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Prognosis in Neurological Intensive Care Units

Nörolojik Yoğun Bakım Ünitesinde Prognoz

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Abstract

Objective: Neurocritical care, or neurological intensive care, provides critical care for patients with neurological or neurosurgical diseases. These patients need to receive medical care for their primary critical illnesses, comorbidities, and complications. This study aims to compare the clinical outcomes of patients with neurological or neurosurgical diseases treated in general ICUs and those of patients treated in neurological intensive care units (neuro-ICU).

Materials and Methods: Patients with neurological and neurosurgical diseases who were treated in the ICUs by a neurointensivist were included in the study. The patients were categorized into two groups according to their ICU types and the study periods: patients in the mixed general ICU (period-1) and patients in the neuro-ICU (period-2). The records in the hospital automation system and this study's database of patients were evaluated retrospectively.

Results: Sixty-one patients in period-1 and 58 patients in period-2 were evaluated. The ICU mortality rate and the ICU and hospital stay duration were lower in the neuro-ICU patients, but this difference was not statistically significant ($P > 0.05$). ICU readmission and in-hospital mortality rates were significantly lower in the neuro-ICU patients ($P < 0.05$).

Conclusion: This study analyzed the effect of specialized neurocritical care and neuro-ICU organization on patient clinical outcomes. To achieve better patient management in the neuro-ICU, it is necessary to provide quality improvements in the process's structure, performance, and standardization. In Türkiye, there is a need for studies regarding this subject to establish and agree on standards for neurocritical care.

Keywords: Neurocritical care, intensive care, outcome, mortality, stroke

Öz

Amaç: Nörokritik bakım ya da nörolojik yoğun bakım, nöroloji ve nöroşirürji hastaları için kritik bakım sağlamaktadır. Bu hastaların hem birincil kritik hastalıkları, hem de eşlik eden komorbiditeleri ve komplikasyonları için tıbbi bakım almaları gerekmektedir. Bu çalışmanın amacı, genel yoğun bakım ünitelerinde (YBÜ) takip edilen nörolojik veya nöroşirürjikal hastalığı olan hastalar ile nörolojik yoğun bakım ünitesinde (nöro-YBÜ) takip edilen hastaların klinik sonlanımlarını karşılaştırmaktır.

Gereç ve Yöntem: Çalışmaya YBÜ'lerde nörointensivist tarafından takip edilen nörolojik ve nöroşirürjikal hastalığı olan hastalar dahil edildi. Hastalar, YBÜ türüne ve çalışma dönemine göre karma genel YBÜ'de izlenen hastalar (dönem-1) ve nöro-YBÜ'de izlenen hastalar (dönem-2) olmak üzere iki grupta incelendi. Hastane otomasyon sistemindeki ve hasta veri tabanımızdaki kayıtlar retrospektif olarak değerlendirildi.

Bulgular: Dönem-1'de 61 hasta ve dönem-2'de 58 hasta değerlendirildi. Nöro-YBÜ'de takip edilen hastalarda yoğun bakım mortalitesi, yoğun bakım ve hastanede kalış süresi daha düşüktü ancak bu fark istatistiksel olarak anlamlı değildi ($P> 0,05$). Yoğun bakıma yeniden yatış ve hastane içi mortalite ise nöro-YBÜ hastalarında anlamlı olarak daha düşüktü ($P< 0,05$).

Sonuç: Uzmanlaşmış nörokritik bakım ve nöro-YBÜ organizasyonunun hastalarda klinik sonlanım üzerindeki etkisini analiz ettik. Nöro-YBÜ'de daha iyi hasta yönetimi elde edebilmek için, sürecin yapı, performans ve standardizasyon açısından kalite iyileştirmesinin sağlanması gerekmektedir. Türkiye'de nörokritik bakım standartlarının oluşturulabilmesi ve üzerinde mutabakata varılabilmesi için bu konuda yapılacak çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: Nörokritik bakım, yoğun bakım, sonlanım, mortalite, inme

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Introduction

Neurocritical care, or neurological intensive care, provides critical care for patients with neurological or neurosurgical diseases (1,2). These patients need to receive medical care not only for their primary critical illnesses, but also for their comorbidities and complications (3). In the 1980s, some academic centers in the United States combined neurosurgical and neurological intensive care units (neuro-ICUs) for this purpose. Patients with neurocritical illnesses can be treated in these units (4). Neurocritical illnesses include traumatic brain injuries, status epilepticus, and neurovascular, neuromuscular, and neurooncological diseases (4).

