisons to test which groups within the sample differ. P-value (0.594) is not significant for any two groups comparison across all the above 5 groups.

Table 13: Predicted death rate %(PRISM):

Age categories	Count of patients	Mean predicted death rate %(PRISM)	Maximum predicted death rate %(PRISM)	Minimum predicted death rate %(PRISM)	Standard deviation of predicted death rate %(PRISM)
Infants	23	36.93%	98.01%	4.01%	33.44%
Toddlers	11	32.18%	69.72%	1.45%	28.61%
Pre-school	4	18.13%	48.65%	1.14%	22.20%
School going	14	21.25%	76.04%	1.36%	23.20%
Adolescent	25	21.21%	90.92%	0.56%	28.11%

Graph 7



Mean predicted death rate is highest among Infants (36.93%) and then followed by Toddlers (32.18%). Mean predicted death rate is lowest among pre-school patients (18.13%).Analysis of variance to test whether the groups within the sample are same or different, suggests that groups within the sample are same with p-value 0.299. Since the p-value is greater than 0.05 at 5% significance level, the groups are statistically same within the sample.

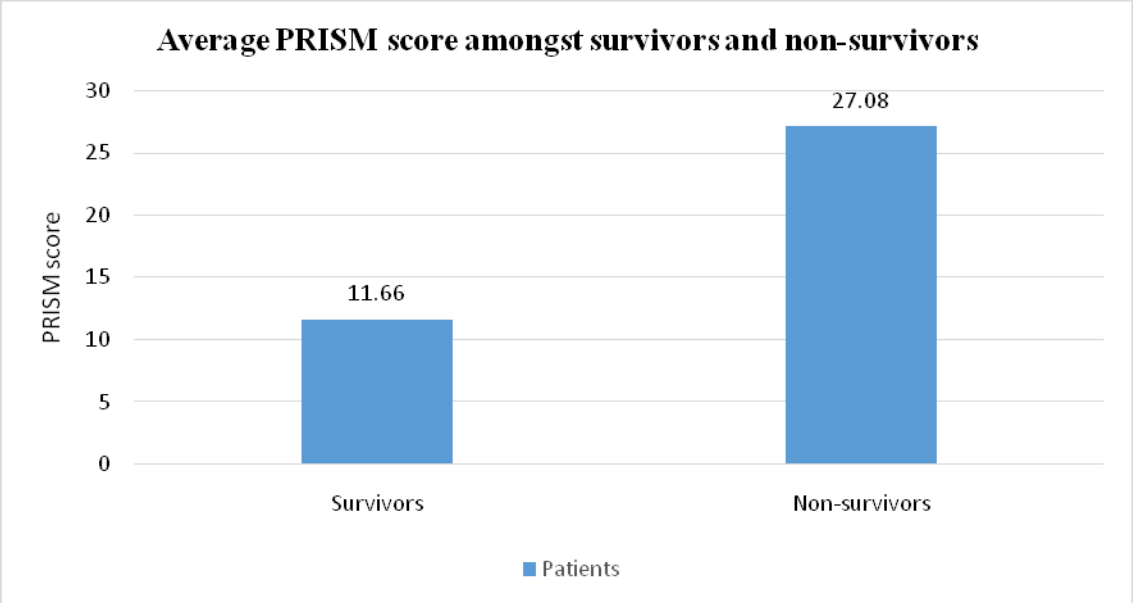
Turkey HSD test to test which groups within the sample differ suggests that all the groups are statistically same. P-value (0.299) for all the groups comparison is more than 0.05 at 5% significance level.

Average PRISM score amongst survivors and non-survivors:

Table 14

Average PRISM score amongst survivors and non-survivors	Score
For survivors	11.66
For non-survivors	27.08

Graph 8



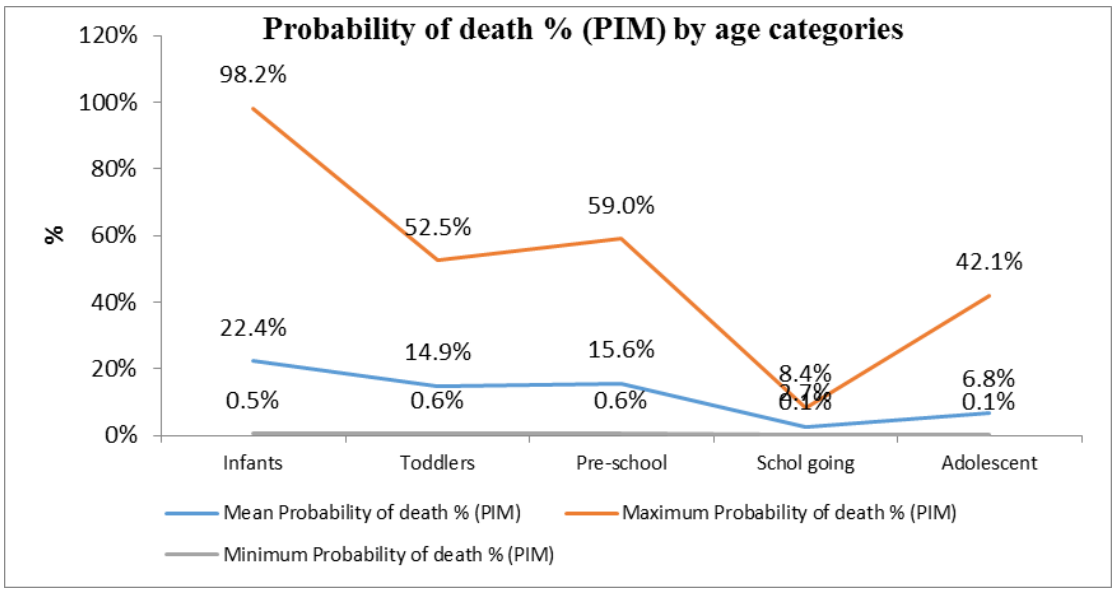
The average PRISM score amongst the patients surviving was much lower than the patients not surviving.

