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RESEARCH ARTICLE

The dynamics of organ donation in the Anesthesia and Intensive Care Clinic of Târgu-Mureș County Emergency Clinical Hospital

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Background: Medical, psychological, social and even technological aspects can influence the process of organ donation.

Objective: This research sought to analyse the organ donation activities in the Anesthesia and Intensive Care Clinic of the Târgu-Mureș County Emergency Clinical Hospital from 2019 to 2024. Additionally, the study intended to assess the impact of the COVID-19 pandemic on these activities.

Material and Methods: We performed a retrospective observational study on 136 patients from the Anesthesia and Intensive Care Clinic of the Târgu-Mureș County Emergency Clinical Hospital. The criteria for inclusion were patients who were officially diagnosed with brain death from January 1, 2019, to December 31, 2024.

Results: A comparison of the total number of cases diagnosed with brain death per year did not yield any statistically significant difference over the six years of interest (p=0.25). Nonetheless, our data analysis revealed a declining trend of donor registries in the more recent years. During the onset of the COVID-19 pandemic (2020), organ donation was impacted as fewer patients were being diagnosed with brain death. An increase in the number of brain death patients in 2021 and 2022 has resulted in a subsequent increase in the number of donors. The overall trend, however, continues to be downwards due to other factors such as the rise of novel technologies available for managing polytrauma and stroke, which reduce brain death cases.

Conclusions: The trend in organ donation from 2019 to 2024 is generally declining with the exception of a post-pandemic spike in 2021 and 2022. Sociopsychological factors, including the pandemic, were initial barriers, but technological and critical care developments seem to now drive the decline in donors.

Keywords: organ donation, brain death, COVID-19, organ procurement

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Introduction

Brain death is a permanent state of irreversible brain (including cortex and reflex activity) function failure [1]. It is an essential concept in medicine, with broad implications especially in death determination and organ transplant care. Accurate diagnosis of brain death is a fundamental step in initiating the organ procurement process, thereby facilitating the saving of the lives of patients on transplant waiting lists [2].

To ensure the process is straightforward and error-free, every step of the diagnosis of brain death is done according to clearly established national and international regulated protocols. Guidelines require extensive testing according to stringent clinical and para-clinical criteria to demonstrate unambiguous cessation of all brain functions. This diagnostic procedure involves profound medical investigations using an interdisciplinary team to ascertain deep coma and absence of brainstem reflexes, and to confirm with an apnea test that the individual has no spontaneous breathing. Furthermore, if doubt arises or specific clinical evaluations may be affected by medical co-morbidities, additional tests such as electroencephalography (EEG), transcranial Doppler ultrasound, or cerebral angiography are employed to demonstrate the absence of cerebral electrical activity and perfusion. [3]

Strict adherence to these protocols is essential for proper, fair, and ethical diagnosis and for building trust among patients' families and the broader medical community in establishing the cause of death [4,5].

Organ transplantation is a life-saving treatment for patients diagnosed with end-stage failure of the organs, such as the kidneys, liver, heart, or lungs. Even with advances in technology and alternative ways (artificial organs, cell therapies), organ transplantation is the only effective way to replace the irreversibly lost functions of the damaged organs [6]. The transplant is not just an alternative for most of these patients, but also one of the few or the only hope of survival and quality of life for many [7]. However, the success of this process depends on the availability of or-

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gan donors, whose contributions can save or transform the lives of multiple individuals in critical condition. Multiple organs and tissues can be donated by a single donor, giving several patients a chance to lead an everyday life [8].

The need for transplantable organs far outstrips the supply, so the waiting lists are long and often lead to death due to a lack of a matching donor [9]. This gap must be reduced to relieve patients from waiting for months before they receive life-sustaining treatments, which means promoting organ donation and public enlightenment about the benefits of these efforts is necessary [10].

This study aimed to describe the evolution of brain-death diagnoses and organ donation activity between 2019 and 2024, and to explore factors associated with organ retrieval, including changes observed during the COVID-19 pandemic.

Materials and Methods

We conducted a retrospective observational study on all cases of brain death recorded in the Anesthesia and Intensive Care Clinic of the Târgu-Mureș County Emergency Clinical Hospital from January 1, 2019, to December 31, 2024. The diagnosis of brain death was established by the national protocol for declaring brain death and the applicable legislation in Romania.

