



# Exploring Brain Death at a Tertiary Pediatric Intensive Care Unit in Turkey; Incidence, Etiology and Organ Donation

Ülkemizde Üçüncü Basamak Bir Çocuk Yoğun Bakım Ünitesindeki Beyin Ölümünün İncelenmesi; İnsidans, Etiyoloji ve Organ Bağışı

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## Abstract

**Introduction:** Severe traumatic brain injury (TBI) is associated with brain death. The overall incidence of pediatric brain death, especially in severe TBI is not known in Turkey. We aimed to investigate the rate of brain death determinations and organ donations in our tertiary pediatric intensive care unit (PICU), and to report the data on demographic pattern and supplementary descriptive data on the brain death declarations.

**Methods:** We retrospectively evaluated all children who were declared brain-dead in our tertiary PICU between March 2012 and December 2014. Pertinent data was obtained from hospital medical records (electronic and chart) and brain death database of the unit.

**Results:** Out of 889 patients, 63 were admitted to the PICU due to trauma in general and 33 had severe TBI. There were 10 brain death declarations, and only 3 were in critically ill children due to non-traumatic causes. The crude incidence of brain death was 1.1% in our patient population. 70% of brain death declarations were due to severe TBI. The mean age and weight of the patients, who were declared brain dead, were 7.2 ( $\pm 3.2$ ) years and 25.7 ( $\pm 9.6$ ) kilograms, respectively. In 13 patients, who died due to severe TBI, brain death was the most common mode of death (53%). Two patients became organ donors (20%).

**Conclusion:** Brain death is a common mode of death after severe TBI, more frequent than non-trauma cases admitted to our PICU. Awareness of the incidence and etiology may contribute to timely diagnosis and declarations, and increased organ donation.

**Keywords:** Traumatic brain injury, brain death, organ donation, pediatric intensive care

## Öz

**Amaç:** Ülkemizde çocuk yoğun bakım ünitelerinde (ÇYBÜ) travmatik beyin hasarı (TBH) sonrası beyin ölümü sıklığı bilinmemektedir. Amacımız ÇYBÜ’ümüzde beyin ölümü ve organ bağışı oranlarımızı saptamak, beyin ölümü gerçekleşen hastaların demografik, etiyolojik ve tanımlayıcı ek bilgilerini paylaşmaktır.

**Yöntemler:** Mart 2012 ve Aralık 2014 tarihleri arasında üçüncü basamak ÇYBÜ’de saptanan tüm beyin ölümü olguları beyin ölümü veritabanımızdan, bu tarihler arası yatırılan tüm hasta sayısı ve yatış etiyolojisi tıbbi (elektronik ve dosya) kayıtlardan elde edildi.

**Bulgular:** ÇYBÜ’ye yatırılan 889 hastadan 63 tanesi travma nedeniyle yatmış olup 33 tanesinde ağır TBH mevcuttu. Beyin ölümü 10 çocukta saptanmıştı. Kaba beyin ölümü oranı %1,1 olarak hesaplandı. Beyin ölümü saptanan hastaların %70’inde ağır TBH mevcuttu. Bu hastaların ortalama yaş ve ağırlıkları 7,2 ( $\pm 3,2$ ) yıl ve 25,7 ( $\pm 9,6$ ) kilogram idi. Ağır TBH olan hastalarda ölümün en sık nedenini beyin ölümünün gerçekleşmesi oluşturuyordu (%53). İki hasta organ vericisi oldu (%20).

**Sonuç:** ÇYBÜ’ümüzde beyin ölümü olgularının çoğunu ağır TBH olanlar oluşturmaktadır. ÇYBÜ beyin ölümü olgularının insidansı ve etiyolojilerinin bilinmesinin farkındalığı arttırarak beyin ölümü tanısını hızlandıracığını, organ bağış oranlarına katkı sağlayacağını düşünmekteyiz.

**Anahtar Kelimeler:** Travmatik beyin hasarı, beyin ölümü, organ bağışı, çocuk yoğun bakım ünitesi

## Introduction

In developed countries, traumatic brain injuries (TBI) are the leading cause of death in children over 1 year of age, and acute brain injuries are the most common cause of brain death in pediatrics.<sup>1-3</sup> Although TBI-related mortality data for Turkey is not clear, national statistics for 2013 show that the rate of mortality due to "ortality due tofor Turkey is not was around 9%, which makes this category the most common reason for death in children aged 0-14 years (available at: [http://www.tuik.gov.tr/PreTablo.do?alt\\_id=1083#](http://www.tuik.gov.tr/PreTablo.do?alt_id=1083#). Accessed February 21, 2015). This etiology ranks as the 5<sup>th</sup> cause in adults after cardiovascular, neoplastic, respiratory diseases, and endocrine-metabolic problems.