Probability of Death % (PIM):

Table 15

Age categories	Count of patients	Mean Probability of death % (PIM)	Maximum Probability of death % (PIM)	Minimum Probability of death % (PIM)	Standard deviation Probability of death % (PIM)
Infants	23	22.38%	98.22%	0.48%	33.82%
Toddlers	11	14.90%	52.50%	0.65%	19.88%
Pre-school	4	15.62%	58.97%	0.64%	28.91%
School going	14	2.70%	8.45%	0.14%	2.67%
Adolescent	25	6.79%	42.08%	0.12%	11.16%

Graph 9



Mean probability of death % is highest among Infants (22.38%) and then followed by Pre-school (15.62%). Mean probability of death % is lowest among School going patients (2.70%).Analysis of variance to test whether the groups within the sample are same or different, suggests that groups within the sample are same with p-value 0.064. Since the p-value is greater than 0.05 at 5% significance level, the groups are statistically same within the sample.

Turkey HSD test to test which groups within the sample differ suggests that all the groups are statistically same. P-value for all the groups comparison is more than 0.05 at 5% significance level.

Mean predicted death rate (PRISM), mean predicted death rate (PIM) and observed death rate:

Table 16

Age categories	Count of patients	Mean predicted death rate (PRISM)	Mean predicted death rate (PIM)	Observed death rate
Infants	23	36.93%	22.38%	39.10%
Toddlers	11	32.18%	14.90%	54.50%
Pre-school	4	18.13%	15.62%	25.00%
School going	14	21.25%	2.70%	21.40%
Adolescent	25	21.21%	6.79%	32.00%

Graph 10

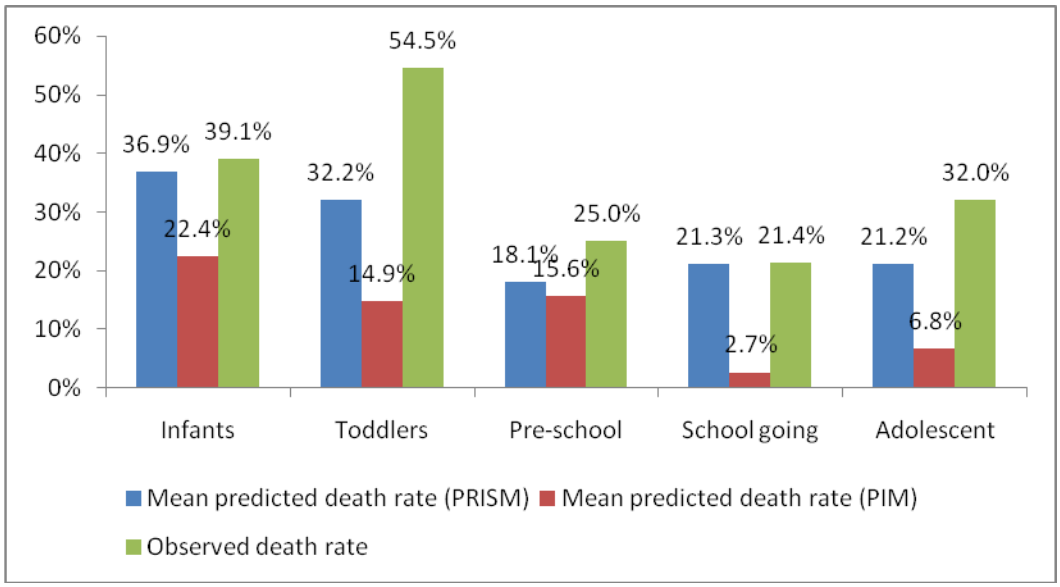


Table and graph showing mean predicted death rate by PRISM and PIM score and comparison with observed death rate. It can be seen that Mean predicted death rate by PRISM is better over Mean predicted death rate by PIM in predicting death rate when compared to observed death rate.

Number of deaths, survival and average duration in PICU by PRISM score:

Table 17

PRISM score	Number of patients	Number of deaths	Number of survivals	Average Duration of Stay in PICU(in Days)
1-5	11		11	4.18
6-10	12	1	11	4.50
11-15	13	1	12	4.23
16-20	12	2	10	3.33
21-25	12	6	6	3.42
26-30	9	9		4.22
>30	8	8		2.63

