Brain Deaths and Donors in an Education and Research Hospital

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ABSTRACT

Background. We aimed to define the causes of brain death (BD), criteria, and tests used for diagnosis, rates of family consent, and rates of organ donation in intensive care units (ICUs) of an education and research hospital.

Methods. The data of patients with BD diagnosis in 7 years in our hospital was collected from an electronic database and archives retrospectively consisting of the demographic data, the causes of BD, criteria, and the tests used for diagnosis, family consent, and organ donation rates.

Results. A total of 210 patients with BD diagnosis were enrolled in the study. There was a decline in number of patients with BD diagnosis between 2012 (54.76%) and 2018 (17.64%) in the neurology and neurosurgery ICU, while it increased from 35.71% in 2012 to 70.6% in 2018 in the general ICU. The most common cause of hospitalization for BD was spontaneous intracranial hemorrhage (43.8%). A total of 47.6% of brain-dead patients who did not qualify for organ donation were resuscitated unnecessarily after cardiac death. In 2012, diagnosis was always supported by ancillary tests, while in 2018, a total of 35.29% of the patients were diagnosed solely by clinical examination; 23.8% of patients' families had given consent for organ donation, and 19.53% of 210 patients became donors.

Conclusion. Physicians should be aware that patients with poor neurologic outcome can be candidates of BD donation, and careful examination and rapid diagnosis is crucial. All segments of society and the health care professionals should be informed and updated about organ donation and BD regularly to raise the numbers of organ donation.

BRAIN death (BD) is defined as irreversible loss of brain function including the brainstem, characterized by deep coma, apnea, and lack of supraspinal reflexes [1,2]. Diagnosis of BD is primarily clinical, which is based on neurologic examination showing loss of brain and brainstem function followed by apnea testing. Ancillary tests may be needed to support the diagnosis of BD if cranial nerves cannot be accurately evaluated clinically if the patient is under deep sedation or has multiple organ failure when apnea testing cannot be completed. Widely available tests of cerebral blood flow include cerebral angiography, transcranial Doppler, magnetic resonance angiography, computed tomography angiography, and radionuclide scanning [3–7].

Recent improvements in transplantation and the increasing number of patients affected by terminal organ failure waiting for transplant have enhanced the significance of organ transplantation as well as BD diagnosis and care of the potential organ donor. Although Turkey introduced organ donation legislation and policy in 1979, rates of organ donation and transplant are less than expected mostly because of failure to notice potential donors, delayed diagnosis of BD, unfavorable attitudes of brain-dead

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Table 1. Brain Death Data Distribution by Years

	2012	2013	2014	2015	2016	2017	2018*
Cases/mo, No.	3.5	3.91	3.41	2.41	1.16	1.66	2.42
Cases (n = 210), No. (%)	42 (20)	47 (22.38)	41 (19.52)	29 (13.8)	14 (6.66)	20 (9.52)	17 (.09)
G-ICU	15 (35.71)	25 (53.19)	22 (53.65)	16 (55.17)	8 (57.15)	10 (50)	12 (70.6)
N/NS-ICU	23 (54.76)	18 (38.29)	18 (43.90)	12 (41.38)	6 (42.85)	10 (50)	3 (17.64)
O-ICU	4 (9.52)	4 (8.51)	1 (2.43)	1 (3.45)	0	0	2 (11.76)
Case:bed ratio	0.52	0.58	0.51	0.36	0.17	0.24	0.20
G-ICU	0.39	0.65	0.57	0.42	0.21	0.26	0.31
N/NS-ICU	1.91	1.5	1.5	1	0.5	0.71	0.21
O-ICU	0.13	0.13	0.03	0.03	0	0	0.06
Family consent, No. (%)	9 (21.42)	16 (34.04)	4 (9.7)	10 (34.48)	5 (35.71)	2 (10)	3 (17.64)
Patients as donors, No. (%)	8 (19.04)	13 (27.65)	4 (9.7)	8 (27.58)	3 (21.42)	1 (5)	3 (17.64)
Organs procured, No. (%)	34	63	24	34	8	6	11
Lung	2 (5.88)	2 (3.17)	0	0	0	0	0
Heart	2 (5.88)	3 (4.76)	1 (4.16)	1 (2.94)	0	1 (16.66)	0
Liver	8 (23.52)	11 (17.46)	5 (20.83)	7 (20.58)	2 (25)	1 (16.66)	1 (9.1)
Kidney	14 (41.17)	23 (36.50)	10 (41.66)	14 (41.17)	2 (25)	2 (33.33)	6 (54.54)
Cornea	8 (23.52)	24 (38.09)	8 (33.33)	12 (35.29)	4 (50)	2 (33.33)	4 (36.36)
CPR after BD, No. (%)	23 (54.76)	22 (46.80)	25 (60.97)	8 (27.6)	7 (50)	11 (55)	4 (23.5)
G-ICU	8 (53.33)	11 (44)	10 (45.45)	1 (6.25)	4 (50)	1 (10)	1 (8.3)
N/NS-ICU	12 (52.17)	10 (55.55)	8 (44.44)	7 (58.33)	3 (50)	10 (100)	2 (66.66)
O-ICU	3 (75)	1 (25)	1 (100)	0	0	0	1 (50)
Diagnostic tests, No. (%)							
Clinical	0	2 (4.25)	1 (2.43)	7 (24.13)	1 (7.14)	3 (15)	6 (35.29)
Clinical + CT angiography	0	0	0	0	0	1 (5)	0
Clinical + TCD	23 (54.76)	8 (17.02)	3 (7.31)	2 (6.89)	8 (57.14)	4 (20)	2 (11.76)
CT angiography	19 (45.23)	15 (31.91)	5 (12.19)	10 (34.48)	0	2 (10)	7 (41.17)
TCD	0	21 (44.68)	27 (65.85)	8 (27.58)	5 (35.71)	8 (40)	2 (11.76)
CT angiography + TCD	0	1 (2.12)	5 (12.19)	2 (6.89)	0	2 (10)	0