The study group included 136 patients, whose data were collected from medical records and included the following variables:

- Demographic data: age and gender of the patient
- The year in which the brain death diagnosis was established
- The primary diagnosis leading to brain death
- The duration of hospitalization in the intensive care unit (number of days)
- Organ procurement or non-procurement
- The organs and/or tissues procured and the total number of organs procured per patient
- Reasons for non-procurement.

All data were extracted from medical records into a standardized spreadsheet (Microsoft Excel). The study was approved by the local ethics committee (approval no. Ad—3608/04.03.2025).

Statistical analyses were performed in IBM SPSS Statistics (Version 26.0) and GraphPad Prism version 8.0.0 for Windows, GraphPad Software, San Diego, California USA. Categorical variables are reported as counts and percentages and were compared using Pearson's χ^2 test; Fisher's exact test was used when expected cell counts were small. Continuous variables are reported as mean ± SD or median (IQR), as appropriate; comparisons between two groups (retrieved vs non-retrieved) were performed using the Mann–Whitney U test. Age differences across brain-death etiologies were assessed using one-way ANOVA analysis with Tukey post-hoc testing. In addition, a multivariable logistic regression model was fitted to identify independent predictors of successful organ retrieval (age, sex, ICU length of stay, and brain-death etiology), reporting odds ratios (OR) with p-values.

Missing data were handled by complete-case analysis for inferential models (listwise deletion); therefore, the number of valid cases varies across analyses. A two-sided p-value <0.05 was considered statistically significant.

Results

Between January 1, 2019, and December 31, 2024, a total of 136 patients were diagnosed with brain death in the Anesthesia and Intensive Care Clinic of the Emergency Clinical Hospital Târgu-Mureș. The annual distribution reveals a significant drop in cases during 2020, likely attributable to the COVID-19 pandemic and associated restrictions, followed by a marked increase in 2021 and 2022. In the subsequent years, the number of cases gradually declined (Table 1).

Table I. – Number of cases diagnosed with brain death per year, distributed by gender

Year	Number of cases	Male	Female
2019	25	15 (60%)	10 (40%)
2020	11	8 (73%)	3 (27%)
2021	30	16 (53%)	14 (47%)
2022	31	18 (58%)	13 (42%)
2023	20	9 (45%)	11 (55%)
2024	16	8 (50%)	8 (50%)

Gender distribution over the six years shows a predominance of male patients in most years, with a reversal of this trend in 2023 and an equal distribution in 2024. Although some annual fluctuations are observed, statistical analysis did not demonstrate a significant difference in the number of brain death diagnoses across the studied interval ($p = 0.25$).

A detailed analysis of the time trend in the leading causes of brain death between 2019 and 2024 reveals notable variability, with no cause maintaining a stable pattern throughout the study period. Hemorrhagic stroke consistently ranked among the most frequent etiologies, despite significant year-to-year fluctuations. Traumatic brain injury (TBI) showed a variable distribution and emerged as the predominant cause in 2024. Cerebral aneurysms exhibited the widest variation, with a peak in 2022 followed by a sharp decline. Ischemic stroke (vertebrobasilar territory) was more prominent in 2021, while resuscitated cardiorespiratory arrest (RCA) maintained relatively stable values across the years. Meningoencephalitis was sporadically reported, with isolated cases and no consistent pattern of occurrence (Table 2).

Age differered significantly across brain-death etiologies (one-way ANOVA: F=11.575, p<0.001). Post-hoc Tukey testing showed that patients with encephalitis were significantly younger (mean 15.3 years) than all other etiologic groups, while hemorrhagic and ischemic stroke cases were significantly older compared with traumatic brain injury

Table II. – Causes of brain death by year

Causes	2019	2020	2021	2022	2023	2024
Cerebral aneurysm	2	0	3	10	3	1
Hemorrhagic stroke (intracranial hematomas)	10	2	6	6	9	4
Ischemic stroke (vertebrobasilar)	2	0	9	2	1	2
Meningoencephalitis	1	3	0	1	1	0
Resuscitated cardiorespiratory arrest (RCA)	5	2	5	6	3	3
Head trauma (TBI)	5	4	7	5	3	6

and cardiac arrest categories.