Brain death, defined as irreversible cessation of all functions of the brain, including brain stem, is valid for medicolegal determination of death. The 1987 guidelines for determination of pediatric brain death has been recently updated.<sup>4</sup> Despite its acceptance as a legal mode of death in Turkey since 1979 (Law number 2238; Law related to organ and tissue removal, preservation and transplantation), the progress in awareness and declaration of brain death has been slow and difficult in pediatric population.

In developed countries, the prevalence of brain death in children is 1-2%.<sup>5</sup> The prevalence of pediatric brain death, specifically due to severe TBI, is not known in Turkey. There are only case reports of pediatric brain death in our literature, and this information is important for planning nationwide preventative measures, optimizing and comparing current care in critical care units, and finally, estimation of potential organ donors for children in need.<sup>6,7</sup> We aimed to report an analysis of the prevalence and relevant data in our brain dead patients.

## Materials and Methods

The study was designed as a retrospective, single-center descriptive study. We evaluated all children who were declared brain dead in our tertiary pediatric intensive care unit (PICU) between March 2012 and December 2014. Critically ill medical and surgical patients are admitted to the 14-bed PICU at Marmara University Pendik Training and Research Hospital. Pertinent data was obtained from medical records and institutional database for brain death and organ donation. The total number of admitted patients during the investigation period was available from medical records and quality improvement database of the hospital. Patient demographics, possible causes of brain death, mechanism of injury, if any, time to declaration of brain death after first examination, the use of confirmatory tests for absence of brain perfusion, and donation status were described.

The SPSS version 15.0 was used for statistical analysis. Descriptive data was presented as mean  $\pm$  standard deviations for normally distributed data, and as median (IQR, interquartile range) for skewed (not normally distributed) data.

## Results

Out of 889 PICU admissions, 63 were related to trauma in general, of which 33 were due to severe TBI (Glasgow coma score  $\leq$ 8). Within the study period, there were 10 brain death declarations; 7 were due to trauma and 3 were due to non-trauma-related causes. The crude rate of brain death was 1.1% in our patient population. 70% of brain death declarations were due to severe TBI. Patient demographics and supplementary data are given in Table 1. The mean age and weight of the patients who were declared brain dead were  $7.2 \pm 3$  years (range: 2-12) and  $25.7 \pm 9.6$  kilograms

**Table 1. Demographic and descriptive supplementary data of brain death patients**

Patient	Age (yrs)	Sex	Mechanism of injury	GCS	Initial BDE day	Confirmatory test	Days to declaration	Donor
1	6	F	MVPA	3	4	TCD	1	No
2	7	M	MVPA	3	1	TCD	1	No
3	12	M	Assault (Gun shot)	3	5	TCD	1	No
4	2	M	Fall	6	2	TCD	3	No
5	9	F	MVPA	7	4	TCD	4	Yes
6	8	M	MVPA	7	9	TCD	5	No
7	12	F	Fall	3	2	CTA	20	Yes
8	7	F	Post CPR Lymphoma	3	1	TCD	26	No
9	4	M	SAH	3	6	TCD	3	No
10	5	M	Post CPR Post fossa tumor	3	3	TCD	1	No

MVPA: Motor vehicle pedestrian accidents, M: Male, F: Female, CPR: Cardiopulmonary resuscitation, SAH: Subarachnoid hemorrhage, GCS: Glasgow coma score, BDE: Brain death examination, TCD: Transcranial doppler, CTA: Computed tomography angiography

(range: 11-53), respectively. The majority of subjects were male (n=6, 60%). The median time after the initial brain death examination and time to declaration was 3 days (1-4.7). All patients had apnea tests. Absence of cerebral perfusion was confirmed by transcranial Doppler ultrasonography (TCD) except in one patient in whom contrast-enhanced cranial tomographic angiography was performed. Among the patients who underwent TCD, only one patient needed serial 3 TCD or confirmation of brain death, the remaining majority underwent 1 TCD. Brain death was the most common mode of death in 13 patients who died due to severe TBI (53%).