Abbreviations: BD, brain death; CPR, cardiopulmonary resuscitation; CT angiography, computed tomography angiography; G-ICU, general intensive care unit; N/NS-ICU, neurology and neurosurgical intensive care unit; O-ICU, other intensive care unit; TCD, transcranial Doppler.
*2018 data are for 7 months.

patients' families toward organ donation, and insufficient donor care [2,8].

The aim of this study is to define the causes of BD, criteria used for determination of BD, and the tests used for diagnosis, rates of family consent, and rates of organ donation in intensive care units (ICUs) of an education and research hospital over the past 7 years.

METHODS

Collected Data

After the hospital ethics committee's approval, the data of patients diagnosed as brain dead between January 1, 2012, and July 31, 2018, in our hospital were collected from an electronic database and archives retrospectively, which consisted of the demographic data (age, sex), principal diagnosis for hospitalization, if the patient had spontaneous ventilation on admission, Glasgow Coma Scale (GCS), if the patient was under sedation on admission, if the patient had brain surgery or endovascular treatment for brain aneurysms, days from hospital admission until the day BD was diagnosed, time for diagnosing BD (days from the first consultation for BD until the day BD was diagnosed), hospital stay (days in hospital), time for cardiac death (days from BD diagnosis until cardiac death), time for family consent (days from diagnosis of BD until the day family consent was taken), time for donation following family consent (days), time for donation following BD diagnosis, if the patient had cardiac death and inappropriate resuscitation after diagnosis of BD, the ICU where the patient was followed (evaluated under 3 groups, which were general ICUs, neurology and neurosurgery ICUs, and other ICUs), tests used for diagnosing BD, if there was family consent, if the patient became a donor, and the organs procured for transplant. Principal diagnosis for hospitalization was evaluated under 8 groups, which were spontaneous intracranial hemorrhage, intracranial hemorrhage following endovascular surgery for aneurysm, ischemic stroke, both ischemic stroke and hemorrhagic stroke together, cardiac arrest, brain tumors, and others (intracranial infections, stab wounds, intoxications).

Statistical Analysis

Continuous variables were expressed as means (SDs) or medians (interquartile ranges), and categorical data were expressed as numbers and percentages. Statistical analysis was performed with SPSS 23.0 software for Windows (IBM, Armonk, NY, United States).

RESULTS

A total of 210 patients with BD diagnosis between January 1, 2012, to July 31, 2018, in our hospital who were 116 men (55.2%) and 94 women (44.8%) aged between 18 to 92 years (55.13 [SD, 17.5]) was enrolled in the study.