Neurocritical care, which has become widespread in recent years, is administered by a specialized multidisciplinary team comprised of physicians, nurses, respiratory therapists, pharmacists, nutritionists, and social workers (3,5). Neurocritical care has been associated with reduced mortality and duration of hospitalization (2).

This study aims to compare the clinical outcomes of patients with neurological or neurosurgical diseases treated in general ICUs with those of patients treated in neuro-ICUs.

Materials and Methods

Study Background

This study was carried out in the ICUs of Nigde Training and Research Hospital. In the hospital, level 3 ICU served as a mixed general ICU during the study period between May 2019 and May 2020. In May 2020, patients with neurological and neurosurgical diseases were treated in the neuro-ICU. Accordingly, a neuro-ICU certificate was obtained for the facility. Due to the coronavirus disease-2019 (COVID-19) pandemic, the neuro-ICU was included in the system as a COVID-ICU and continues to serve as one.

Study Population

The study population comprised patients with neurological and neurosurgical diseases treated by a neurointensivist in level 3 adult ICUs between 05.01.2019 and 08.15.2020. Ethics committee approval was obtained from the Ethics Committee of Nigde Omer Halisdemir University (approval no: 2021/07-14).

Data Collection

The records in the hospital automation system and this study's database of patients were evaluated retrospectively. Patients with neurological and neurosurgical diseases treated in a level 3 ICU by a neurointensivist were included in the study. Patients with neurological and neurosurgical diseases transferred to other ICUs due to the COVID-19 pandemic were excluded from the study.

Patients admitted to ICU more than once were included in the study only once, and ICU readmission during hospitalization was one of the study variables. A readmission was defined as readmission to ICU within the same hospital stay. Age, sex, comorbidities, type of ICU admission, admission date to ICU, acute physiologic and chronic health evaluation II (APACHE II) score, the primary diagnoses, raised intracranial pressure radiological signs (the presence of mass effect with midline shift greater than 5 mm, basal cistern effacement, or the effacement of cortical sulci), Glasgow Coma score (GCS), mechanical ventilatory support, inotropic and vasopressor requirements, and use of intravenous antihypertensive medications at ICU admission were recorded on the data collection forms. Neurological progression in ICU follow-ups, ICU readmission rates, ICU and hospital stay duration, ICU mortality rates, and in-hospital mortality rates were also recorded on the data collection forms as clinical outcome variables.

Patients with neurological and neurosurgical diseases were categorized into two groups according to their ICU types and the study periods: patients in the mixed general ICU (period-1) and patients in the neuro-ICU (period-2). Period-1 lasted for one year, and period-2 lasted for 3.5 months. During period-1, patients with neurological and neurosurgical diseases and patients with other critical illnesses were treated in the mixed general ICU by a neurointensivist. In period-2, patients with neurological and neurosurgical diseases were treated in the neuro-ICU by the same neurointensivist as in period-1. Specialized neurocritical care was provided for patients in the neuro-ICU during period-2.

Statistical Analysis

Statistical analyses were performed using SPSS 22.0 statistics package software. Categorical variables were expressed as frequency and percentage values, and continuous variables were expressed as median (minimum–maximum). Continuous variables were compared with the Mann–Whitney U test, and the chi-square test was used to compare the categorical data. A P value of <0.05 was accepted as statistically significant.

Results

In period-1 of the study, 940 patients were treated in the level 3 ICU. Of these, 236 patients were treated by a neurointensivist. Sixty-one patients who were admitted to the ICU due to neurological or neurosurgical disease among 236 patients were included in the study. In period-2, four patients with neurological or neurosurgical diseases who were transferred to other ICUs due to the COVID-19 pandemic and continued to require level 3 intensive care were excluded from the study. In period-2, a total of 58 patients were included in the study.