In a two-way ANOVA, age did not differ significantly across years (p=0.270), but differed strongly by etiology (p<0.001). Importantly, a significant age × etiology interaction was observed (p=0.014), suggesting that the relationship between etiology and patient age varied over time.

Between 2019 and 2024, the median age of patients diagnosed with brain death showed considerable variation, reflecting shifting demographic patterns. The most heterogeneous age distribution was observed in 2020, marked by both pediatric and geriatric cases, while the highest median age was recorded in 2024, indicating a predominance of older patients in recent years. Over the six years, a general trend toward increased median age can be observed, with fewer extreme age values reported in the later years. These variations suggest evolving profiles of critical neurological pathology and possibly changes in referral or admission patterns (Figure 1).

The duration of hospitalization for brain-dead patients between 2019 and 2024 showed notable year-to-year fluctuations. A downward shift was observed during the pandemic period, followed by gradual increases in subsequent years. The most extended hospital stays were recorded in 2024, along with the broadest range of durations, suggesting increased variability in clinical trajectories. Overall, the data reflect the dynamic interplay between case severity, resource availability, and changes in care protocols during the analyzed period (Figure 2).

ICU length of stay showed a trend toward lower retrieval likelihood: retrieved patients tended to have shorter ICU stays, without reaching conventional statistical significance (Mann–Whitney U=1182, p=0.075). In multivariable logistic regression, ICU stay remained the strongest predictor, showing a near-significant negative association with retrieval (OR 0.915 per additional ICU day, p=0.056), whereas age (p=0.945), sex (p=0.463) and etiology (p=0.863) were not significant independent predictors in this cohort.

The proportion of brain-dead patients who underwent organ retrieval between 2019 and 2024 varied significantly. After a modest retrieval rate at the beginning of the period, a progressive increase was observed, culminating in a peak in 2022. However, this was followed by a marked decline in 2023 and 2024, reaching the lowest retrieval rates of the six-year interval. These fluctuations may reflect changes in institutional protocols, donor consent rates, or logistical

