

# Characteristics of Patients Diagnosed as Brain Death in Intensive Care Unit of a Tertiary Hospital

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## ABSTRACT

**Objective:** The aim was to examine the characteristics of brain death cases detected in the intensive care unit of our hospital in the last 12 years, respectively.

**Methods:** In this study, archive records of cases diagnosed with brain death in an intensive care unit between January 1, 2011, and December 1, 2022, were examined. Demographic characteristics, hospitalization diagnoses, time until apnea test and cardiac arrest, supporting tests used in diagnosis, acceptance rates of organ donation by families, transplanted organs, and blood groups of patients were recorded.

**Results:** Thirty-five cases diagnosed with brain death were included in the study. The most common diagnosis among these patients was intracranial hemorrhage (68%) at initial admission. The apnea test was completed in 94.7% of the patients, and radiological imaging methods were used to support the diagnosis of brain death in 62.9% of the patients. Anesthesiology and reanimation specialists had taken part in all diagnoses. The mean timespan from hospitalization to the apnea test was  $5.94 \pm 3.07$  days. The timespan for the diagnosis of brain death was  $6.17 \pm 3.02$  days. A total of 22.8% of the cases were organ donors. The liver was the most often donated organ (49%).

**Conclusion:** Revealing the characteristics of patients diagnosed with brain death will inform us about which patient groups can be donor candidates. Thus, the number of donor organs from cadavers will be increased.

**Keywords:** Apnea test, brain death, intensive care unit, organ donation

## INTRODUCTION

Brain death is the complete and irreversible loss of all brain functions, including the brainstem.<sup>1,2</sup> It is a clinical diagnosis where irreversible coma, areflexia, and apnea are present. The diagnosis is made with both the absence of brainstem reflexes and spontaneous respiratory effort, and a positive apnea test, combined with a clinical condition that will explain the cause of the deep coma.<sup>3,4</sup> Some supporting methods can be used while making the diagnosis of brain death. The purpose of these methods is to demonstrate either a cessation of cerebral blood flow or an irreversible cessation of brain function.<sup>5,6</sup>

The current updated regulation states that the decision must be made unanimously by two physicians, one

of whom must be a neurology or neurosurgery specialist, and the other must be an anesthesiology & reanimation or intensive care specialist.

There are two ways of organ transplantation: through living donors and from cadavers. Although organ transplantation from a living donor is safely performed today, it is inevitable that a healthy person is put at risk. Therefore, obtaining organs from cadavers is the safest source. Thus, the number of organs taken from cadavers needs to be increased.<sup>7,8</sup>

Since the number of patients diagnosed with brain death is limited in terms of hospitalization rates, and this limited resource cannot be fully evaluated, every patient with a diagnosis of brain death has great importance. A delay in

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the diagnosis of brain death would lead to organ loss and as a result, the number of patients awaiting transplantation will continue to rise.<sup>9</sup> For this reason, knowing the characteristics of brain death cases is very important for these cases to be fully evaluated as organ donors.

In this study, we aimed to evaluate the characteristics of brain death cases that occurred in a tertiary intensive care unit between 2011 and 2022.

## MATERIAL AND METHODS

This study was carried out by examining the archive files and computer records of brain death cases that occurred in the tertiary intensive care unit of Erzincan Mengücek Gazi Training and Research Hospital between January 1, 2011, and November 1, 2022, after the approval of the ethics committee of Erzincan Binali Yıldırım University (IRB: 02.11.2022-212499; Date: November 2, 2022). Patients whose files could not be reached were excluded from the study. Demographic characteristics of the cases, diagnosis for admission to the intensive care unit (ICU), from which service they were admitted, which day of the apnea test was performed, supportive tests used for diagnosis, time from the patient's arrival to the diagnosis of brain death, specialties of the physicians in charge of the brain death commission, donor patient rates, time from diagnosis to cardiac arrest in non-donor patients, length of stay in the intensive care unit, number of donated organs, and blood groups of the patients were recorded from their files.

### Statistical Analysis

The International Business Machines (IBM®) Statistical Package for the Social Sciences (SPSS®) 21.0 (IBM SPSS

Corp.; Armonk, NY, USA) software was used for statistical analysis. Descriptive statistics of parametric numerical data in the study group were calculated as mean  $\pm$  SD, descriptive statistics of non-parametric numerical data were calculated as median (lowest and highest values), and categorical data were given as percent (%). The Shapiro–Wilk test was used to evaluate the normal distribution of data.