A detailed comparison of the demographics and the clinical and imaging data of patients with neurological or neurosurgical diseases in period-1 and period-2 is shown in Tables 1, 2. When the groups were compared in terms of outcomes (Table 3), ICU readmission and in-hospital mortality rates were lower in period-2 than in period-1 ($P = 0.033$, $P = 0.046$, respectively).

Of the 119 patients diagnosed at ICU admission, 47 (39.5%) had a traumatic brain injury, 20 (16.8%) had an ischemic stroke, 15 (12.6%) had an intracerebral hemorrhage, 10 (8.4%) had a neurooncological disease, 7 (5.9%) had status epilepticus, 9 (7.6%) had received spinal surgery, and 11 (9.2%) had received different diagnoses (hydrocephalus, meningoencephalitis, malignant neuroleptic syndrome, Arnold-Chiari malformation, posterior reversible encephalopathy syndrome, sinus vein thrombosis, and subdural empyema). When the mortality rates were evaluated according to patients' diagnoses, 4 of the 22 patients with traumatic brain injury died in the ICU in period-1 (ICU mortality was 18.2%), and 5 of the 25 patients with the same condition died in the ICU in period-2 (ICU mortality was 20%). The ICU mortality rate in patients with ischemic stroke was 30.8% (4/13) in period-1 and 14.3% (1/7) in period-2. These rates for patients with intracerebral hemorrhage and neurooncological diseases in period-1 were 55.6% (5/9) and 25% (1/4), respectively, and the rates in period-2 were 50% (3/6) and 16.7% (1/6), respectively.

Table 1. Demographics and clinical data of patient groups				
	Total (n = 119)	**Period-1 (n = 61)**	**Period-2 (n = 58)**	***P***
Age, median year (minimum–maximum)	59 (18–90)	62 (18–90)	58 (19–89)	0.483
Sex				
Female, % (n)	37% (44)	37.7% (23)	36.2% (21)	0.866
Comorbidities				
Hypertension, % (n)	48.7% (58)	47.5% (29)	50% (29)	0.789
Coronary artery disease, % (n)	18.5% (22)	23% (14)	13.8% (8)	0.198
Diabetes mellitus, % (n)	16% (19)	16.4% (10)	15.5% (9)	0.896
COPD/asthma, % (n)	14.3% (17)	11.5% (7)	17.2% (10)	0.369
Atrial fibrillation, % (n)	12.6% (15)	16.4% (10)	8.6% (5)	0.202
Malignancy, % (n)	8.4% (10)	4.9% (3)	12.1% (7)	0.160
Heart failure, % (n)	5.9% (7)	8.2% (5)	3.5% (2)	0.271
Chronic renal failure, % (n)	2.5% (3)	4.9% (3)	0% (0)	0.087
Liver cirrhosis, % (n)	1.7% (2)	1.6% (1)	1.7% (1)	0.971
Neurological comorbidities, % (n)	21% (25)	16.4% (10)	25.9% (15)	0.205
Admission source				
Emergency department	47.1% (56)	42.6% (26)	51.7% (30)	**0.015**
Operating room	37% (44)	31.1% (19)	43.1% (25)	
Level 1 and 2 ICU	12.6% (15)	19.7% (12)	5.2% (3)	
Inpatient service	3.4% (4)	6.6% (4)	0% (0)	

Bold text indicates statistical significance. COPD: Chronic obstructive pulmonary disease, ICU: Intensive care unit

The ICU mortality for patients with other neurological and neurosurgical diseases was 14.3% (1/7) in period-1 and 25% (1/4) in period-2.

Discussion

This study analyzed the effect of specialized neurocritical care and neuro-ICU organization on clinical outcomes in patients with neurological or neurosurgical diseases. In this study, the ICU mortality rate and ICU and hospital stay duration were lower among the neuro-ICU patients, but this difference was not statistically significant ($P > 0.05$). The ICU readmission and in-hospital mortality rates were significantly lower among the neuro-ICU patients ($P < 0.05$).

