

Pediatric Intensive Care Unit in a Developing Nation: Exploring Acute Neurological Illnesses and Their Clinical Course

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ABSTRACT

Introduction

The burden of neurological illnesses is high in pediatric age group. Both primary neurological illnesses and neurological complication of systemic illness are commonly seen in pediatric intensive care unit (PICU). Neurological illness prolongs the length of PICU stay and also increases the mortality and morbidity. To assess the burden and describe the spectrum of acute neurological illness in a pediatric intensive care unit and analyze the early outcome.

Methods

This was a prospective observational study conducted in Department of Pediatric intensive care unit from April 2021 to March 2022. All children from 1 months to 16 years of age with neurological illness being admitted to PICU were included in the study. Basic demographic characters, diagnosis, treatment modalities and outcome were analyzed.

Results

During study period, 237 (24.89%) were admitted to PICU with neurological illness. Mean age was 66 ± 42 months and 138 (58.22%) were male. Out of 237 children, 196 (82.70%) had primary neurological illness and 41 (17.30%) neurosurgical diagnosis. In primary neurological illness, 102 (52.10%) had primary CNS infection, followed by status epilepticus (21.52%), septic encephalopathy (11.70%), neuromuscular illness (8.16%), and metabolic encephalopathy (4.08%). In neurosurgical cases, 32 (78.04%) had Traumatic Brain Injury and 9 (22%) were shifted to PICU postoperatively. Mechanical ventilation was required in 156 (65.82%) and 88 (37.13%) required inotropic support. The mortality rate in neurological cases was 24 (10.12%) as compared to overall mortality rate of 6.8% in PICU.

Conclusion

Neurological disorders are common in PICU and are associated with higher mortality rate. Primary central nervous system infection, severe traumatic brain injury and status epilepticus were common cause of PICU admission in our cohort.

Keywords

Mortality; neurological illness; outcome; pediatric intensive care unit

INTRODUCTION

The burden of neurological illnesses is high in pediatric age group. Acute neurological illnesses constitute about 25% of pediatric intensive care unit (PICU) admissions.¹ Primary neurological illness, neurological complications of systemic illness and Neurosurgical illness are commonly admitted in PICU. The burden of Neurological disorders in children is enormous with overall prevalence rate of 1-3% in children less than 5 years of age.² Common neurological illness are primary central nervous system (CNS) infection, status epilepticus, septic encephalopathy, neuromuscular illness, and metabolic encephalopathy. In neurosurgical cases, Traumatic brain injury, postoperative cases following brain tumor, meningomyelocele, ventriculo-peritoneal shunt, hydrocephalus were common reason for admission. Children admitted to PICU with neurological illness have higher chances of mortality, morbidity and longer duration of PICU stay.

Higher mortality in neurological illness occur due to acute brain injury. Apart from treatment of primary illness, prevention and treatment of secondary injury is important for survival of children. Prevention and treatment of hypoxia and hypotension early in the course of illness, can improve the survival of children. Early resuscitation, provision of neuroprotective strategies and measures to reduced raised intracranial pressure has significantly reduced the mortality in various neurological illness.³ There are few studies⁴ describing incidence and outcome of acute neurological illness in children but comprehensive review of clinical spectrum of neurological illness in pediatric intensive care unit is lacking. The objective of this study is to assess the burden and describe the clinical spectrum of acute neurological illness being admitted to pediatric intensive care unit.

METHODS

This study is a prospective observational study conducted on children with acute neurological illness admitted to PICU of Nobel Medical College and Teaching Hospital during 12 months period January 2022 to December 2022. This study was started after acquiring approval from the Institutional Review Committee of Nobel Medical College. Nobel Medical College is a tertiary referral center located in Biratnagar, Nepal. Department of Pediatrics consists of 63 bedded pediatric ward and 15 bedded level III pediatric intensive care unit.

Primary objective of this study was to assess the burden and describe the spectrum of neurological illness in a pediatric intensive care unit. Secondary objectives was to analyze the outcome (Duration of PICU stay, Need of vasoactive agents and mortality) in children admitted with acute neurological illness.

All children from 1 months to 16 years of age with acute neurological illness being admitted to PICU were included in the study. Basic demographic characters, diagnosis, clinical profile and outcome were analyzed. Children with syndromic association, cerebral palsy and any known genetic or hereditary condition presenting with neurological involvement were excluded from this study.