## RESULTS

35 patients diagnosed with brain death were identified. Among the cases, 2 (5.7%) of them were children and 33 (94.3%) were adults. Seventeen (48.5%) of the patients were female and 18 (51.5%) were male. The mean age was 52.09.

The cases were evaluated in 6 groups according to their diagnoses as follows: intracranial hemorrhage, ischemic cerebrovascular disease, methanol intoxication, multiple trauma, post-cardiopulmonary resuscitation (CPR), and gunshot injury. Brain death resulted most often after intracranial hemorrhage (68.6%) (Table 1).

Moreover, it was found that 94.3% (n = 33) of the patients were admitted to the intensive care unit from the emergency department. Apnea test was performed in all, except for 2 cases due to improper conditions. While the diagnosis was made by apnea test + neurological examination in 37% (n = 13) of the cases, supportive tests were needed for the remaining. Radiological imaging studies were the most often used supportive test, in 60.1% of the patients (Table 2).

The anesthesiology and reanimation specialists took part in all of the diagnoses. Neurology, cardiology, and

### MAIN POINTS

- The number of patients diagnosed with brain death is limited in terms of hospitalization rates, and this limited resource cannot be fully evaluated. So, every patient with a diagnosis of brain death has great importance.
- Organ transplantation is important for maintaining the lives of patients with end-stage organ failure. For this reason, it is vital to determine the cases of brain death and to ensure a sufficient number of donations for patients with organ failure.
- In this study, we aimed to determine the most common diagnosis in patients who are admitted to the intensive care unit and who later become brain dead. We also aimed to explain the methods of the apnea test, neurological examination, and supportive tests that are used for diagnosis.
- For the purposes of this study, the data of patients diagnosed with brain death in the last 11 years in our hospital was retrospectively investigated.

**Table 1.** Demographic Characteristics

Gender (n, %)	
Woman	16 (45.71%)
Man	17 (48.57%)
Child	2 (5.71%)
Age (Years, Mean $\pm$ SD)	
	52.09 $\pm$ 20.22
Diagnosis of Hospitalization (n, %)	
Intracranial Bleeding	24 (68.6%)
Ischemic CVA*	3 (8.6%)
Methanol Intoxication	1 (2.9%)
Multiple Trauma	2 (5.7%)
CPR**	4 (11.4%)
Firearm injury	1 (2.9%)

\*CVA, cerebrovascular accident.

\*\*CPR, cardiopulmonary resuscitation.

**Table 2.** Pre-intensive Care Clinic of Patients, Apnea Test Results, Supportive Tests, Practitioners

<b>Pre-intensive Care Clinic of Patients (n, %)</b>	
Emergency service	33(94.3%)
In-hospital service	2(5.7%)
<b>Apnea Test Results (n, %)</b>	
Completed	33(94.7%)
Failed	2(5.7%)
<b>Supportive Tests (n, %)</b>	
Cranial CT angiography	19 (54.3%)
Cranial CT angiography + cervical CT angiography	1 (2.9%)
EEG	1 (2.9%)
Neurological examination	13 (37.1%)
Cranial CT + second neurological examination	1 (2.9%)
<b>Practicing Clinician (n, %)</b>	
Anesthesiologist + neurologist	27 (77.1%)
Anesthesiologist + neurosurgeon	1 (2.9%)
Anesthesiologist + neurologist + neurosurgeon	3 (8.6%)
Anesthesiologist + neurologist + neurosurgeon + cardiologist	4 (11.4%)

CT, computed tomography; EEG, electroencephalography.

neurosurgery specialists were the remaining members of the board (Table 2).

The average time between admission to the ICU and the apnea test was  $5.94 \pm 3.07$  days. The mean time elapsed for the definitive diagnosis of brain death was  $6.17 \pm 3.02$  days, while the elapsed time from admission to the ICU until cardiac arrest was  $35.69 \pm 67.67$  hours in non-donor cases. The mean duration of hospitalization in the ICU was  $7.43 \pm 4.01$  days (Table 3).