Graph 11

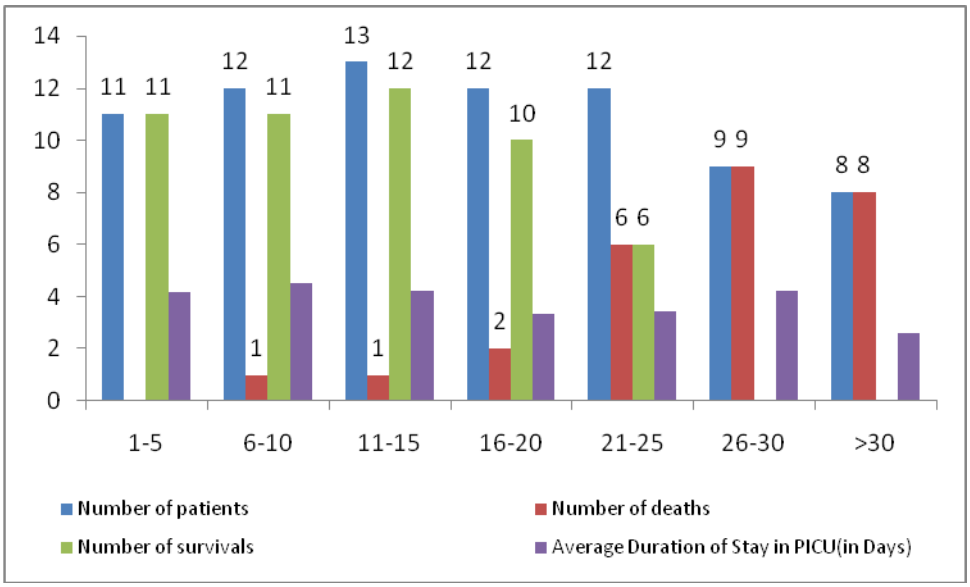


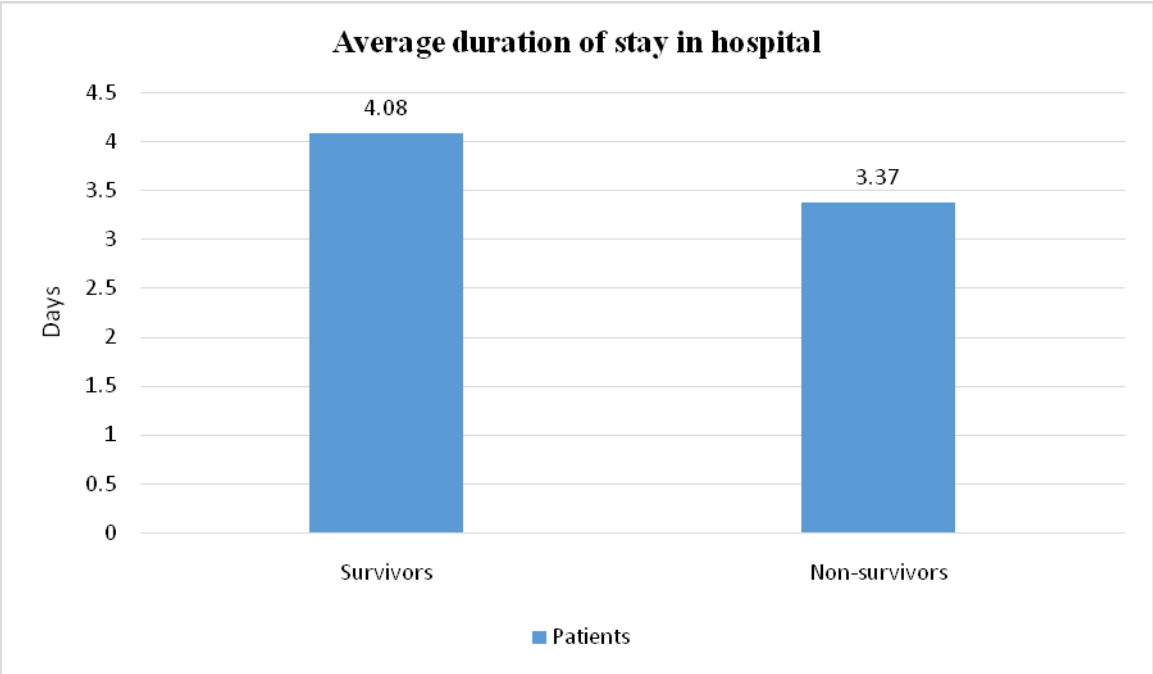
Table showing, number of deaths, number of survivals and average duration of stay in PICU in association with PRISM score, it can be seen that number of deaths increased with increase in PRISM score and average duration of stay was relatively higher with low PRISM score which can be attributed to high survival rate with low PRISM score.

Average duration of stay in hospital:

Table 18

Average duration of stay in hospital	**In days**
For survivors	4.08
For non-survivors	3.37

Graph 12



The average duration of stay was higher in survivors when compared to non-survivors.

STATISTICAL METHODS

Selection of statistical test:

Statistical tests in general manipulate the data to calculate the probability of obtaining a difference between two different groups. In statistical tests certain formulae / procedures based on certain concepts / assumptions are used to calculate the p(probability) values, which reveal whether a result is significant or not. A significant result is a result which is not likely to have occurred by chance.

In our present study performance of both the scores was evaluated by assessing discrimination and calibration. Discrimination estimates the probability of concordance between outcomes and predictions. It is the ability of a test to differentiate patients who meet the outcome (death) and those who do not[47]. It is

assessed by measuring the area under the Receiver Operating Characteristic (ROC) curve. Acceptable discrimination is represented by an area under the curve of 0.70-0.79, and good discrimination by an area > 0.80. Calibration measures the correlation between the predicted outcomes and actual outcome over the entire range of risk prediction. Calibration was assessed by Hosmer and Lemeshow goodness-of-fit chi-square test[48]. While calibrating, based on percentiles of the estimated probabilities, subjects are first arranged in ascending order of expected mortality and evenly divided into 10 groups from low to high mortality. These groups are often referred to as the "deciles of risk", and Chi squared statistical analysis is then applied.

Statistical software: The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1 ,Systat 12.0 and R environment ver.2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

Logistic regression output:

Predicted death rate% (PRISM)

Table 19: Hosmer and Lemeshow test results (PRISM)

Hosmer and Lemeshow Test		
Chi-square	**Df**	**Sig.**
7.585	8	0.475

The model is significant as the Chi-square value is significant at 5% significance level, i.e. as p value is 0.475 (p>0.05). It indicates that data fits well into the model.