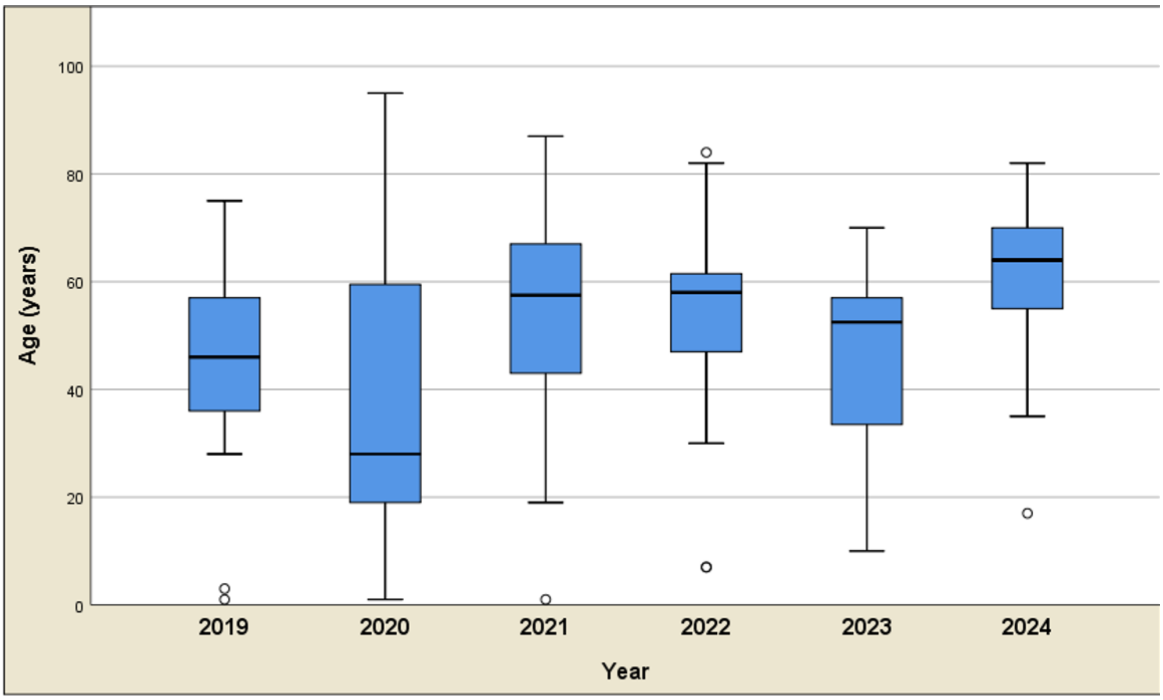

Figure 1. Median age by year

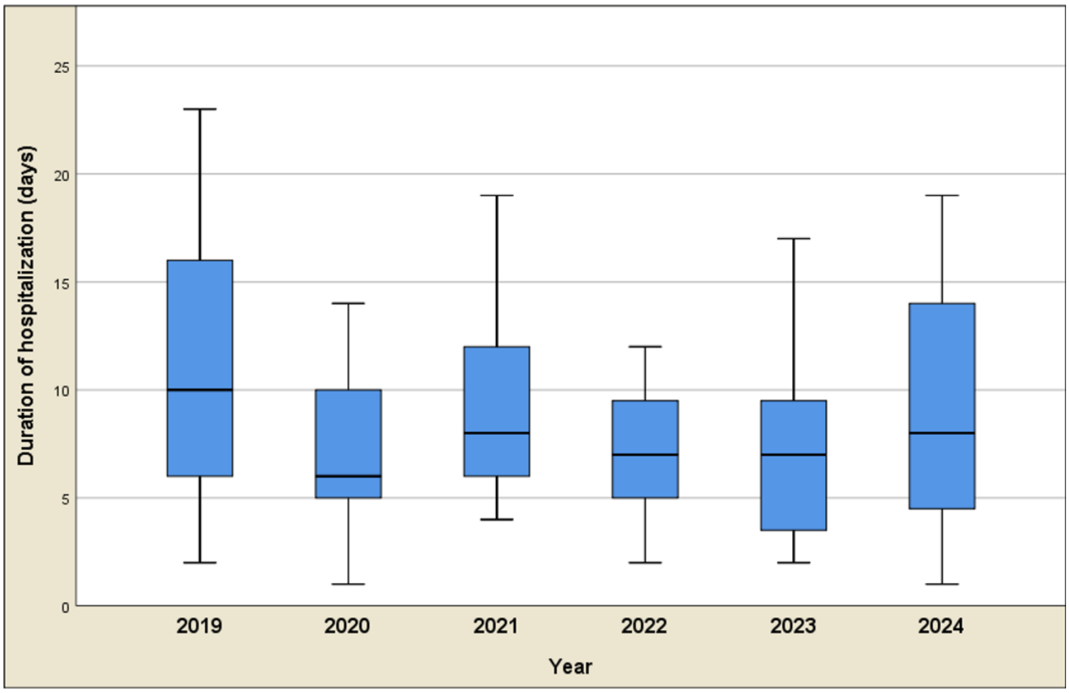

Figure 2. Number of hospitalization days by year

and systemic factors that affect the transplantation process (Table 3).

Table III. – Percentage of Retrieved Patients

Status	2019	2020	2021	2022	2023	2024
Retrieved	13.79%	27.27%	23.33%	35.48%	10%	12.50%
Non-retrieved	86.20%	72.72%	76.66%	64.51%	90%	87.50%

Retrieval rates did not differ significantly by sex ($\chi^2(1)=0.621$, $p=0.431$; Fisher's exact $p=0.528$). Age was not significantly associated with organ retrieval (Mann–Whitney $U=1439$, $p=0.707$). Brain-death etiology was not significantly associated with retrieval ($\chi^2(5)=6.117$, $p=0.295$), although descriptive differences were observed across categories.

