

# Evaluation of patients admitted to the pediatric intensive care unit due to neurological problems

## Çocuk yoğun bakım ünitesine nörolojik nedenlerle yatan hastaların değerlendirilmesi

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### ABSTRACT

**Objective:** The principal objective of this study was to produce a profile of the patients hospitalized in the pediatric intensive care unit due to neurological problems and to identify the major etiologies most commonly leading to mortality.

**Methods:** We detected that 293 of 2843 patients hospitalized in our hospital's pediatric intensive care unit over the 3-year period between 2011 and 2013 were admitted for neurological reasons. Patients' etiologies, comorbidities, and dates of admission to the pediatric intensive care unit and of discharge were evaluated.

**Results:** The most frequently seen neurological morbidity was convulsion in 39% (n=114) of the cases. Neurological problems were the sole cause of admission in 186 (63.7%) cases, while 106 (36.3%) patients had a comorbid condition in addition to neurological problems. The most common of these comorbidities was infection in 68.8% (n=73) of the cases. One hundred and sixteen (39.7%) patients were discharged in a healthy condition, while abnormal neurological findings were present in 131 (44.9%) patients. While 28 (9.6%) patients exited during admission. Respiratory problems were the most common cause of death. Mortality, and hospitalization rates in patients under 3 years of age were found to be higher when they are compared with other groups. They are an important cause of admissions to the particularly pediatric intensive care unit and of mortality.

**Conclusion:** Neurological problems constitute a significant group in admissions in pediatric intensive care. They constitute an important cause of admission into the pediatric intensive care unit and of mortality, particularly children under 3 years of age. Effective treatment of infections may reduce mortality rates.

**Keywords:** Mortality, neurology, pediatric intensive care unit

### ÖZ

**Amaç:** Bu çalışmanın temel amacı, çocuk yoğun bakım ünitesine nörolojik nedenlerle yatan hastaların profilinin çıkarılması ve mortaliteye neden olan başlıca etiyolojik faktörlerin tanımlanmasıdır.

**Yöntem:** Çocuk yoğun bakım ünitesine 2011 ve 2013 yılları arasındaki üç yıllık süreçte yatırılan 2843 hastanın 293 tanesinin nörolojik nedenlerle yattığı saptandı ve çalışmaya dahil edildi. Hastalar etiyoloji, ko-morbidite ve yatış süreleri açısından değerlendirildi.

**Bulgular:** En sık görülen morbidite nedeni %39 (n=114) ile konvülsiyonlar olarak saptandı. Yüz seksen altı (%63,7) hastanın yatış nedeni nörolojik nedenlerken, 106 (%36,3) hastada ko-morbid hastalığı mevcuttu. En sık görülen ko-morbidite enfeksiyonlardı (%68,8, n=73). Yüz onaltı (%39,7) hasta şifa ile taburcu edilirken, 131 hastanın taburculukta anormal nörolojik bulguları mevcuttu. Hastaların 28'i (%9,6) yatış sırasında ölmüş, en sık ölüm nedeni solunum sorunları olduğu görülmüştür. Üç yaşın altında yoğun bakıma yatırılan hastaları diğerlerine göre mortalite oranının daha yüksek olduğu saptandı.

**Sonuç:** Nörolojik sorunlar, çocuk yoğun bakım ünitesine yatışların önemli bir grubudur. Özellikle 3 yaş altındaki çocuklar, yoğun bakım ünitesine yatışların ve mortalitenin önemli bölümünü oluşturur. Enfeksiyonların etkin tedavisi mortalite oranlarını azaltabilir.

**Anahtar kelimeler:** Mortalite, nöroloji, çocuk yoğun bakım ünitesi

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## INTRODUCTION

In the new era, pediatric intensive care units in developed countries are specializing as neurological, cardiological or nephrological intensive care units. The aim of this specialization is to provide better care for patients and to prevent discharge with sequelae. Pediatric neurology intensive care is a branch developing out of pediatric intensive care and pediatric neurology. While statistical studies have investigated pediatric intensive care epidemiology and outcomes at discharge in developed countries, the situation in developing countries such as Turkey is still unclear. Although there is still no center with a pediatric neurology intensive care unit in Turkey, knowing mortality and morbidity rates of the patients with neurological problems in pediatric intensive care units, will reveal requirements in this area. These findings also serve as a guide in terms of preventing existing diseases.