Probability of death (PIM)

Table 20: Hosmer and Lemeshow test results (PIM)

Hosmer and Lemeshow Test		
Chi-square	**Df**	**Sig.**
4.781	8	0.781

The model is significant as the Chi-square value is significant at 5% significance level, i.e. as p value is 0.781 (p>0.05). It indicates that data fits well into the model.

Table 21: Classification table PRISM

Classification Table				
		Predicted		
		Outcome		
Observed		0	1	Percentage correct
Outcome	0	47	3	94%
	1	5	22	81.5%
Overall Percentage				89.6%

Here 0 indicates patients survived and 1 indicates patients died.

Classification accuracy is 89.6%. Classification % near the 100% is the better model. As the classification % is very high, it indicates better model accuracy.

Table 22: Classification table PIM

Classification Table				
		Predicted		
		Outcome		
Observed		0	1	Percentage correct
Outcome	0	46	4	92%
	1	8	19	70.4%
Overall Percentage				84.4%

Here 0 indicates patients survived and 1 indicates patients died.

Classification accuracy is 84.4%. Classification % near the 100% is the better model. As the classification % is very high, it indicates better model accuracy.

Table 23: Estimates of Binary Logistic model (PRISM)

Variables in the Equation					
	Beta	**Std error**	**Wald**	**Df**	**P-value**
Predicted death rate% (PRISM)	10.548	2.318	20.713	1	0.0
Constant	-3.672	0.762	23.236	1	0.0

Application of Binary Logistic Model showed that the model is accurate as the p value is 0.0000 (<0.05) with a std error of 2.318 and a beta of 10.548.

The variable Predicted death rate % (PRISM) has significant impact on the outcome at % significance level.

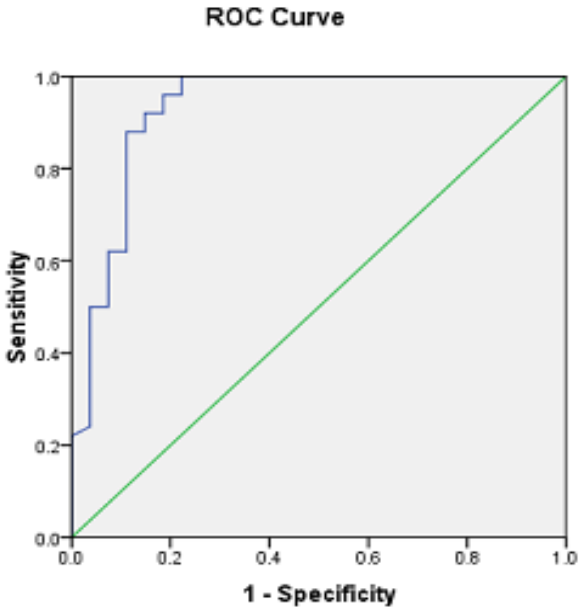
Table 24: Estimates of Binary Logistic model (PIM)

Variables in the Equation					
	Beta	**Std error**	**Wald**	**Df**	**P-value**
Probability of death % (PIM)	50.687	13.539	14.017	1	0
Constant	-3.438	0.765	20.176	1	0

Application of Binary Logistic Model showed that the model is accurate as the p value is 0.0000 (<0.05) with a std error of 13.539 and a beta of 50.687.

The variable Probability of death % (PIM) has significant impact on the outcome at % significance level.

Graph 13: ROC curve for PRISM scores



Graph 14: ROC curve for PIM scores

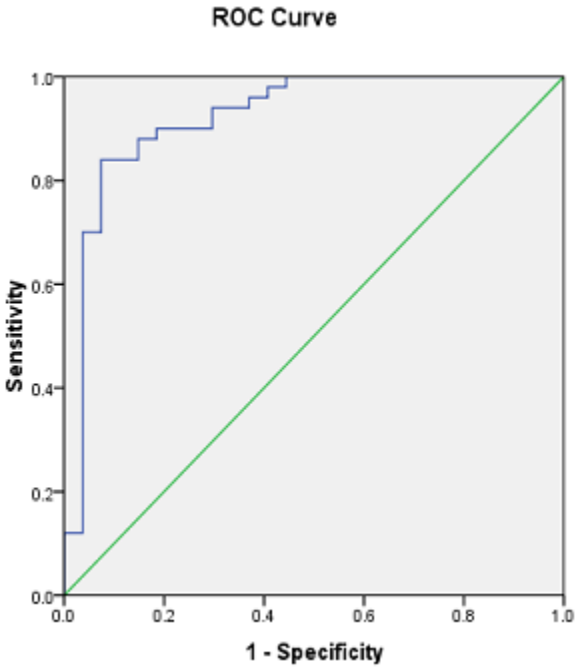


Table 25: Area under the ROC curves:

Area under the curve	Area	Std. Error	Asymptotic Sig.b	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Predicted death rate% (PRISM)	0.930	0.036	0.000	0.859	1.001
Probability of death (PIM)	0.922	0.037	0.000	0.850	0.994

Both PRISM and PIM scores offer good discriminative power with area under the ROC curve >0.80. Area under the curve is an expression of the overall accuracy of a model in differentiating outcome groups and is a good measure of predictive ability. The closer the ROC curve area is to 1.0, the better the prediction model.