Eight of the 35 patients diagnosed with brain death in our clinic in the last 12 years, and 22.8% of all patients

**Table 3.** The Duration of Intensive Care Hospitalization of Patients, the Time Until the Apnea Test After Hospitalization, the Duration of Brain Death Detection, and the Duration of Cardiac Arrest After Brain Death

<b>The duration of intensive care hospitalization of patients (day) (mean <math>\pm</math> SD)</b>	<b>7.43 <math>\pm</math> 4.01</b>
The time until the apnea test after hospitalization (day) (mean $\pm$ SD)	5.94 $\pm$ 3.07
The duration of brain death detection (days) (mean $\pm$ SD)	6.17 $\pm$ 3.02
The duration of cardiac arrest after brain death (hours) (mean $\pm$ SD)	35.69 $\pm$ 67.67

became donors. The distribution of cases diagnosed and donated organs by year is demonstrated in Figure 1. The highest number of patients diagnosed with brain death was in 2018 and 2019, with 5 cases. Organ donation was highest in the years 2017 and 2019. Organs taken from donor cases are shown in Figure 2. In cases where families accept organ donation, the most often donated organ was the liver (49%) (Figure 2).

The distribution of the patients according to their blood groups is given in Figure 3.

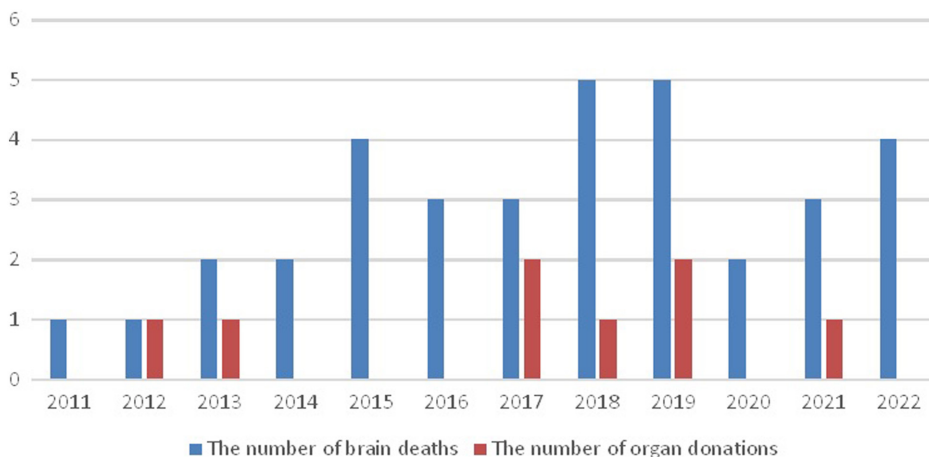
## DISCUSSION

In this study, 35 patients were diagnosed with brain death in the intensive care unit between January 01, 2011, and December 01, 2022, and intracranial bleeding was found to be the most common (68%) cause for ICU admission. In addition, it was determined that 62.9% of 33 (94.7%) patients who completed the apnea test required supportive tests. Finally, it was found that the average time passed for the definitive diagnosis of brain death was  $6.17 \pm 3.02$  days, and 8 (22.8%) patients in total were donors.

Brain death is a clinical diagnosis made by a detailed neurological examination and an apnea test. When the neurological examination cannot be thoroughly performed and the apnea test cannot be completed due to reasons like facial trauma, supportive tests are required. In order to obtain an accurate result from the apnea test, the patient's systolic blood pressure should be  $\geq 100$  mm Hg, body temperature  $\geq 36^\circ\text{C}$ ,  $\text{PaO}_2$  in blood gas  $\geq 200$  mm Hg, and  $\text{PaCO}_2 = 40$  mm Hg. In addition, there should be no drug use and metabolic changes that will suppress respiration during the test. The apnea test could not be completed because these conditions could not be met in 2 patients.

In this study, supportive tests were required in 60.1% of cases, and cranial computed tomography (CT) was chosen in 54.3% of the cases. In a study conducted in Spain, supportive tests were used in 95% of cases, and electroencephalography (EEG) or transcranial Doppler ultrasonography (USG) was used most frequently because of easy applicability.<sup>10</sup> We think that the reason behind the preference for other modalities in our hospital is the lack of physicians with sufficient experience in performing transcranial Doppler USG and the inaccurate results of EEG in the ICU settings.

Anesthesiology and reanimation specialists is included in the detection report of all cases in this study. A team of anesthesiology and reanimation, neurology and intensive care sub-specialists, coordinators and intensive care nurses work actively to ensure the diagnosis of brain death is made quickly without being missed in our hospital.