The purpose of this study was to examine the reasons for admission and prognoses of patients admitted between 2011-2013. due to neurological causes to the pediatric intensive care unit of Dr. Behçet Uz Children's Diseases and Surgery Training and Research Hospital Izmir, Turkey, The principal objective was to produce a profile of patients admitted to the pediatric intensive care unit due to neurological problems and to identify the factors most commonly leading to mortality.

## MATERIAL and METHODS

We enrolled 293 patients among 2843 patients hospitalized in our hospital's pediatric intensive care unit for neurological indications over the 3-year period between 2011 and 2013. Ethics Committee approval was obtained from our tertiary hospital (Date: 22.11.2012, No: 2012/46), and the study was executed abiding by the Declaration of Helsinki. Patients' ages were calculated based on age at the time of hospital admissions. Disease etiologies, comorbidities, and dates of admission to the pediatric intensive care unit and of discharge, diagnoses at discharge were based on data in patients' hospital files. Magnetic resonance examinations (MRI) were performed at radiology department in our hospital

and assessed by radiologists. The mortality rate was calculated as the proportion of patients dying from neurological causes to total number of deaths in the pediatric intensive care unit during the study period. Patients with both primary neurological problems (such as status epilepticus, complex febrile convulsion and Guillain-Barré syndrome) and patients with primary neurological diseases who were admitted to intensive care unit with a secondary cause (such as urosepsis or pneumonia) were included in the study.

Prevalence rates obtained were expressed as percentages, median and mean values. Fischer's exact test and relative risk were used to calculate factors capable of causing mortality. The chi-square test was used in the analysis of categorical data, and p values <0.05 were regarded as significant.

## RESULTS

A total of 2843 patients were admitted to the pediatric intensive care unit within 3-year study period between 2011 and 2013. Acute or chronic neurological problems were present in 293 of these patients. Eighty-nine (30.5%) patients with neurological problems were hospitalized in the pediatric intensive care unit in 2011, 99 (33.9%) in 2012, and 104 (35.6) in 2013.

Of the patients with neurological problems, 58.4% (n=170) of them were male and 41.6% (n=122) of them were female. The patients aged <1 (n=129; 37.3%), 1-3 (n=56; 19%), and >3 (n=127; 43.5%) years and 127 (43.5%) were aged over 3. The median age of the patients was 5.6 years.

Mean duration of stay in the pediatric intensive care unit (PICU) was 10.2 days, while the patients also remained in PICU for 24 (12.7%) 48 (47.3%), and >48 (40.1%) hours.

The most common etiological cause was convulsion in 39% (n=114) of cases. Of the subjects with convulsion, 58.9% experienced generalized seizures, and 67.5% (n=75) exhibited status epilepticus. The second most common etiology was cerebral palsy in 32.5% (n=95) of the patients (Table 1).

One-hundred and eighty-six patients (63.7%) had only neurological problems, while 106 (36.3%) patients had a comorbid condition in addition to neurological

**Table 1. Patients' etiological profile.**

Etiology	No.	%
Convulsion	114	39
Cerebral palsy	95	32.5
Neurometabolic disease	37	12.7
CNS infection	17	5.8
Neuromuscular disease	9	3.1
Impaired consciousness	6	2.1
Neurocutaneous disease	3	1
SOIL	3	1
Stroke	2	0.7
Intracranial haemorrhagic	2	0.7
Other	4	1.4
<b>TOTAL</b>	<b>292</b>	<b>100</b>

CNS: Central nervous system

SOIL: Space occupying intracranial lesions

problems such as pneumonia, urinary system infection or hematological problems. The most common of these comorbidities was infection (68.8%; n=73), electrolyte imbalance (16.9%; n=18), hematological (10.3%, n=11) and endocrinological problems (3.7%; n=4).