Performance of (PRISM) Paediatric Risk of Mortality Score and (PIM) Paediatric Index of Mortality Score:

Table 26: Calibration of PRISM scores

Deciles	Observed survival	Expected survival	Observed death	Expected death
1	8	7.782	0	0.218
2	7	7.761	1	0.239
3	8	7.697	0	0.303
4	7	7.607	1	0.393
5	7	7.361	1	0.639
6	7	6.421	1	1.579
7	6	4.153	2	3.847
8	0	0.99	8	7.01
9	0	0.214	8	7.786
10	0	0.014	5	4.986

Table 27: Calibration of PIM scores:

Deciles	Observed survival	Expected survival	Observed death	Expected death
1	7	7.702	1	0.298
2	8	7.648	0	0.352
3	8	7.59	0	0.41
4	8	7.416	0	0.584
5	7	6.907	1	1.093
6	6	6.089	2	1.911
7	3	4.502	5	3.498
8	3	2.143	5	5.857
9	0	0.005	8	7.995
10	0	0	5	5

Calibration evaluates how well the model classifies the subjects. Here it divides the data into 10 equal deciles in increasing order of predicted mortality and calibrates the expected with the observed outcome.Both PRISM and PIM have significantly good calibration for PICU asserting that expected and observed mortalities are comparable in various levels. HoweverPRISM score showed relatively better calibration over PIM in the present study.

Observations from logistic regression model and calibration of PRISM III and PIM 2 scores.

From the above mentioned it was observed that applicability of both the scores were accurate in our PICU, but PRISM score application was significantly better over PIM score because of the following:

Hosmer and Lemeshow test results showed that both PRISM and PIM scores were good and satisfied the test, as p value in both the studies for the analytical test was >0.05.

Both PRISM and PIM are significant in predicting the outcome. Both are significant as the p-value of Hosmer and Lemeshow test is >0.05 at 5% significance level. PRISM has the better prediction than PIM score as the classification accuracy is better in PRISM. PRISM has classification accuracy of 89.6 over 84.4 of PIM. This indicates that PRISM is better in predicting deaths and survival over PIM score.

ROC curve showed that area under ROC curve was >0.8 for both PRISM and PIM scores which offered a good discriminative power for both the scores. Discriminative power for PRISM was better over PIM as area under ROC curve is more for PRISM is more when compared to PIM, i.e. 9.30 over 9.22.

In the calibration table both the studies showed good calibrations (p>0.05). Better calibration indicates better prediction and PRISM showed better calibration in predicting the outcome when compared to PIM.

The mean predicted death rate was nearer to observed death rate in PRISM when compared to PIM, i.e. 25.94% to 34.40% over 12.48% to 34.40%.

Estimates of Binary Logistic model showed that both PRISM and PIM were accurate but PRISM was better over PIM, with a standard error of 2.318 over 13.539.

Discussion

DISCUSSION

Advances in our understanding of the pathophysiology of complex life threatening processes, pharmacotherapy, and technological capability to monitor and stabilize vital functions have dramatically improved the level of care that can be offered to seriously ill patients. The concepts of intensive care units (ICU) evolved from the efforts to deliver this highly sophisticated and specialized care in an organized manner by a multidisciplinary team approach under one roof. Emergence of subspeciality of Neonatal and Pediatric Intensive Care is a result of the realization that children have distinct physiologic, pharmacologic and psychologic needs, and that these can be met only through ICUs especially designed, equipped and staffed for critically ill children.[35]

Severity scoring systems in the intensive care unit have been developed in response to an increased emphasis on the evaluation and monitoring of health care services[36]. According to Gregoire[37], there are four major purposes of severity-of-illness scoring systems. First, scoring systems are used in clinical trials for matching. Second, scoring systems are used to quantify severity of illness for administrative decisions such as resource allocation. Third, scoring systems assess ICU performance and compare the quality of care. Fourth, scoring systems are used to assess the prognosis of individual patients.

Following the increasing prevalence of rapid response teams (RRTs) is a demand for an accurate risk-stratification tool for patients on the wards who are at-risk for clinical deterioration and subsequent ICU admission. A number of "track and trigger" systems have been developed for this purpose, designed to trigger reassessment by the medical team whenever tracked physiologic parameters reached

an arbitrary critical level. However, validation of these track-and-trigger systems has generally revealed poor sensitivity, poor positive predictive value, and low reproducibility[38].

In the present study it was seen that the there was no much difference in the gender ratio amongst the patients getting admitted to PICU. Infants and adolescents contributed to more than half of the cases, i.e. 62% of which around 30% were infants alone. Disease involving Respiratory System contributed to most of the cases getting admitted to PICU, i.e. around 35% followed by patients getting admitted because of hemodynamic instability, i.e. around 24%. Death rate was maximum in pre-schoolers (54%) followed by infants (39%) and adolescents (32%). Death rate was maximum inpatients with Central Nervous System involvement (50%) followed by patients with hemodynamic instability (44%) and respiratory system involvement (30%). Mean PRISM score was maximum amongst infants (19.61) followed by toddlers (17) and adolescents (16.32). The average death rate predicted by PRISM was better over PIM when compared to observed mortality rate i.e. 25.94% to 34.40% over 12.48% to 34.40%, with PRISM predicting 99% of observed deaths in school going and 95% in infants and PIM predicting 62% of observed deaths in pre-school group. The average duration of stay in PICU when compared to average PRISM score showed that patients with a low PRISM score had a relatively longer duration of stay in PICU, this could be attributed to better outcomes in patients with low PRISM scores.

In this study PIM predicted a mean mortality of 12.48% when the observed mortality was 34.4%, this could be attributed to the fact that most of the patients were admitted with an evolving and rapidly progressing disease due to which the patients would have been relatively stable at the first hour of admission, during which

parameters for PIM2 score are assessed. The other reason would have been the criteria for high risk and low risk diagnosis.