After consent from caregiver and assent from older children, Basic demographic features, presence of any chronic illness, nutritional status, and data on significant family illness and social and economic factors were noted. Any illness which primarily involved the nervous system within 2 weeks of admission was labeled as acute neurological illness. Diagnosis was divided into two main categories Primary neurological illness and Neurosurgical illness. Primary neurological category includes structural (CNS infections, vascular and intracranial space occupying lesion), metabolic/toxic (encephalopathy due to status epilepticus, poisoning, hypertensive encephalopathy and metabolic like inborn error of metabolism, diabetic coma, liver failure) and Neuromuscular illness like Guillain-Barre syndrome (GBS), myasthenia gravis, and botulism. Neurosurgical illness included traumatic brain injury and postoperative care after any neurosurgical procedures. Neurological illness was diagnosed on the basis of clinical examination, results of lumbar puncture and brain imaging computed tomography (CT) scan and or magnetic resonance imaging (MRI) brain. All diagnosis were made on basis of history, physical examination, laboratory tests, neurodiagnostic tests like imaging CT/MRI, electro-encephalography (EEG) and nerve conduction test (NCT).

Data was entered in MS Excel and analyzed using SPSS 20. Data was summarized using mean and standard deviation for quantitative variables and frequency and percentage for qualitative variables. Independent sample t-test was used for comparison of means. Categorical variables between groups was compared using chi square test. Logistic regression was done to assess the relationship between clinical variables and outcome. Results were considered significant if p value <0.05. In various studies, the incidence of acute neurological illness in children admitted to PICU has been reported to be 20–25%.¹ We calculated sample size of 245, using sample size formula $[N = Z^2 pq/d^2]$ (where $q = 1-p$) and incidence of 20%.¹ However, we included all the cases being admitted as acute neurological illness during the study period and consenting to participate in this study.

Sample size formula: $N = Z^2 pq/d^2$ (where $q = 1-p$) where, $Z = 1.96$ (value of standard normal distribution corresponding to a significance level of 0.05), $d =$ Error of margin (0.05)

RESULTS

During study period, a total 237 (24.89%) were admitted to PICU with neurological illness. Among them, 138 (58.22%) were male and 99 (41.78%) were female. Mean age of children with neurological illness was 66 ± 42 months. We found 112 (47.25%) cases between 1-5 years of age, 88 (37.13%) cases between 5-10 years of age and 37 (15.61%) cases were above 10 years of age. Out of 237 children, 196 (82.70%) had primary neurological illness and 41 (17.30%) neurosurgical diagnosis. In primary neurological illness, 102 (52.10%) had primary CNS infection, followed by status epilepticus (21.52%), septic encephalopathy (11.70%), neuromuscular illness (8.16%), and metabolic encephalopathy (4.08%).

In neurosurgical cases, 32 (78.04%) had Traumatic Brain Injury and 9 (22%) were shifted to PICU postoperatively (following brain tumor, meningomyelocele, V-P shunt, Hydrocephalus surgery). Majority (91.82%) children with neurological illness admitted to PICU, required respiratory support. 26 children (11%) required CPAP support, 36 (15%) required HFNC support and 156 (65.82%) required Mechanical ventilation as a respiratory support. Out of 237 children 119 (50.21%) had shock, Shock was defined when a patient required more than 20 mL/kg of IV fluid resuscitation or inotropic support to maintain blood pressure above the 5th centile. Among 119 children in shock, 88 (37.13%) required inotropic support, others were fluid responsive. Vasoactive Inotropic score (VIS score) > 10 was associated with higher chances of mechanical ventilation [87.5% vs 12.5%, p value 0.0037] and longer duration of PICU stay [9.5 (2.8) days vs 5.5 (1.8) days, p value < 0.0001].