**Figure 1.** The number of brain deaths and organ donations by year.

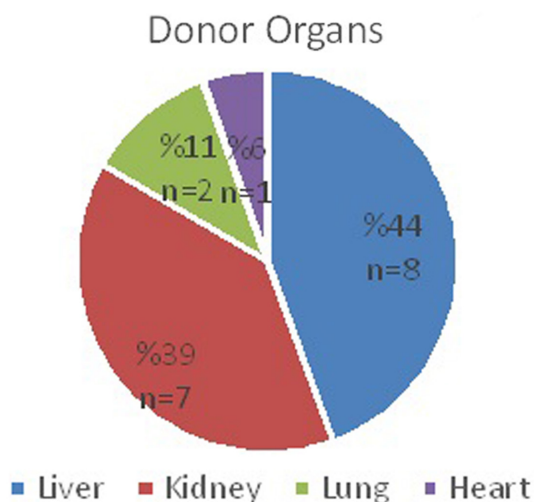
There are regional differences in the gender of patients with brain death. In this study, 48.57% of those diagnosed with brain death were male. In the study of Sipahioğlu et al., including 111 hospitals and 1998 patients diagnosed with brain death, it was shown that 63.8% of the cases were male. In concordance, other studies conducted in our country also report that the cases diagnosed with brain death are predominantly male.<sup>2,6,8,9,11,12,13</sup> In the study conducted abroad by Escudero et al. which included a multicenter group of 1844 patients diagnosed with brain death, the male sex ratio was found to be 59%. On the contrary, in a study conducted by Han et al. in South Korea, it was found that women were diagnosed with brain death more often (65%).<sup>10,14</sup>

The mean age of patients with brain death was found to be  $52.09 \pm 20.22$  years in this study, which is consistent with other studies. In the study of Karasu et al., 40.65; in the study of Battal et al., 41; in the study of Palabiyik

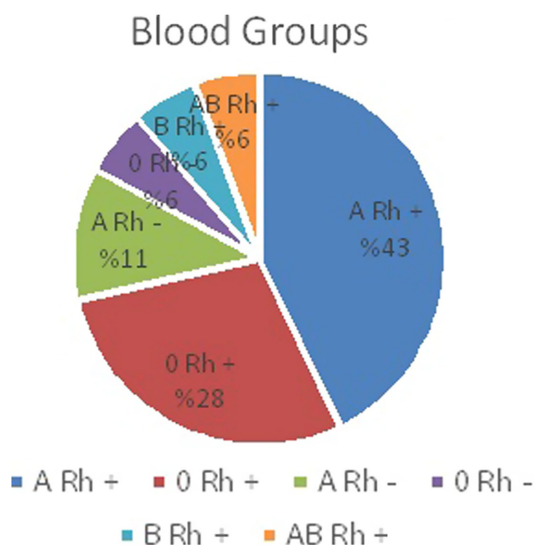
et al.,  $46.73 \pm 23.5$ ; in the study of Öztürk et al.,  $55.6 \pm 19.2$ ; in the study of Akbaş et al.,  $62 \pm 14$ ; in the study of Karan et al.,  $39.88 \pm 20.57$ ; in the study of Sipahioğlu et al., it was found to be 38.<sup>2,5,8,9,12,13,17</sup>

In this study, 94% of the cases were admitted to the intensive care unit from the emergency department. In the study of Eminoğlu et al., this rate was found to be 95.3%, which is similar to this study.<sup>15</sup> In the studies of Karasu et al.<sup>1</sup> and Kuşçu et al.,<sup>5</sup> it was determined as 60% and 71%, respectively.

In this study, intracranial hemorrhage (68.4%) was found to be the most common hospitalization diagnosis causing brain death process. Similarly, other studies have shown that intracranial pathologies are the most common cause. In a study conducted by Escudera et al., 1844 cases were examined and it was reported that the most common diagnosis causing brain death was intracranial



**Figure 2.** Donor organs.



**Figure 3.** Distribution of patients according to blood groups.



hemorrhage.<sup>12</sup> This rate was 67.7% in the study of Kuşçu et al., 51.9% in the study of Öztürk et al., 70.84% in the study of Ferhatoğlu et al., and 54.3% in the study of Eminoglu et al. In a multicenter study by Sipahioğlu et al., the most frequent cause was found to be intraparenchymal hemorrhage and intracranial hemorrhage with rates of 30.9% and 29.9%, respectively.<sup>1,13,15,16,17</sup>

The number of patients whose treatment and life depend on organ transplantation is increasing day by day in our country. Only kidneys and liver can be obtained from living donors. Organs such as lungs, hearts, and pancreas can only be obtained from cadavers. This situation highlights the importance of organ transplantation from cadavers. It is important to be able to diagnose brain death in potential donor candidates in order to increase the number of organ transplants from cadavers.<sup>18</sup> In order to do this, the characteristics of patients with brain death should be fully revealed.