Eighty-two percent of the patients in whom convulsion was the only reason for admission, were discharged without sequelae. Patients who were admitted only with convulsion without any co-morbidity had significantly more improved prognosis (p=0.003).

The median hospital stay was 14 days (min: 24 hours, max: 325 day). Length of stay exceeded 48 hours in 40.1% (n=117) of the patients and total length of hospitalization was longer than 4 weeks in 11.3% (n=33) of the patients.

MRI of the brain was performed in 276 (94.1%) patients, and 137 (46.9%) of them had normal MRI findings. The most common pathological finding in cranial MRI was cerebral atrophy in 47 (16.1%) fol-

**Table 2. Causes of mortality profile.**

Cause of mortality	No.	%
Respiratory problem	14	50
Cardiac problem	5	17.8
Multiorgan failure	9	32.1
<b>TOTAL</b>	<b>28</b>	<b>100</b>

lowed by gliotic changes in 23 (7.9%) patients,

One hundred and sixteen (39.7%) patients were discharged in a healthy condition, while abnormal neurological findings were present in 131 (44.9%) patients. Twenty-eight (9.6%) patients exited. Respiratory problems were the most common cause of death, being observed in 14 (50%) cases (Table 2).

Status epilepticus manifested in 75 (25.7%) patients, 9 of whom died. Although a high proportional relationship was determined between status epilepticus and mortality, this was not statistically significant (p=0.09).

Sixty-three of 165 patients aged under 3 years were discharged in a healthy condition, while 22 (34.9%) patients died. This correlation between age group and mortality was statistically significant (p=0.02) (Table 3).

## DISCUSSION

In the era of rapid growth in technology and therapeutic options aimed at preventing brain damage, there is a rising interest in treatment options and approaches under intensive care conditions for neurological diseases. However, same strategic approach for pediatric neurological diseases is as yet unclear. The aim of this study was to emphasize that neurological diseases constitute a significant proportion of

**Table 3. Status at discharge by age groups.**

Age group	Cured	Sequel	Died	Referred to other hospital	Discharged of own volition	Total
<3 Years	63	65	22	7	8	165
>3 Years	53	66	6	2	0	127
<b>TOTAL</b>	<b>116</b>	<b>131</b>	<b>28</b>	<b>9</b>	<b>8</b>	<b>292</b>

admissions to the pediatric intensive care units and to highlight the importance of joint investigation in terms of additional diseases.

Neurological problems were determined in 293 (10%) of the 2843 patients admitted to the pediatric intensive care unit during the period between 2011, and 2013. Different figures have been reported in other studies. Poyrazoğlu et al. <sup>(1)</sup> reported that patients with neurological problems constituted 16.6% of all patients, while Adudu et al. <sup>(2)</sup> cited this figure as 16.7 percent .

The most common neurological condition was convulsion in 39% (n=111) of the cases, and 67.5% (n=75) of them were evaluated as status epilepticus. Convulsion was also the most common cause identified in Bell et al.'s <sup>(3)</sup> study, in 19% of their cases. Our study data are compatible with reports from Eurasia. However, figures from Sub-Saharan regions are very different, with head traumas and diseases commonly seen in developing countries, such as cerebral malaria and tetanus, being most frequently observed <sup>(2,4)</sup>. The second most common etiological cause in our study was cerebral palsy (n=95, 95.9%). This high level may be due to the inclusion in our study not only of children with acute neurological events, but also of children with chronic neurological diseases admitted to the pediatric intensive care unit due to secondary causes (such as pneumonia). Different etiological causes have been also determined in various regional studies <sup>(1-3)</sup>.

Traumatic brain injury was observed among the most common etiology of admission to pediatric intensive care units in previous researches, but it was rare in our study. This may be due to the fact that patients with multiple trauma are not referred to pediatric intensive care unit of our hospital, because our centre is not a tertiary hospital in the fields of brain surgery and orthopedics.

Central nervous system infection was determined in 17 patients. Growth of *Neisseria meningitidis* was determined in one patient and *Streptococcus pneumoniae* in another, while no agent was identified in the remaining cases. Herpes virus encephalitis was suspected with clinical findings in five cases, but no agent could be identified. Our study is compatible

with similar studies, while infections with atypical agents for Turkey, such as malaria, were common in a study from Africa <sup>(2)</sup>.