CT scan Head was done in 114 cases (48.10%), MRI Brain was done in 123 cases (51.89%), EEG was performed in 98 cases (41.35%), whereas CSF analysis was done in 125 (52.74%) Acute Kidney Injury was seen in 59 cases (24.89%). Among children with Acute kidney injury, 15 (6.32%) required Hemodialysis support and 10 (4.21%) required peritoneal dialysis support. Out of 156 children requiring invasive mechanical ventilation, 55 (35.25%) required prolonged mechanical ventilation (> 7 days). Children requiring mechanical ventilation for more than 7 days had higher mortality (79.16%) as compared to children requiring mechanical ventilation for less than 7 days (20.84%). This difference in mortality was statistically significant (p value 0.0067). Mean duration of PICU stay was 7.5 days. Out of 237 cases, 199 cases (83.96%) survived, 14 cases (5.90%) went on LAMA and 24 cases (10.12%) expired. Among children who went on LAMA, 9 cases went due to poor neurological outcome and 5 cases went on LAMA due to financial issues. The mortality rate in neurological cases was

Table 1. Primary neurological illness in children admitted to PICU

Diagnosis	Number (percentage)
Primary CNS Infection	102 (52.10%)
Status epilepticus	42 (21.52%)
Septic encephalopathy	23 (11.70%)
Neuromuscular illness	16 (8.16%)
Metabolic encephalopathy	8 (4.08%)
Hypoxic ischemic encephalopathy	5 (2.44%)

24 (10.12%) as compared to overall mortality rate of 6.8% in PICU.

DISCUSSION

We found that 237 (24.89%) of all PICU admission were categorized as Acute neurological illness. The spectrum of neurological illness is very wide range, ranging from CNS infection, status epilepticus to traumatic brain injury. Studies has shown that majority of deaths occur in PICU secondary to neurological dysfunction.⁵ Our study has shown that 1/4th of all admissions in PICU was acute neurological illness, similar to study done by Bell et al.⁶ and they had longer length of PICU stay similar to study done by Moreau AF et al.¹ Studies from developing countries has shown CNS infection as commonest cause of acute neurological illness in PICU, similar to our study (52.10%).⁷ Whereas in developed countries, status epilepticus and traumatic brain injury were commonest cause of Acute neurological illness.¹ In our study status epilepticus and traumatic brain injury accounted for only 21.52% and 13.50% of all PICU admissions respectively.

Our study showed that children requiring prolonged mechanical ventilation had significantly higher mortality (79.16% vs 20.84%) as compared to children requiring mechanical ventilation for less than 7 days (p value 0.0067). Similarly (VIS score) > 10 was associated with higher chances of mechanical ventilation and longer duration of PICU stay. These findings were similar to study done in india and Pakistan where prolonged mechanical ventilation and requirement of inotrope was associated with higher mortality.^{7,8} Higher mortality in children with prolonged mechanical ventilation can be attributed to severe neurological impairment, hospital acquired infections (ventilator associated pneumonia, central line associated bloodstream infection) or ventilator induced lung injury. Similarly higher VIS score suggest myocardial dysfunction or multiorgan failure, which can result in higher mortality. Our study showed Acute Kidney Injury was seen in (24.89%) cases but only 10.54% children required renal replacement therapy in form

of Hemodialysis or Peritoneal dialysis.

The mortality rate in neurological cases was 24 (10.12%) as compared to overall mortality rate of 6.8% in PICU. The mortality rate in acute neurological illness in children from developing countries reported are high and ranges from 10-30%.^{7,9} Our study also had higher mortality 10.12% compared to overall mortality of 6.8%, which can be attributed to several factors, including late presentation to hospital, severity of neurological impairment and poor financial status. Pediatric neurocritical care is evolving branch of pediatric intensive care unit and requires skilled manpower and resources to provide care to child with acute neurological illness. Early recognition and prompt management of these children can prevent hypoxic ischemic encephalopathy and neurological sequelae.

CONCLUSION

Neurological disorders are common in PICU and are associated with higher mortality rate. Primary CNS infection, severe traumatic brain injury and status epilepticus were common cause of PICU admission in our cohort. Early recognition and effective management of acute neurological illness can result in improved neurological outcome. There are few limitations to this study, we didn't assessed PRISM III score or SOFA score to categorize cases based on severity of illness. Moreover this study was single center study done in small population. Multicenter study from different regions of Nepal will help to assess actual burden of acute neurological cases in PICU.

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CONFLICT OF INTEREST

The author(s) declare that they do not have any conflicts of interest with respect to the research, authorship, and/or publication of this article.

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