In addition, 3 patients with severe TBI had fulfilled the clinical brain death criteria, but the ancillary tests showed positive cerebral blood flow which prevented declaration of brain death. These patients died subsequently from hemodynamic failure during the evaluation process. Within the study period, there were 3 declarations in critically ill non-trauma patients. All were admitted post arrest, 2 of them had malignancies and 1 subarachnoid hemorrhage (Table 1). The incidence of brain death declarations for severe TBI was higher than that of non-trauma patients admitted to the PICU (7/889=0.8% and 3/889=0.3%, respectively). Two patients became organ donors (20%). From two donors, four kidneys, two livers, one heart and one cornea were transplanted successfully. There were no donors among patients without trauma. The reasons for refusal of donation were mainly related to faith and cultural beliefs expressed as rural beliefs expressed as rhave (Tableluation process. Within the study periodudy pernts died subsequently from hemodyeaders or members of the family. One of the donations was inspired by an organ donation from a brain death donor in one of the television series at that time. The other donation was approved by the religious leader of the familyand cult.

## Discussion

Despite being a retrospective and a single-center study, we assume that our results may be valid for representation of a Turkish tertiary PICU. Turkish law for organ and tissue donation has passed more than 35 years ago, but there is still very limited data about the incidence of brain death in Turkish intensive care units (ICUs). Here, we reported an incidence rate of 1.1% in our combined medico-surgical PICU in a university setting. To our knowledge, this report is likely to be the first regarding the pediatric critical care population in Turkey. In the adult ICU settings, the reported incidence is 2.7%.<sup>8</sup> Our observed brain death rate seems to be similar to the pediatric literature.<sup>5</sup>

Our study revealed that brain death was more common in severe TBI patients admitted to PICU compared to other critically ill children without a history of trauma (0.8% vs.

0.3%). In our patient population, 70% of brain deaths occurred after trauma, whereas in adult ICUs, trauma was responsible from 23-48% of all brain deaths in Turkey.<sup>8-11</sup> Only one study from an adult ICU reported trauma to be as high as 67% in their brain dead population. In this retrospective study, 10 of the 40 patients (25%) were children.<sup>12</sup>

The solid organs donated and successfully transplanted were kidneys, livers and a heart from our unit. Liver and kidney transplants are common in Turkey; despite Turkey's leading status in living donor transplantation, the cadaveric transplant rates remain low.<sup>13</sup> 2013 data reveals that living versus cadaveric donors per million population was 46.64 and 5.05, respectively (International Registry in Organ Donation and transplantation data). According to the Ministry of Health records, the number of patients waiting for an organ transplant as of the end of 2014 were 445 for kidney, 155 for liver, 33 for heart, and 3 for heart and lung. Last year, only 31% of kidney (67/217) and 21% of liver transplants (46/217) were cadaveric (Data inquiry from the Turkish Ministry of Health, Directorate General for Health Services, Department of Organ and Tissue Donation and Dialysis). Due to the unmatched needs of patients with end-stage organ failures, there have been substantial efforts to improve the status of cadaveric donations. "Technical Assistance for Alignment in Organ Donation Project" is an ongoing, vigorous project to improve donation rates with public awareness and training of the medical personnel involved in the decision and donation process ([www.organdonationproject.com](http://www.organdonationproject.com)). The results of this project may be seen in the near future.

## Conclusion

We conclude that patients with severe TBI are the most likely candidates for brain death declaration and donation of suitable organs for children in need. The donation rates may increase with carefully planned public educational broadcasting campaigns, including social media, television series and shows with high ratings addressing sensitive parental concerns by medical, spiritual and religious leaders.

## Ethics

*Ethics Committee Approval: This study was approved by Marmara University Faculty of Medicine Ethics Committee.*

*Peer-review: External and Internal peer-reviewed.*

## Authorship Contributions

*Concept: Nilüfer Yalındağ Öztürk, Design: Nilüfer Yalındağ Öztürk, İsmail Cinel, Data Collection or Processing: Feyza İnceköy Girgin, Deniz Birtan, Analysis or Interpretation: İsmail*

*Cinel, Literature Search: Nilüfer Yalındağ Öztürk, Deniz Birtan, Writing: Nilüfer Yalındağ Öztürk, Feyza İnceköy Girgin.*

*Conflict of Interest: No conflict of interest was declared by the authors.*

*Financial Disclosure: The authors declared that this study received no financial support.*

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