In the 7 years (91 months) of data, 108 patients (51.42%) from the general ICU, 90 (42.85%) from the neurology and

neurosurgery ICU, and 12 (5.71%) from the other ICU (medical, surgical and coronary ICU) were diagnosed as brain dead. In our hospital, there are 38 beds in the general ICU, 12 in neurology and neurosurgery until 2017 and 14 afterward, and 30 in the other ICU. The distribution of cases of BD by years and intensive care bed types are shown in Table 1. The largest population diagnosed as brain dead was in 2013 with 47 cases, and the smallest was in 2016 with 14 cases. The number of patients diagnosed as brain dead decreased from 54.76% in 2012 to 17.64% in 2018 in the neurology and neurosurgery ICU, while it increased from 35.71% in 2012 to 70.6% in 2018 in the general ICU.

The reasons of hospitalization were examined under 8 groups. The most common cause of hospitalization for BD was spontaneous intracranial hemorrhage with 92 patients (43.8%); it was ischemic stroke in 30 (14.3%), intracranial hemorrhage following endovascular surgery for aneurysm in 24 (11.4%), cardiac arrest in 19 (9%), brain tumor in 17 (8.1%), traumatic intracranial hemorrhage in 16 (7.6%), ischemic and hemorrhagic stroke in 7 (3.3%), and others in 5 (2.4%).

A total of 183 patients (87.1%) had spontaneous ventilation on admission; 8 (3.8%) were under sedation so only 202 patients could be evaluated for GCS with median 9. A total of 48 patients (22.85%) had recent endovascular or surgical brain intervention.

Time for BD was 8.2 (SD, 11.4) days, time for diagnosing BD was 0.83 (SD, 2) days, total days of hospitalization was 10.2 (SD, 11.9) days, time for cardiac death was 2 (SD, 2.2) days, time for family consent was 0.24 (SD, 0.48) days, time for donation following family donation was 0.93 (SD, 0.57) days, time for donation after diagnosis of BD was 1.17 (SD, 0.67) days.

Although diagnosed as brain dead, 100 patients (47.6%) who did not qualify for organ donation were resuscitated unnecessarily after cardiac death. Table 1 shows distribution of unnecessary resuscitations through years and ICUs. In 2012, a total of 54.76% of the patients were resuscitated unnecessarily, while it had decreased to 23.5% in 2018. When we look at the distribution of resuscitations by ICU, we can tell that this decrease was more evident in the general ICU, which was 53.33% in 2012 and decreased to 8.3% by 2018, while these ratios were 52.17% for neurology and neurosurgery ICU and 75% for other ICUs in 2012, which decreased to 66.66% and 50%, respectively, in 2018.

A total of 50 patients (23.8%) had only clinical diagnosis, while 27 (12.85%) had both clinical diagnosis followed by computed tomography (CT) angiography, 22 (10.47%) had clinical diagnosis followed by transcranial Doppler, 20 (9.52%) had only CT angiography, 7 (3.33%) had only transcranial Doppler and 1 (0.47%) had CT angiography combined with transcranial Doppler for diagnosis of BD. Distribution of diagnostic tests through years is shown in Table 1. We can see that in the year 2012, diagnosis was always made with supporting tests following clinical examination, while in 2018, a total of 35.29% of the cases were diagnosed solely with clinical examination.

A total of 50 patients' families (23.8%) have given consent for organ donation; 41 of 210 patients (19.53%) could become donors, which means 82% of the patients with family consent became donors. Of 41 donors, 180 organs were procured, 71 of which were kidneys (39.44%) followed by 62 corneas (34.44%), 35 livers (19.44%), 8 hearts (4.44%), and 4 lungs (2.22%). Distribution of organs procured after family consent through years can be seen in Table 1.

DISCUSSION

Döşemeci et al reported a retrospective survey of 134 patients diagnosed as brain dead from a general ICU with 24 beds within 39 months. Average age of the patients was 39.1 (SD, 24.6) years (range, 2–71 years) [8]. In an education and research hospital, 79 cases of BD from April 2007 until March 2014 (84 months) were examined retrospectively. Most of the them were pooled in 2013 (25.31%), and the least were pooled in 2009 (6.32%) [9]. In our study, the cases were 55.2% male and 44.8% female aged 55.13 (SD, 17.5) years (range, 18–92 years). A total of 51.42% of them were from the general ICU, 42.85% were from the neurology or neurosurgery ICU, and 5.71% were from other ICUs. Distribution through years shows that diagnosis of BD increased in the general ICU, while it decreased in other ICUs.