Neurological problems were not the sole indications for admissions to the pediatric intensive care unit, while 106 (36.3%) patients were admitted to PICUs due to a secondary condition developing from a background of neurological disease. The most common of these secondary diseases was infection, at 68.8% (n=73). The most prevalent infections were related to the airways. Respiratory tract infections due to both orthopedic and thoracic anomalies in patients with chronic neurological disease are known to be more frequent and more complex than those of infections in the normal community. As shown in the present study, these represented a significant part of morbidities requiring pediatric intensive unit care. Considering primary preventive measures such as passive and active immunization and respiratory physiotherapy, secondary protection such as antibiotic therapy and bronchodilator therapy and tertiary prophylaxis such as respiratory physiotherapy may reduce pediatric intensive care unit admissions of patients with chronic neurological diseases <sup>(5-7)</sup>.

Sixty-two (60%) patients with secondary disease additional to primary neurological disease were hospitalized for longer than four weeks. Although this was a higher hospitalization rate , it was not statistically significant (p=0.1). Various studies have reported that such high levels may be due to nosocomial infections developing in association with prolonged hospital stay <sup>(8-11)</sup>.

At least one neuroimaging technique was applied to 276 (94.1%) patients. The most common pathological finding in cerebral imaging was cerebral atrophy in 47 (16.1%) patients. Cerebral atrophy emerging as the most common finding may be due to cerebral palsy, one of the most common etiological causes, being one of the most common MRI findings, and to its appearing as a non-specific finding in cases with undiagnosed neurometabolic disease. Apart from chronic central nervous system findings, acute cerebral events were observed including acute cerebral ischemia in 4, acute intracranial bleeding in 2, and cerebral edema in 3 patients. MR findings of

central nervous system were infection in 5, space occupying intracranial lesion in 3, and demyelinated areas in 2 patients. Acute events being identified in 19 out of 276 MRIs raised the question of whether MRI was being used unnecessarily in intensive care units. Despite the considerable advances in neuroimaging techniques in this age of technology, laboratory tests must not become more important than neurological examination. This is important in terms of both patient health and health policies <sup>(12)</sup>.

The mortality rate in our study was 9.6% (n= 28). The most common cause of mortality was respiratory problems, identified in 14 (50%) patients. We think that infections being the most common secondary etiology during admission to the pediatric intensive care units of patients with neurological problems also led to respiratory problems occupying the predominant place in the etiology of mortality.

Nine (12%) of the 75 patients with a manifestation of status epilepticus died. Although there was a history of status epilepticus in the admission of nine of 28 patients who died within 3 years, the relation between status epilepticus and mortality was not statistically significant (p=0.09). In particular treatment-refractory status epilepticus appears to be closely associated with mortality, especially in the infants leading to metabolic acidosis and metabolic imbalance. In a study of childhood status epilepticus, Bargezar et al. <sup>(13)</sup> reported that mortality occurred in 13 (10%) of 132 patients interned in the pediatric intensive care unit with a diagnosis of status epilepticus. Vooturi <sup>(14)</sup> reported mortality in 24 (19%) of 126 patients with adult status epilepticus. Loddenkemper <sup>(15)</sup> reported a figure of 0.95% in a long-term study. Twenty-two (13.3%) of the 165 patients aged under 3 years died from various causes. This death rate under the age of 3 represents 78.5% of the total mortality rate. Patients under the age of 3 are at greater risk of mortality, and the association was statistically significant (p=0.02). The increased mortality rates may be due to neurometabolic diseases, respiratory tract infections, and chronic neurological disease appearing more commonly under the age of 3, and to ventilator-associated pneumonia that leads a more fetal course in that age group <sup>(16)</sup>.

## CONCLUSION

Neurological problems constitute a significant group in pediatric intensive care. They are among important reasons of admission to the pediatric intensive care units and of mortality, particularly in patients under 3 years of age. Effective treatment of infections can reduce mortality rates.

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