The yearly distribution of retrieved organs illustrates a more intricate pattern in temporal organ procurement dynamics from 2019 to 2024, which may represent a transition from a single-major organ (kidney, liver) to a broader approach that includes tissue retrieval (bone, tendon, cornea). Starting in 2021, a diversification of retrieved tissue types is noticeable. (Table 4)

Table IV. – Retrieved Organs by Year

Organs	2019	2020	2021	2022	2023	2024
Heart	-	1	-	-	-	-
Lung	-	-	1	-	-	-
Bone	-	-	1	1	-	2
Tendon	-	1	1	-	-	2
Cornea	-	-	1	2	2	1
Tissues	-	-	-	-	2	-
Liver	4	3	5	7	2	2
Kidney	4	2	7	10	2	2

Between 2019 and 2024, the analysis of factors impeding organ retrieval in brain-dead patients revealed considerable variability. Hemodynamic instability consistently emerged as the most frequent barrier, with intermittent reductions but a notable resurgence in 2024. Family refusal represented a significant impediment in the early years, peaking in 2021, but showed a progressive decline and was no longer reported by 2024. Legal constraints, particularly the absence of coroner's approval, fluctuated, reaching a maximum in 2023 before decreasing the following year. Medical contraindications remained relatively stable throughout the period, while the inability to perform the apnea test was reported sporadically. Multiple organ failure was a rare but occasionally relevant factor (Table 5).

Table V. – Reasons for Non-Retrieval by Year

Reason	2019	2020	2021	2022	2023	2024
Medical contraindications	2	2	1	4	2	3
Inability to perform the apnea test	-	-	2	4	1	1
Hemodynamic instability	11	4	7	2	3	5
Not approved by the coroner	2	-	5	2	9	4
Multiple organ failure	-	-	-	-	2	-
Family refusal	5	2	8	7	-	-

Discussions

The variability in the declaration of brain death can be swayed by the natural fluctuations of critical patients as well as contextual factors such as pandemics, the health status of the population, and the availability of medical resources that interfere with establishing and reporting this diagnosis.

Although the statistical comparison of the number of cases diagnosed with brain death per year did not show a significant difference across the six years studied (2019–2024), this analysis highlights the medical setting and changes in healthcare infrastructure that may have influenced the number of patients examined. Compared to 2019, the pandemic year 2020 saw a significant decrease in cases, a trend that may be linked to imposed restrictions, system overload, and limited access to critical care appointments. With the easing of measures and the gradual resumption of medical activities, we saw a spike in brain death cases in 2021 and 2022, reflecting a return to standard diagnostic and post-pandemic treatment procedures. In the years following this, the trend dropped, suggesting interventions are changing or the critical patient population is.

The observed decline in brain-death diagnoses in the last two years may be associated with several concurrent factors, including advances in trauma and stroke management and the broader implementation of modern neurocritical care strategies. Optimization of surgical interventions and hemorrhage control techniques may prevent critically ill patients from progressing to brain death, thereby reducing the pool of potential organ donors [11]. Furthermore, the increasing use of decompressive craniectomy in patients with malignant intracranial hypertension has been associated with improved survival and neurological outcomes [12]. Given the retrospective observational design, causality cannot be inferred; these explanations should be considered hypothesis-generating and warrant prospective confirmation.

Although other organs can be supported with mechanical ventilatory support, artificial life support can lead to ambiguity between patients' families, who may perceive cardiac or circulatory activity as a sign of life [13]. Additionally, the intense emotional burden of receiving such tragic news, combined with the urgency required for organ transplantation [14], significantly affects families' ability to cognitively and emotionally process the information and develop understanding [15].

In this context, the need for transparent and empathetic communication to deliver the diagnosis of brain death is paramount, not merely ethically but also to aid families in navigating the informed decision-making process. A detailed explanation of the medical criteria and the implications of this diagnosis helps relatives understand the irreversible reality of the situation and manage their emotions consciously and responsibly [16]. Specialized medical personnel play a crucial role in supporting informed decision-making about donations, both from a medical and an ethical perspective, thereby facilitating a donation process that is carried out with utmost responsibility and transparency. Consent decisions are primarily influenced by the deceased person's past knowledge of their wishes.