Performance of PRISM III and PIM 2 scores:

In the present study PIM predicted a mortality rate of 12.48% and PRISM predicted a 25.95% mortality. The observed mortality was 34.4% which was nearer to that predicted by PRISM over PIM. PRISM had a better discriminative power over PIM with the area under ROC curve being better for PRISM over PIM i.e. 0.93(0.859-1.000) over 0.922 (0.850-0.994) and the std error being marginally less for PRISM over PIM, i.e. 0.36 over 0.37. But both had excellent discriminative power as area under ROC curve was >0.9 in both the cases. Classification accuracy was 89.6% in PRISM which was better over PIM which had a classification accuracy of 84.4%. When calibrated PRISM score showed a better calibration over PIM.

Table 28: Composite Statistical Table PRISM and PIM

Statistical Parameter	PRISM III	PIM 2
Mean mortality rate (SD)	25.94% (27.12)	12.48% (19.29)
Area under ROC curve (95% CI)	0.93 (0.859-1.000)	0.922 (0.850-0.994)
Standard error AUC	0.036	0.037
Hosmer Lemeshow test, χ^2	7.585	4.781
Hosmer Lemeshow test; p value	0.475	0.781
Classification accuracy	89.6%	84.4%
Std. error in estimates of binary logistic model	2.318	13.539
Calibration	Better over PIM 2	Good

From the above table it is clear why PRISM has an edge over PIM in our PICU. PIM takes into consideration the parameters at 1st contact with a medical personnel i.e. within one hour of contact. The first parameter need not be the worst one and may not actually represent the actual extent of organ dysfunction in an individual. For PRISM score the parameters are monitored over first 24hours after admission and the worst parameter is considered for scoring and hence it represents the organ dysfunction better.

A similar study done byRoshani N. Taori et al[39] in the past under Indian circumstances showed the following:

Table 29: Composite table of Taori et.al.

Statistical Parameter	PRISM	PIM
Median of mortality risk; % (IQ)	13.28 (5.43-31.42)	2.44 (1.74 – 5.8)
Mean of mortality risk; % (SD)	24.2 (25.61)	7.38 (14.01)
Area under ROC curve (95% CI)	0.851 (0.790 – 0.912)	0.838 (0.776-0.899)
Hosmer Lemeshow test, χ^2	1.746	10.866
Hosmer Lemeshow test; p value	0.627	0.0281

They observed that the predicted deaths with PRISM score was 24.3%. The area under the ROC curve was 0.851 (95% CI 0.790 – 0.912). The Hosmer and Lemeshow goodness-of-fit test showed good calibration (p=0.627, chi square =1.75,

degree of freedom = 3). The predicted deaths with the PIM score was 7.38%. The area under the ROC curve for PIM score was 0.838 (95 % CI 0.776- 0.899). The Hosmer and Lemeshow goodness-of-fit showed a poor calibration for PIM score (p = 0.0281, chi- square = 10.866, degree of freedom = 4). Hence they concluded both PRISM and PIM scores have a good discriminatory performance. The calibration with PRISM score is good but the PIM score displays poor calibration[39].

In another study done under Pakistani circumstances by Qureshi et al[40]. wherein three scoring systems were assessed it showed the following:

Table 30: Composite table of Qureshi et.al.

Performance of the models[40]			
	PIM 2	**PRISM**	**PELOD**
Mean of mortality risk; % (SD)	20.49±24.72	19.49±26.21	18.26±29.99
Median of mortality; %	8.5	7.4	1.3
Estimated mortality; n	20.69	19.67	18.44
Standardized mortality rate (SMR) (CI 95%)	1.4 (0.77-2.0)	1.47(0.9-2.0)	1.57 (1.0-2.1)
Hosmer Lemeshow goodness-of-fit test; x^2 (p)	9.65 (p=0.29)	7.49 (p= 0.49)	20.03 (p=0.006)
Area under ROC (CI 95%)	0.88(0.81-0.95)	0.78(0.67-0.89)	0.77(0.68-0.87)
Standard error AUC	0.035	0.056	0.05

They observed that Estimated mortality was; PRISM: 19.7(19.5%), PIM: 21.01(20.5%) and PELOD: 18.4(18.3%). SMR was 1.47 (SD ± 0.19), 1.4 (SD ± 0.19) and 1.57 (SD ± 0.19), respectively. PRISM had better calibration ($x^2 = 7.49$, $p = 0.49$) followed by PIM 2 ($x^2 = 9.65$, $p = 0.29$). PIM 2 showed best discrimination with area under ROC = 0.88 (0.81-0.94) followed by PRISM 0.78 (0.67-0.89) and PELOD 0.77 (0.68-0.87). Spearman's correlation r between PRISM and PIM 2 returned 0.74 ($p < 0.001$). They concluded PRISM as well as PIM 2 is validated for PICU setting in Pakistani circumstances. PELOD performed poorly. PIM 2 has advantages over PRISM for stratification of patients in clinical trials[40].

In another study from Hong Kong by Choi et al[41]. assessment of the Pediatric Index of Mortality (PIM) and the Pediatric Risk of Mortality (PRISM) III score for prediction of mortality was done. A total of 303 patients were admitted to the paediatric intensive care unit during the study period. The overall predicted number of deaths using The Pediatric Risk of Mortality III score was 10.2 patients whereas that by Pediatric Index of Mortality was 13.2 patients. The observed mortality was eight patients. The area under the receiver operating characteristics curve for the two models was 0.910 and 0.912, respectively. In Conclusion the predicted mortality using both prediction models correlated well with the observed mortality[41].