Researchers found the most frequent reasons for BD to be intracranial hemorrhage (59.5%), cerebrovascular events (59%), traumatic brain injury (32%), cardiac arrest, brain tumors, carbon monoxide intoxication, encephalitis, and cerebral palsy [8,9]. In our study we found spontaneous intracranial hemorrhage (43%) to be the most frequent principal diagnosis followed by ischemic stroke, intracranial hemorrhage following endovascular surgery for aneurysm repair, cardiac arrest, brain tumors, traumatic intracranial hemorrhage, ischemic and hemorrhagic stroke, and other pathologies (intracranial infections, stab wounds, intoxications). Studies from different centers showed similar reasons with different ratios; 10% to 15% of patients with severe cerebral pathologies or hypoxia as well as patients with GCS < 7 are likely to develop BD, so it is reasonable to accept them as potential donors. Intensive care units where aforementioned patients are admitted should be considered as potential donor sources [8,10].

One study showed the time from ICU admission until the diagnosis of BD to be 68.2 (SD, 109.6) hours (range, 12–480 hours) [8], while in our study it was 8.2 (SD, 11.4) days. Brain death is associated with severe cardiovascular and metabolic changes, so early diagnosis is crucial for the protection of organs.

If families do not give consent for donation, the legislations passed in 2014 in our country permit the withdrawal of life support legally [8,10]. In one study, time from BD diagnosis until cardiac death was 6.8 days (range, 1–28 days) for patients younger than 18, and 2.5 days (range, 1–13 days) for patients 18 years and older [9]. We found the time for cardiac death to be 2 (SD, 2.2) days, which is shorter.

The reason why the time for cardiac death lasts longer than expected may be because the physicians tend to continue life support both for cultural reasons and also to gain time in case the families change their minds.

In our study, we found out from the hospital records that 100 patients (47.6%) diagnosed as brain dead who did not have family consent were resuscitated following cardiac death unnecessarily. When the distribution is analyzed, the unnecessary resuscitation rates declined in the general ICU through the years, while it was still higher in the other ICUs. The reason for unnecessary resuscitation after cardiac death may be because of lack of knowledge, cultural or religious factors, legal concerns because of lack of information, and concerns about the families of brain-dead patients. We did not find any study on this issue, so we believe that new studies to analyze the knowledge and attitudes of physicians related to BD are needed.

Karasu et al [9] showed that 30.4% of the cases of BD needed ancillary tests for diagnosis. In 13% of cases transcranial Doppler, in 13% of cases cranial magnetic resonance angiography, and in 4% of cases transcranial Doppler combined with cranial magnetic resonance angiography were used for diagnosis. In our study, 76.2% of patients needed ancillary tests, which were CT angiography (22.37%), transcranial Doppler (13.8%), and transcranial Doppler combined with CT angiography (0.47%). In 2012, ancillary tests were used in 99.9%; it declined to 64.71% in 2018. We believe that the need for ancillary tests declined throughout the years because of awareness and clinical experience of the physicians involved.

In studies, 34% to 37% of cases with BD received family consent for donation while 81% to 85% of them could become donors. The organs procured from donors were mostly kidneys (35%–60%), followed by liver (30%–31%), heart (7%–18%), lungs (3%), and pancreas (0.64%) [8,9]. In our survey, 23.8% of brain-dead patients got family consent, of whom 82% became donors. A total of 180 organs were procured, most of which were kidneys (39.44%). The numbers are still less than expected, and there are many patients still on transplant waiting lists.

To increase the deceased donor pool, it is necessary to increase awareness on BD and reduce the rate of family rejection. Once the family members of the brain-dead patients are ensured that every possible measure is taken for the well-being of their relative and are well informed by their physician about the irreversible situation, numbers of organ donation can rise [8].

CONCLUSION

Physicians involved in the diagnosis of BD should be aware of the fact that patients with poor neurologic outcome can be candidates of BD, and that careful examination and rapid diagnosis is crucial. The families should be informed that BD is considered death, and the importance of organ donation must be emphasized. All segments of the society and the health professionals should be informed and updated about organ donation and BD regularly to raise the numbers of organ donation.

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