Patients were treated by a neurointensivist in both periods. Neurointensivists are specialists providing comprehensive care to neurocritical patients, including for cardiac, pulmonary, renal, and infectious problems (3). It has been reported that neurointensivist co-management may improve clinical outcomes in patients with neurocritical illnesses (3). However, according to the data from the point prevalence in neurocritical care study, neurointensivists only treated a fifth of neuro-ICU patients (2). In the United States, neurointensivists are trained among neurologists and neurosurgeons and can add this experience to their development (4). In Türkiye, the role of neurointensivists has not been clearly determined. Neurologists receive the title of intensive care specialist after undergoing a general intensive care subspecialty training program.

Previous studies showed that neurocritical care services, neuro-ICUs, and neurointensivists could improve clinical outcomes in patients with neurocritical illnesses. Such care has been associated with reduced mortality, hospital stay duration, and cost of care (1,2,3,6,7,8). In this study, both patient groups were treated by a neurointensivist. In addition to providing physicians specialized in this field, organizing the ICU infrastructure is important for providing adequate care to patients with neurocritical illnesses (1). This study believes that the organization of the neuro-ICU and specialized neurocritical care were the main reasons for the better outcomes in period-2.

Despite their important effects on outcomes, most neuro-ICUs are only found in large academic institutions. Certain questions need to be answered, including deciding which patients will be treated with neurocritical care and determining the ideal bed number for neuro-ICUs. One of the ways to address these questions is to establish and agree on neuro-ICU standards (5). As a starting point, this study's institution received a level III neuro-ICU certificate from the Ministry of Health. The Neurocritical Care Society recommends level-based classification of neuro-ICUs. A level I neuro-ICU provides neurocritical care for patients with the most complex neurological catastrophes. A level II neuro-ICU ensures the stability of patients with acute illnesses and the safe management of stable neurocritical care processes. A level III neuro-ICU evaluates and stabilizes patients with neurological emergencies and transfers patients to level II or I units after their initial management (5). This system is like the general ICU system in this study's hospital. The level I neuro-ICU corresponds to the

Table 2. Clinical and imaging data of patient groups on ICU admission and follow-up				
	Total (n = 119)	**Period-1 (n = 61)**	**Period-2 (n = 58)**	***P***
Diagnoses				
Traumatic brain injury, % (n)	39.5% (47)	36.1% (22)	43.1% (25)	0.354
Ischemic stroke, % (n)	16.8% (20)	21.3% (13)	12.1% (7)	
Intracerebral hemorrhage, % (n)	12.6% (15)	14.8% (9)	10.3% (6)	
Neurooncological disease, % (n)	8.4% (10)	6.6% (4)	10.3% (6)	
After spine surgery, % (n)	7.6% (9)	3.3% (2)	12.1% (7)	
Status epilepticus, % (n)	5.9% (7)	6.6% (4)	5.2% (3)	
Others, % (n)	9.2% (11)	11.5% (7)	6.9% (4)	
Radiological signs of raised intracranial pressure				
Effacement of cortical sulci, % (n)	71.4% (85)	67.2% (41)	75.9% (44)	0.297
Basal cistern effacement, % (n)	37% (44)	32.8% (20)	41.4% (24)	0.332
Midline shift >5 mm, % (n)	17.6% (21)	18% (11)	17.2% (10)	0.910
Findings on ICU admission				
GCS, median (minimum–maximum)	9 (3–15)	9 (3–15)	9 (3–15)	0.636
Mechanical ventilation, % (n)	40.3% (48)	39.3% (24)	41.4% (24)	0.821
Inotropic/vasopressor support, % (n)	12.6% (15)	11.5% (7)	13.8% (8)	0.703
Use of IV antihypertensive, % (n)	8.4% (10)	8.2% (5)	8.6% (5)	0.934
ICU follow-up				
Neurological progression	13.4% (16)	14.8% (9)	12.1% (7)	0.668
APACHE II, median (minimum–maximum)	20 (6–43)	21 (6–43)	19 (7–38)	0.394

ICU: Intensive care unit, GCS: Glasgow Coma score, IV: Intravenous, APACHE: Acute physiologic and chronic health evaluation