In another study done in Netherlands by van Keulen, Polderman, Gemke[42] with an aim to assess the reliability of mortality risk assessment using the Paediatric Risk of Mortality (PRISM) score and the Paediatric Index of Mortality (PIM) in daily practice. Twenty seven physicians from eight tertiary paediatric intensive care units (PICUs) were asked to assess the severity of illness of 10 representative patients using the PRISM and PIM scores. Physicians were divided into three levels of experience: intensivists (>3 years PICU experience, n=12), PICU fellows (6– 30 months of PICU

experience, n=6), and residents (<6 months PICU experience, n=9). Individual scores and predicted mortality risks for each patient varied widely. For PRISM scores the average intraclass correlation (ICC) was 0.51 (range 0.32–0.78), and the average kappa score 0.6 (range 0.28–0.87). For PIM scores the average ICC was 0.18 (range 0.08–0.46) and the average kappa score 0.53 (range 0.32–0.88). This variability occurred in both experienced and inexperienced physicians. The percentage of exact agreement ranged from 30% to 82% for PRISM scores and from 28 to 84% for PIM scores. Thus it was concluded that in daily practice, severity of illness scoring using the PRISM and PIM risk adjustment systems is associated with wide variability. These differences could not be explained by the physician's level of experience. Reliable assessment of PRISM and PIM scores requires rigorous specific training and strict adherence to guidelines. Consequently, assessment should probably be performed by a limited number of well-trained professionals[42].

In a study done by Tibby SM et al. in England[43] wherein the aim was to assess the impact of two paediatric intensive care unit retrieval teams on the performance of three mortality risk scoring systems: pre-ICU PRISM, PIM, and PRISM II. A total of 928 critically ill children retrieved for intensive care from district general hospitals in the south east of England (crude mortality 7.8%) were studied. Risk stratification was similar between the two retrieval teams for scores utilizing data primarily prior to ICU admission (pre-ICU PRISM, PIM), despite differences in case mix. The fewer variables required for calculation of PIM resulted in complete data collection in 88% of patients, compared to pre-ICU PRISM (24%) and PRISM II (60%). Overall, all scoring systems discriminated well between survival and non-survival (area under receiver operating characteristic curve 0.83–0.87), with no differences between the two hospitals. There was a tendency towards better discrimination in all scores for

children compared to infants and neonates, and a poor discrimination for respiratory disease using pre-ICU PRISM and PRISM II but not PIM. All showed suboptimal calibration, primarily as a consequence of mortality over prediction among the medium (10–30%) mortality risk bands. Finally it was concluded that PIM appears to offer advantages over the other two scores in terms of being less affected by the retrieval process and easier to collect. Recalibration of all scoring systems is needed[43].

In another study two generic paediatric mortality scoring systems had been validated in the paediatric intensive care unit (PICU) in France[44]. The aim of the present study was to validate PRISM, PRISM III and PIM at the time points for which they were developed, and to compare their accuracy in predicting mortality at those times with their accuracy at 4 hours. All children admitted from June 1998 to May 2000 in one tertiary PICU were prospectively included. Data were collected to generate scores and predictions using PRISM, PRISM III and PIM. There were 802 consecutive admissions with 80 deaths. For the time points for which the scores were developed, observed and predicted mortality rates were significantly different for the three scores ($P < 0.01$) whereas all exhibited good discrimination (area under the receiver operating characteristic curve ≥ 0.83). At 4 hours after admission only the PIM had good calibration ($P = 0.44$), but all three scores exhibited good discrimination (area under the receiver operating characteristic curve ≥ 0.82). It was concluded that among the three scores calculated at 4 hours after admission, all had good discriminatory capacity but only the PIM score was well calibrated[44].

In another study by Thukral et al[45]. under Indian circumstances, Performance of Pediatric Risk of Mortality (PRISM), Pediatric Index of Mortality (PIM), and PIM2 in a pediatric intensive care unit in a developing country was assessed and it was found that for the 215 children enrolled the areas under the curve (95% confidence

intervals) for Pediatric Risk of Mortality (PRISM), Pediatric Index of Mortality (PIM), and PIM2 were 0.80 (0.74-0.86), 0.82 (0.76-0.88), and 0.81 (0.75-0.87), respectively. The area under the receiver operating characteristic curves was significantly greater for older children compared with infants. The existing scores underpredicted the mortality; the standardized mortality ratios (SMRs) (95% confidence interval) using PRISM, PIM, and PIM2 models were 1.20 (0.94-1.50), 1.57 (1.24-1.96), and 1.57 (1.24-1.59), respectively. The SMRs were higher in children with severe malnutrition, those with underlying illness, and those with serum albumin <or=2.5 g/dL. Thus it was concluded that the area under the receiver operating characteristic curve for all the models evaluated was >0.8, however, all the models underpredicted mortality. The likely reasons for this could be differences in the patient profile and greater load of severity of illness being managed with lesser resources--both physical and human--and differences in the quality of care[45].

Conclusion

CONCLUSION

Although a score does not provide a risk assessment for individual patients, it does permit categorization into a particular risk category, which may allow for targeting of novel or high risk therapies towards the sickest patient groups. A significant proportion of paediatric mortality occurs soon after ICU admission, thus a score such as PIM that allows early identification of high risk patients has greater usefulness over PRISM III-24 which takes a longer time for estimation. The data required for calculation of PIM 2 score are easy to collect, non-proprietary, and because the data are collected at "point-of-care", risk stratification does not appear affected by retrieval practice. Mortality risk can be calculated at an early stage after ICU admission. But since PIM 2 score parameters are estimated within 1 hour of admission there will be a high probability of false representation of organ dysfunction status which may significantly contribute to erroneous prediction of mortality.