In our patient cohort in 2019, the predominant cause of brain death among all cases we studied was cerebrovascular pathologies, with a high frequency attributed to severe neurological emergencies because these are the leading cause of all strokes. In 2020, an observed rise in infections, specifically meningitis and encephalitis, was noted, possibly linked to the resurgence of certain viral infections during the pandemic. This trend suggests the impact of the pandemic on the incidence and progression of serious neurological diseases. By 2022, a progressive shift in the dominant causes of brain death became evident. Hemorrhagic strokes and cerebral aneurysms were the top causes in years past, with 2024 seeing an increasing share of traumatic brain injury (TBI). The pattern, as we know it, may predispose us to alter the profile of patients, influenced by emerging risk factors like the increasing incidence of traumatic accidents or shifts in prevention and treatment strategies for cerebrovascular conditions.

In the analyzed patient group, we have observed an increase in the age of patients diagnosed with brain death in recent years, with a narrower distribution of extreme age ranges. This trend may reflect a shift in the demographics of patients with severe illnesses.

In addition, after breaking down the percentage of organ donors in total brain death cases, there was a steady increase in the retrieval rate until 2022, followed by a significant decline in the subsequent years, primarily due to the decreasing number of patients diagnosed with brain death. An analysis of non-retrieval from 2019 to 2024 reveals that family refusal for organ donation has decreased significantly, with this reason no longer being reported as an obstacle by 2024, indicating an increasing social value placed on organ donation. Nevertheless, significant obstacles at the medical and organizational level remained, which limited the operational viability of organ retrieval from brain-dead donors. In 2024, hemodynamic instability emerged as the leading cause of non-retrieval, followed by the presence of medical contraindications against donation, like polycystic disease, cancer, or tuberculosis. The trend reflected in this passage also demonstrates the problem of controlling the physiological stability of brain-dead individuals, essential for organs that will be transplanted.

Benchmarking single-center donation pathways against national or European indicators is challenging because publicly available datasets are typically reported at country level and use different denominators (such as actual deceased donors per million population) than ICU-based brain-death cohorts. Nonetheless, Romanian national reports consistently place the country among low-to-moderate deceased donation rates compared with Western Europe, highlighting the relevance of optimizing local ICU donation processes and identifying center-specific barriers. [17,18]

The near-significant association between prolonged ICU stay and reduced retrieval likelihood suggests that early donor identification and aggressive hemodynamic stabilization may be critical for preserving donation potential. Structured donor-alert protocols and early involvement of transplant coordinators could represent pragmatic interventions derived from these findings.

Limitations

This study is limited by its retrospective single-center design, which restricts generalizability and does not allow causal inference. Some analyses were underpowered for detecting small-to-moderate effects, and missing variables (e.g., detailed ICU occupancy, staffing levels, timing of family approach, and protocol adherence metrics) limited deeper mechanistic interpretation. Additionally, comparisons with national or European benchmarks are imperfect because available data are usually aggregated at country level and use different denominators than ICU-based brain-death cohorts.

Conclusion

Analyzing the evolution of organ donation between 2019 and 2024 reveals a downward trend in the number of donors, influenced by a combination of factors. Innovations in trauma and stroke care may contribute to a reduced incidence of brain death and, consequently, to a smaller pool of potential organ donors. Psychological factors, such as cognitive dimensions (awareness about organ donation, brain death perception) and emotional factors (grief after losing a loved one and fear of post-mortem mutilation), play an essential role in the formation of attitudes to donation and may therefore hinder them. Also, from the family's perspective, there is a hesitation due to social determinants (community pressure, healthcare system experiences) and cultural factors (religion, social norms), which can impact families' hesitation in consenting to donation, remaining a significant barrier in this process, despite a gradual improvement in organ donation acceptance. To reverse this trend and increase donor numbers, it is essential to develop strategies that help with the identification and stabilization of brain-dead patients as well as the efficiency of the retrieval process through improved communication and alliance between the aligned parties.

Authors' contributions

DS – Investigation, Writing – original draft, Writing – review & editing
MS – Conceptualization, Resources, Supervision
GR - Data curation, Visualization, Formal Analysis
MRM - Data curation, Validation, Resources
RSF – Conceptualization, Methodology, Resources, Writing – review & editing, Validation

Conflict of interest

Authors declare no conflict of interest.

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