Table 3. Outcomes				
	Total (n = 119)	**Period-1 (n = 61)**	**Period-2 (n = 58)**	***P***
ICU stay, median day (minimum–maximum)	5 (1–50)	5 (1–46)	4.5 (1–50)	0.314
Hospital stay, median day (minimum–maximum)	12 (1–168)	14 (2–168)	11.5 (1–91)	0.091
ICU readmission, % (n)	9.2% (11)	14.8% (9)	3.5% (2)	**0.033**
ICU mortality, % (n)	21.8% (26)	24.6% (15)	19% (11)	0.458
In-hospital mortality, % (n)	31.1% (37)	39.3% (24)	22.4% (13)	**0.046**

Bold text indicates statistical significance. ICU: Intensive care unit

level 3 ICU. However, in this study's hospital, no first- or second-level neuro-ICUs correspond to levels II and III. Since it is only a level III neuro-ICU, patients in the acute phase of the neurocritical illnesses who should have been treated in a level II neuro-ICU were treated in the level III neuro-ICU instead. After the critical acute phase, these patients were transferred to level 1 and 2 general ICUs. Although this monitoring protocol has handicaps in terms of cost, two reflections of this protocol can be seen in the study. One is lower patient admissions from level 1 and 2 ICUs to level 3 ICU in period-2 (20% in period-1 vs. 5% in period-2). Additionally, ICU readmission rates decreased significantly in period-2 (15% in period-1 vs. 4% in period-2) ($P < 0.05$). In Suarez et al.'s (7) study, patient admissions from ICUs to the neuro-ICU were found to associate with in-hospital mortality. The lower rates of ICU readmission and patient transfer from other ICUs to the neuro-ICU in period-2 could be two reasons for the low in-hospital mortality during period-2 in this study.

In this study, there was a difference between period-1 and period-2 in terms of primary neurological diagnoses at ICU admission. While the rate of traumatic brain injury was 36% in period-1, it was 43% in period-2. In addition, there was a difference in the ratio of patients admitted to the ICU after spinal surgery (3% in period-1, 12% in period-2). All these data may explain the lower mortality rates in period-2. However, both patient groups had similar characteristics in terms of initial GCS, mechanical ventilatory supports, inotropic and vasopressor requirements, use of intravenous antihypertensive medications, raised intracranial pressure radiological signs at ICU admission, and APACHE II score, which are factors that may contribute to determining the critical illness severity ($P > 0.05$ for all).

Study Limitations

The difference in treatment protocols between the two periods may have affected clinical outcomes. The fact that neurocritical care protocols were not evaluated in this study is one of its limitations. The second limitation is the lack of data concerning scales evaluating neurological functional outcomes. The third limitation is the study's retrospective nature.

Patients with neurological and neurosurgical diseases were admitted to the neuro-ICU for 3.5 months. Due to the COVID-19 pandemic, most ICUs in this study's hospital were converted into COVID-ICUs. If the pandemic ends and the neuro-ICU returns to service, the forward-set goals for the neuro-ICU will be implemented. These goals include using bedside electroencephalography and intracranial pressure monitoring.

Conclusion

In this study, ICU readmission and in-hospital mortality rates were lower in the neuro-ICU patients ($P < 0.05$). This study believes these data are valuable. It is currently thought that there are no studies about the clinical outcomes of patients with neurological or neurosurgical diseases in general ICUs vs. neuro-ICU in Türkiye. To bolster patient management in the neuro-ICU, it is necessary to provide quality improvements in the structure, performance, and standardization of the process. In Türkiye, there is a need for studies regarding this subject to establish and agree on neurocritical care standards.

Ethics

Ethics Committee Approval: Ethics committee approval was obtained from the Ethics Committee of Nigde Omer Halisdemir University (approval no: 2021/07-14).

Informed Consent: Retrospective study.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Concept: T.M., H.Ş., Design: T.M., H.Ş., Data Collection or Processing: T.M., Y.T., Analysis or Interpretation: T.M., Y.T., Literature Search: T.M., Writing: T.M., H.Ş.

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