- From the current study we concluded that both PRISM III-24 and PIM 2 scoring systems are suitable for application in our PICU.
- Both the scoring systems showed good calibrations.
- Prediction of mortality was better with PRISM over PIM as average predicted mortality was nearer to observed mortality in PRISM.
- PIM 2 application was relatively easier as all the parameters were assessed within 1 hour of admission but the scoring was less reliable because most of the parameters did not represent the actual state of organ dysfunction as most of the diseases were at the initial stage with an intact hemodynamic system.
- With application of PRISM III-24 on all acutely sick cases as a routine it would help us in being selectively more aggressive in management of such

cases with judicial utilization of available resources and hence bring down the mortality and morbidity in our PICU.

- It would also help us in in counseling the patient attenders about the probable outcome at the earliest.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Summary

SUMMARY

- The present study was conducted at a tertiary level PICU with an objective of determination of performance of PRISM and PIM scores and comparison of the predicted mortality with the observed mortality and to determination of the suitability of each score for application in our paediatric intensive care unit.
- A total of 77 cases were analyzed.
- All patients fell under AAP protocol for admission to PICU.
- PIM 2 scoring was done within 1 hour of admission.
- PRISM III-24 score was applied within 24 hours of admission.
- The main cause for admission into our PICU was Respiratory System involvement followed by patients with hemodynamic instability.
- The mean PRISM score amongst non-survivors was higher than survivors.
- The average duration of stay in PICU was higher amongst survivors over non-survivors.
- The average mortality predicted by PRISM was nearer to observed mortality over that predicted by PIM.
- Both PRISM and PIM showed good calibration ($p>0.05$) but PRISM was relatively better over PIM.
- Both PRISM and PIM were significant in predicting the outcome as the p-value of Hosmer and Lemeshow test was >0.05 at 5% significance level.
- Classification accuracy was better in PRISM over PIM, i.e. 89.6% over 84.4%
- ROC curve showed that area under ROC curve was >0.8 for both PRISM and PIM scores which offered a good discriminative power for both the scores.

Discriminative power for PRISM was better over PIM as area under ROC curve is more for PRISM is more when compared to PIM, i.e. 9.30 over 9.22.

- Estimates of Binary Logistic model showed that both PRISM and PIM were accurate but PRISM was better over PIM, with a standard error of 2.318 over 13.539.
- Both PRISM III-24 and PIM 2 are suitable for application in our PICU but PRISM III-24 fared better over PIM 2.

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ANNEXURE

PROFORMA

COMPARATIVE STUDY BETWEEN PAEDIATRIC RISK OF MORTALITY SCORE AND PAEDIATRIC INDEX OF MORTALITY SCORE AS PREDICTORS OF MORTALITY IN PAEDIATRIC INTENSIVE CARE UNIT.

Investigator: Dr. Puneet Varma. **Guide: Dr. Beeregowda Y C.**

NAME: **DATE:**

AGE: **I.P.NO:**

SEX:

Diagnosis:

Duration of Stay in PICU:

PRISM III SCORE CHART

Variable	Value	Score
SBP		
Temperature		
Mental Status		
Heart Rate		
Pupillary Reflexes		
Acidosis(pH or Total CO_2)		
pH		
PCO_2		
Total CO_2/HCO_3^-		
Arterial PaO_2		
Glucose		
Potassium		

Creatinine		
Urea		
WBC Count		
Platelet Count		
PT or PTT		
Total Score		

Calculate risk of death(r)

r = (0.207×PRISM) - [0.005×(age in months)] – 0.433×1 (if post-operative) – 4.782

=

Predicted death rate = $e^r/(1+e^r)$

=

PIM2 SCORE CHART

Variable	Value	Score
SBP		
Pupillary Reaction to Bright Light		
$FiO_2/PaO_2 \times 100$		
Base Excess in arterial or capillary blood, mmol/L		
Mechanical Ventilation at any time during the first hour of admission		
Elective admission to ICU		
Recovery from Surgery or a Procedure is the main reason for ICU admission		
Admitted following Cardiac Bypass		
High risk diagnosis is the main reason for ICU admission		
Low risk diagnosis is the main reason for ICU admission		

PIM2 = {0.01395×[absolute(a-120)]} + (3.079×b) + (0.2888×c) + (0.104×absolute d) + (1.3352×e) – (0.9282×e) – (0.9282×f) – (1.0244×g) + (0.7507×h) + (1.6289×i) – (1.5770×j) – 4.8841

PIM2 =

Probability of death = $e^{PIM2}/(1+ e^{PIM2})$

=

CONSENT FORM

I/we have been explained in our own language about our child being enrolled in a research study about "Comparative Study between Paediatric Risk of Mortality Score and Paediatric Index of Mortality Score as Predictors of Mortality in Paediatric Intensive Care Unit" Conducted by Dr. Puneet Varma, Post Graduate in department of Paediatrics in Sri Devraj Urs Medical College, Kolar under the guidance of Dr. Beeregowda Y.C Professor and HOD, department of Paediatrics Sri Devraj Urs Medical College, Kolar.

I/we have been explained about the details of the study, purpose of the study and have also been explained that the management of the patient will not be affected irrespective of the enrollment in the study. Once decided to participate I/We have been explained that we are free to withdraw from the study without affecting any of the management.

I/we have been explained that since this study is a comparative observational study no special invasive procedures or financial burden would be added on the patient. I/We would not be given any financial incentive and confidentiality would be maintained.

I/We after understanding the above mentioned give consent for the same.

Signature of subject: **Date:**

Name of the subject:

Signature of witness: **Date:**

Name of the witness: