TO ANALYZE THE CLINICAL PROFILE AND PREDICTION OF MORTALITY OF THE VENTILATED CHILDREN IN PICU

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ABSTRACT

Aims: To analyze the clinical profile and prediction of mortality of the ventilated children between age group of 1 month to 17 years by application of PRISM score in paediatirc intensive care unit of a tertiary care hospital of Bundelkhand Region.

Method: 100 sick children were taken of which 54 were males and 46 were females based on their clinical profiles and PRISM scores were calculated at 12 hours to 24 hours. Hospital (PICU) outcome was recorded as (Died/Alive) ROC curve analysis was done for evaluating the efficacy of PRISM score to predict the mortality.

Result: During the study period we had taken total 100 ventilated children out of which 60 were alive and 40 died. Receiver operating characteristic was obtained for evaluating the efficacy of PRISM score to predict the mortality. Area under curve for PRISM score at 12 hours was 0.835 and for PRISM score at 24 hours was 0.967. A positive correlation was obtained between PRISM scores at 12 hours and 24 hours with PICU stay that is higher PRISM score was correlating with increase mortality and increased hospital stay. Probability of death in PICU was obtained according to PRISM score.

Conclusion: There was male preponderance of cases in our study. PRISM score appear to be an easy tool and had a good predictive value in assessing the probability of mortality in relation to children admitted to PICU under Indian circumstances in tertiary care referral hospital that showed increase in PRISM score was associated with increase mortality.

Keyword: Paediatric intensive care unit, Receiver operating characteristic curve, Pediatric Risk of Mortality (PRISM) score, Paediatric risk of mortality score.

INTRODUCTION:

Paediatric intensive care units are meant to provide sophisticated care for children and adolescents but increased quantum of therapy can also increase the suffering, financial burden and in the end, may just prolonged the death process[1]; because of this, it is important to be able to quantify the severity of the patient and predict the probability of death based on clinical status of the admitted children[2]. The PRISM score is one of main indicators used in the PICU. It uses 17 parameters (physiological and lab data) and for each one was used the highest severity value recorded in the first 24 hours[3]. We collected data in our study in order to analyze the clinical profile and demographic profile of ventilated children admitted in PICU and to see the predictive value of PRISM III score in our setting for predicting the mortality and length of hospital (PICU stay) thus, the purpose of this study was to evaluate the predictive power of mortality of PRISM III score in a tertiary care PICU in developing country.

Paediatric specialities are rapidly developing in the country. Paediatric intensive care is an important speciality among these. The care of critically ill patients has become increasingly complex as the severity of illness continues to increase, the amount of clinical information available at the bedside is growing, and also the quantity of evidence supporting or refuting specific therapies and interventions for this population is escalating. To ensure that the critically ill children got the highest quality of care, various strategies are used; one of these is use of protocols for management of various conditions.

Mechanical ventilation can be lifesaving, but >50% of complications in conditions that require [4] intensive care are related to ventilatory support, particularly if it is prolonged

Patients receiving mechanical ventilation represent only a small proportion of hospitalizations, it is a life-saving invasive technology which is expensive, labour-intensive and is associated with various complications. The

percentage of children receiving mechanical ventilation in PICUs [5] ranges from 17-64% in developed countries. The mortality rate is higher in children who require [6]

Mechanical ventilation as compared to those who do not require respiratory support Modern equipments play an important role in the management and outcome of children. Equally important is the role of well trained staff working in the PICUs has improved but the cost has increased significantly.

Currently severe sepsis, septic shock and respiratory illness are the major indications for admission to the PICU. In a resource limited setting, the prediction models highlight the cases where more medical attention is required and also enable the physicians to assess the prognosis of the patient so adequate measures can be taken beforehand. However data for PICU in Uttar Pradesh especially in Bundelkhand region is limited. Hence this study is being planned to avail baseline statistics for patients admitted in PICU.

Commonly used modes of ventilation

1. Controlled Mechanical Ventilation (CMV): In this mode, the ventilator controls all the ventilation while the patient has minimal or no respiratory effort.

2. Assist Control Ventilation (ACV): In this mode, the patient initiates the breathing. However, if he/she fails to initiate the breathing within a prescribed time, the ventilator triggers the breathing and provides a controlled breath as in CMV, thus ensuring a guaranteed minute ventilation.

3. Intermittent Mandatory Ventilation (IMV): It is essentially a combination of spontaneous breathing and CMV. A modified circuit provides a continuous flow of gas that allows the patient to breathe spontaneously with minimal work of breathing.

At a predetermined frequency, the ventilator provides a positive pressure breath to the patient[7].

4. Synchronized Intermittent Mandatory Ventilation (SIMV): When IMV is synchronised to the patient's inspiratory efforts, it is referred to as SIMV breath[8].

5. Pressure Support Ventilation (PSV): In this mode, the patient triggers the breath as in assisted ventilation. Therefore, this mode is applicable only to spontaneously breathing patients. Once initiated, the ventilator delivers

air and gas mixture at a preset positive pressure in the ventilatory circuit. Patients determine their own inspiratory time and tidal volume. It is mainly used as a weaning mode and may be tolerated better than SIMV by some patients[9].

6. Pressure Control Ventilation (PCV): This is a time-initiated, pressure-limited and time-cycled mode intended for patients requiring total mechanical ventilatory support. Most ventilators also allow patient triggering of these breaths, producing pressure assisted breaths (pressure assist control ventilation).

7. Airway Pressure Release Ventilation (APRV): This is a pressure- limited, timecycled ventilation, in which the preset pressure limit is equal to the level of CPAP required and the PEEP is usually ambient pressure, or a selected lower airway

pressure[10].

8. Pressure Regulated Volume Control (PRVC): This is a control mode, which delivers a set tidal volume with each breath at the lowest possible peak pressure[11].

9. Continuous Positive Airway Pressure (CPAP): CPAP is best described as PEEP during spontaneous respiration. Infants with severe respiratory disease develop grunting which is a compensatory mechanism to elevate physiologic PEEP, preventing alveolar collapse. In spontaneously breathing patients, CPAP can be administered through a valve or water column in the expiratory circuit. Most ventilators are, however, equipped with a CPAP mode, which can be administered through tight fitting mask, nasopharyngeal catheter, nasal prongs or through endotracheal tube.

10. High frequency ventilation (HFV): They are characterised by supraphysiologic ventilatory frequencies (>60 cycles/min) and low tidal volumes. Four distinct methods are high frequency positive pressure ventilation, high frequency oscillatory ventilation, high frequency jet ventilation, high frequency chest wall oscillation[12].

Monitoring of a patient on ventilator

While the child is on mechanical ventilation, the patients have to be meticulously monitored. Monitoring may be noninvasive such as repeated cardiopulmonary assessment, pulse oximetry, x rays, ECG, capnography, non-invasive blood pressure monitoring, or invasive such as blood gases, central venous pressures, and arterial blood pressure. However excellent may be the information provided by respiratory monitors, it cannot replace careful bedside clinical examination. In addition, fluid balance, intake and output, weight of children should be monitored

daily. Close monitoring allows titration of therapies to optimise patient ventilator interactions and aid in weaning from the ventilator[13].

A record of FiO2, tidal volume, peak inspiratory pressure, mean airway pressure and any alterations made in the ventilator settings have to be documented.

Sedation, Analgesia and Muscle relaxants

Sedatives and muscle relaxants are often needed to enable effective ventilation[14]. These medications can be used on an intermittent dosing schedule or as a continuous infusion. In most patients, sedation alone is sufficient. Muscle relaxants are needed in patients requiring maximal ventilatory support and higher oxygen concentrations. It is important to understand that agitation and 'fighting with ventilator' frequently results from tube related complications or hypoxemia and correcting them often obviates the need for further sedation requirement.

Tracheostomy

In chronically ventilated patients (more than 2-4 weeks), it is better to maintain the airway through a tracheostomy tube, since it is more comfortable, protects the airways and larynx, allows oral feeding and is less likely to be obstructed or inadvertently dislodged. Frequent suctioning, continuous humidification and meticulous wound toilet are necessary for care of the tracheostomy.

Weaning from mechanical ventilation

Weaning is defined as liberation from mechanical ventilation while spontaneous breathing is allowed to assume the responsibility for effective gas exchange[15]. During weaning, the emphasis is on ways of enhancing the return of full diaphragmatic function and discontinuation of mechanical ventilation[16].

The most commonly used weaning trials are T-piece, CPAP and pressure support trials[17]. Children who have been ventilated for a period of less than 2-3 days and who were in good health prior to respiratory failure may usually be weaned from ventilator and allowed to breathe spontaneously. However, those patients who have been ventilated for a longer period need to be weaned gradually by allowing increasing periods of time for spontaneous ventilation over a period of several days. Throughout weaning, vitals must be closely monitored and blood gases must be checked at the end of each weaning period off the ventilator[18]

Extubation:

Extubation is the removal of the endotroacheal tube. Criteria for extubation include spontaneous ventilation, hemodynamic stability, intact airway reflexes and manageable airway secretion.

a) Early extubation failure: Refers to extubation failure rising within 6 hours of extubation.

b) Intermediate extubation failure: Refers to extubation failure rising within 6-24 hours of extubation.

c) Late extubation failure: Refers to extubation failure rising within >24-72 hours of extubation.

Complications of ventilation

As a complex and invasive technology, mechanical ventilation is fraught with numerous adverse outcomes, both iatrogenic and unavoidable[19]. Mechanical ventilation can no longer be viewed simply as a harmless support modality that is employed to keep patients alive while diseasespecific treatments are used to ameliorate the underlying pathology[20]. Mechanical ventilation can be lifesaving, but more than 50% of complications in conditions that require intensive care are related to ventilatory support, particularly if it is prolonged[21]. These need to be anticipated and managed promptly:

1.Airway Complications: Accidental tracheal extubation or obstruction of the tracheal airway by mucus or blood are potentially life threatening complications. They can be prevented by proper airway care, adequate humidification of the inspired gas, physiotherapy of the chest and frequent suction. Prolonged intubation may lead to vocal cord damage, post-extubation subglottic stenosis, tracheal granuloma and fibrotic bands.

2.Pulmonary Complications: Most of the adverse physiological responses to positive pressure ventilation result from inappropriately high mean airway pressure[22]. Sudden hypoxemia or deterioration in the circulatory status in a patient on mechanical ventilation warrants immediate examination to exclude tension pneumothorax. The danger of pneumothorax is increased and interstitial emphysema may occur when peak inspiratory pressure exceeds 40 cm water or when the end expiratory pressure exceeds 15 cm water. Barotrauma can be minimized by maintaining low inspiratory pressures and tidal volume with minimum peak end expiratory pressure compatible with adequate ventilation.

3.Ventilator Induced Lung Injury: Ventilation is associated with the development of pulmonary tissue injury due to epithelial and endothelial damage, lung capillary

permeability alterations[23].

4.Oxygen toxicity: Prolonged exposure to high concentration of oxygen can damage the alveolar capillary membrane and produce congested edematous lungs with intra alveolar hemorrhage and exudates[24]. Oxygen toxicity is suggested by increasing alveolar-arterial oxygen difference in the absence of pulmonary fluid accumulation. Use of the lowest concentration of inspired oxygen to prevent hypoxemia is the best method to avoid pulmonary oxygen toxicity. General consensus indicates that FiO2 <0.5 can usually be tolerated satisfactorily.

5.Ventilator Associated Pneumonia: Ventilator-associated pneumonia is defined as nosocomial pneumonia in mechanically ventilated patients that was not present at the time of intubation, and occurs 48 hours after intubation. It is the second most common cause of nosocomial infections, next only to blood stream infections[25] and is a major risk factor for mortality in ICU settings. Nosocomial pneumonia is caused by a wide spectrum of bacterial pathogens. They may also be polymicrobial and are rarely due to viral and fungal pathogens in immunocompetent[26].

6.Other Complications: PEEP increases the intrathoracic pressure and reduces systemic venous return and cardiac output. These effects may cause serious consequences in patients with pre existing hypovolemia. They are overcome usually by fluid boluses to increase blood volume with or without inotropic agents. In this respect, a patient treated with mechanical ventilation must be followed by the Paediatric intensive team and in a PICU[27].

In conclusion, judicious use of ventilation when indicated, is essential along with very close monitoring of these critically ill children for a successful outcome.

METHODS:

All the cases admitted in PICU of tertiary care referral hospital of Bundelkhand region who were ventilated in a PICU between July 2020 to August 2021. Minimal sample size of 100 randomly selected cases were taken which was calculated based on Daniell's formula.

The PRISM score is a measure of illness' severity based on the abnormality observed in the bed side examination and laboratory assessment. Therefore all the patients were further evaluated by the following study variables which included 14 physiological parameters of PRISM score.

Study design: Prospective observational study.

Prism Score III:

Infant -	[1-12 months]
Child-	[>12 month to 144 (12 years) months]
Adolescents-	[>144 months (>12 years)]

Sub scores:

1. Cardiovascular and neurological vital signs:5 measures
2. Acid base and blood gas: 5 measures
3. Chemistry tests: 4 measures
4. Haematology tests: 3 measures
5. Grading variables: use the highest and lowest values for scoring.

Interpretation of PRISM score:

1. Minimum sub score and total score =0
2. Maximum cardiovascular and neurological sub score=30
3. Maximum acid base and blood gas sub score=22
4. Maximum chemistry sub score=10
5. Maximum haematology sub score=12
6. Maximum total PRISM III score=74

The higher the total score, the worse the prognosis. It is performed during first 12 hours and 24 hours of PICU admission which were known as PRISM 12 and 24 scores respectively.

Inclusion criteria:

- Children age >30 days and ≤17 years who were ventilated in PICU.
- Parents willing to give consent for the inclusion in study.

Exclusion criteria:

- Children ventilated for <12 hours.
- Children who were ventilated outside the hospital and referred for further care.

RESULTS:

Table 1: Sex distribution

Clinical profile	Number	Percentage
Male	54	54.00%
Female	46	46.00%

In our study male to female ratio was 1.8:1.Male preponderance of cases were seen.

Table 2:

Variables	Total Number	Alive [n=60]		Died [n=40]	
		Freq.	%	Freq.	%
Age					
1-12 months (infant)	25	17	68.00%	8	32.00%
13-36 months (Toddler)	15	5	33.33%	10	66.67%
>3-6 years (Preschool)	10	8	80.00%	2	20.00%
>6-10 years (School)	17	12	70.59%	5	29.41%
11-17 year (Adolescent)	33	18	54.55%	15	45.45%
Indication of ventilation					
Respiratory	41	31	75.61%	10	24.39%
Sepsis	20	7	35.00%	13	65.00%
CNS	14	10	71.43%	4	28.57%
CVS	10	4	40.00%	6	60.00%
Others (snake bite, poisoning, renal, hepatic and misc.)	15	8	53.33	7	46.67
Association of PRISM score at 24 hours and their outcome					
1-9	38	37	97.37%	1	2.63%
10-19	26	21	80.77%	5	19.23%
20-29	12	1	8.33%	11	91.67%
≥30	24	1	4.17%	23	95.83%
Association of Duration of ventilation and outcome					
1-3 days	5	4	80.00%	1	20.00%
4-7 days	43	32	74.42%	11	25.58%
8-14 days	43	21	48.84%	22	51.16%
>15 days	9	3	33.33%	6	66.67%

The mean age of children put on ventilator was found to be 7.17 In our study 25(25%) ventilated cases were infants (1m-1yr);15(15%) ventilated cases were toddlers (13 m-36m);10(10% ventilated children were preschool (>3y-6y);17(17%)ventilated cases were school age(>6y-10y);33(33%)ventilated cases were adolescents. Maximum mortality of about 66.67% was seen in the age group (13-36 months) while minimum mortality was found in the age group >3-6yrs.

In our study Male preponderance (54 %) of cases were seen with male to female ratio of 1.8:1. The chi-square (□2) statistics is 12.07. The p-value is 0.017. The result was significant at $p < .05$.

The most common indication of ventilation in our study was respiratory illness. Out of 41 respiratory cases-31 (75.61% were alive) & 10 (24.39% died) least common indication for ventilation in our study was cardiovascular illnesses. Out of 10 % cases - 40% were alive & 60% died.

The chi-square ($\square^2$) statistics is 10.43. The p-value is 0.015. The result was significant at $p < .05$.

In our study with higher PRISM score ≥30 among 17 patients, 14 died at 12 hours while out of 24 patients 23 died at 24 hours .

Also when the PRISM score was less i.e . between 1 – 9 , out of 38 patients only 1 died while rest survived .

The mortality rate was around 66.67 % in cases which were given more ventilation of > 15 days followed by cases which required 8-14 days ventilation with 51.16% mortality rate. Also , the chi-square ($\square 2$) statistics is 9.46. The p-value is 0.024. (statistically significant) The result was significant at $p < .05$.

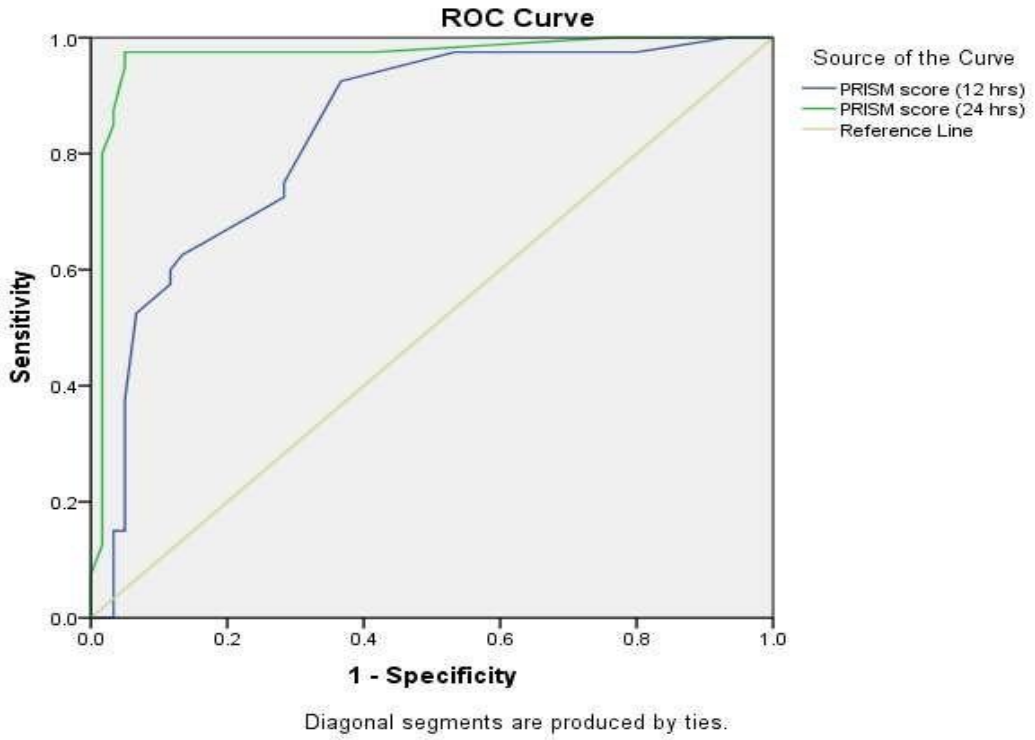
Table 3: Correlation of Prism score (12 and 24 hours) with hospital stay (PICU stay)

Variables	Pearson correlation value (r)	p value (p)
Duration of Hospital stay in days (PRISM score 12 hours)	0.161	0.010
Duration of Hospital stay in days (PRISM score 24 hours)	0.204	0.042

A positive correlation was observed between PRISM score at 12 hours and 24 hours with PICU stay i.e. higher PRISM score was correlating with higher mortality & increased duration of PICU stay which was found statistically significant.

Table 4: Comparison of Prism score at 24 hour and Prism score at 12 hour

Area Under the Curve					
Test Result Variable(s)	Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
PRISM score (12 hours)	.835	.041	.000	.755	.916
PRISM score (24 hours)	.967	.021	.000	.926	1.000



Prism score at 24 hour was better than Prism score at 12 hour and the area under the curve is 0.967, 0.835 respectively and both are statistically highly significant.

DISCUSSION:

The outcome of patient in PICU relies on various factors like severity of illness, treatment received by the patient before seeking intensive care, time required to transfer the patient from referring doctor to tertiary care center and mode of transport used to shift the patient (Private vehicle and Ambulance) had a direct and significant impact on the intensive care therapy and outcome of the patient in PICU.

On the other hand the correct and timely utilization of resources in the PICU, use of sophistication equipment, staffing and the effectiveness of an aggressive therapy are some of the important factors which had to be looked in terms of cost effectiveness.

All this can be achieved successfully if the outcome of the patient is predicted early and managed accordingly.

The PRISM score is developed from the physiological stability index (PSI), a severity of illness measure used to predict mortality. The score described the severity of illness according to physiological dearrangements detected on the clinical examination and standard laboratory tests. Our observation that increase in PRISM score was associated with an increase in the mortality was showing the correlation with the outcome was similar to the previous studies of Castello et -al, Singhal D et-al[27] & Shann et –al[28].

Analysis of demographic distribution shows that in PICU more male children were admitted during study period than female children & this difference was significant. This may reflect male susceptibility to various serious diseases but it could also be because of more ignorance of female child due to still existing preferences to a male child among Indian families. This finding was similar to PICU data generated from North India in a recently published study by Makhija et-al[29]. Costa et –al[30] observed median PRISM score significantly lower in patients who survived (p<

0.01). Singhal D et al[27] in their study in their study on ROC analysis showed area under curve of PRISM score as 72%.Madaan et -al in their study observed PRISM score was significantly higher among expired cases as compared to survived cases. In our study of 100 cases of exclusively ventilated children in PICU; 40% mortality was seen. A similar study from Africa by Jeena PM et-al reported an overall mortality of 35.44% .Higher mortality in our PICU may be contributed by several factors. Firstly our hospital is the only government tertiary care referral hospital of Bundelkhand region of Uttar Pradesh. Our PICU caters to seriously ill Paediatrics patients from other nearby peripheral remote areas of Madhya Pradesh as well as from other departments including paediatric surgery; neurosurgery; neurology & nephrology etc.

CONCLUSION

This study is one of the first study in Bundelkhad region of Uttar Pradesh on ventilated children in PICU. Under 5 years children constituted the major load of PICU. There was male preponderance of PICU admission. The most common indication of ventilation was of respiratory illness wheareas the most common cause of death among ventilated children were due to sepsis which was statistically significant. PRISM score at presentation may be used as a tool in predicting mortality in critically ill children. Therefore PRISM score had a great relevance in clinical epidemiology & can be used as a stratification variable in clinical trials.

Mechanical ventilation is one of the major supportive modalities used in critical care all over the world but this treatment modality is being used in very limited number of children in few government tertiary care hospitals. Despite the limitations of a greater percentage of critically ill children arriving late to a hospital in our study; the overall survival was of 60%.To improve the outcome of mechanically ventilated children in PICUs ;we need effective, organised & wellstructured educational courses from basic concepts to clinical application for all physicians & nurses involved in the care of critically ill children receiving mechanical ventilation. As we gain more

experience in the ventilation; our complication rate & mortality related to mechanical ventilation would also decrease hopefully.

Reliability of Prism score in our study was calculated by Cronbach's alpha test of 0.803 in our study which was found statistically good.

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