After the patients are diagnosed with brain death, family interviews are conducted. If the family approves the organ donation, the patient then becomes a donor. Family approval rate in patients with a diagnosis of brain death varies among provinces. In a 2-year study conducted by Kiraklı et al., 48 of 1759 patients hospitalized in the intensive care unit were diagnosed with brain death and organ donation was approved by their relatives in 33 (69%) cases.<sup>11</sup> In the study of Han et al., 107 cases diagnosed with brain death were examined and the organ donation rate was found to be 58%.<sup>19</sup> In another study conducted at Bursa Uludağ University Faculty of Medicine, the rate of organ donation was found to be 41.7%.<sup>20</sup> In this study, 35 patients were diagnosed with brain death in the last 12 years. Organ donation was made in 8 (22.8%) of these patients, which is lower in comparison with others.

It has been reported that liver and kidney are the most frequently donated organs.<sup>21</sup> Similarly, in this study, liver and kidney were used most frequently in patients whose families accepted organ donation.

The effect of the time elapsed for the diagnosis of brain death on the approval rates of families was also investigated. It is suggested that passing time has an impact on the donation rate. In the study conducted by Kiraklı et al. the time for definitive diagnosis of brain death was determined to be 75-26 hours, and this time was found to be significantly lower in cases accepting organ donation.<sup>11</sup> In another study, it was reported that the donor rates decreased from 57% to 45% as the duration of diagnosis increased.<sup>20</sup>

In this study, the diagnosis of brain death was made in an average of 6 days, and this period was found to be shorter in other studies. We attribute the low rate of

organ donation in our clinic to the prolongation in the diagnosis process. As the duration of the diagnosis of brain death increases, the sadness and stress levels of the families increase, and especially in families who are not adequately informed, the expectation of the possibility of their patients to survive occurs. When the diagnosis of brain death is suspected for a patient, quick application of supporting tests such as cranial CT and CT angiography will help shorten the diagnosis time. Starting from the moment the patient is admitted to the ICU, positive communication and adequate information with the patient's relatives have a positive impact on the donation approval rate. Social structure, religious belief, and donor age also have effects on organ donation.<sup>10,22</sup>

Patients with a poor neurological prognosis who are admitted to the intensive care unit with diagnoses such as head trauma, cerebrovascular accidents (CVA), and post-resuscitation syndrome should be followed closely in terms of brain death and potential donors.<sup>3</sup> More attention should be paid to making the diagnosis of brain death as soon as possible. After the diagnosis is made, fast action should be taken without losing time.

The most important problem in organ transplantation in our country is the loss of cases before a diagnosis of brain death can be made. The reason for this may be the lack of information and the hesitations of physicians in making the diagnosis. The process progresses effectively and rapidly, thanks to the coordinators specially assigned in many centers for the diagnosis of brain death.<sup>23</sup>

Brain death can be diagnosed in a very small proportion of patients admitted to the intensive care unit. In addition, organ donation can be provided in very few of the patients with brain death diagnosis. However, considering that not every organ of the donor is suitable for use, the value of patients diagnosed with brain death in terms of donation is better understood. Therefore, education should be given to all segments of society about the importance of organ donation, and programs to raise awareness should be increased. Strategies to reduce family rejection rates in organ donation should be established. There is a need for well-trained organ transplant coordinators with strong communication skills, a high sense of duty, and experience. In addition, clinics should establish a standard donor care protocol in accordance with the current literature. These protocols should be applied to patients diagnosed with brain death rapidly.<sup>24</sup>

In this study, the examination of single center data, the fact that it was conducted with a small number of cases, and the retrospective data can be stated as limitations. However, it carries great importance since it is the first study in which our hospital is evaluated on this subject.

Revealing the characteristics of patients diagnosed with brain death will inform us about which patient groups can be donor candidates. Thus, the number of donor organs from cadavers will increase.

**Ethics Committee Approval:** The Erzincan Binali Yıldırım University Faculty of Medicine Clinical Research Ethics Committee granted approval for this study (Date: November 2, 2022 IRB: 02.11.2022-212499).

**Informed Consent:** N/A. Permission was obtained from the hospital management to use patient data.

**Peer-review:** Externally peer-reviewed.

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