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RESEARCH

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Management of adult organ donors after brain death in ICU: insights from an Italian survey

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Abstract

Background Managing donors after brain death (DBD) is a complex task, but intensivists are believed to play a crucial role in optimizing organ perfusion to enhance organ procurement. This survey aims to gather important data on the practical management of DBD in Italy and to identify areas for potential improvement.

Methods This national survey was conducted online and distributed to all members of the Italian Society of Anesthesia, Analgesia, and Intensive Care (SIAARTI). The questionnaire consisted of 30 questions covering aspects such as the respondents' region of work, level of experience, and workplace characteristics. Clinical questions focused on hemodynamic monitoring and management in the ICU, fluid therapy, mechanical ventilation practices, nutritional habits, and management of endocrine disorders. Additionally, the survey examined practices during the brain death determination process and the organizational procedures involved in organ procurement in the operating room. The data collected were analyzed using descriptive statistics to provide a comprehensive overview of the current practices in DBD management in Italy.

Results From May 4 to August 30, 2024, 364 valid responses have been considered. 63% of respondents reported that they have written guidelines or diagnostic and therapeutic care pathways (PDTA) for DBD, while 34.5% indicated that such pathways do not exist. Nearly 49% of the respondents rely exclusively on standard hemodynamic monitoring techniques. By contrast, 42% incorporate cardiac ultrasound along with both basic and advanced invasive hemodynamic monitoring methods. Norepinephrine was chosen as the preferred treatment by 64.5% of participants. 58% of respondents used balanced crystalloids, while both normal saline and human albumin were used by 20% of them. Most participants implemented protective mechanical ventilation strategies (tidal volume ≤ 6 mL/kg and PEEP ≤ 10cmH_2O). Nutrition practices varied significantly among respondents. Additionally, 41% reported that they almost always administered hormonal replacement therapy, while 38% used it only in case of hemodynamic instability. In the assessment of brain death, 43% of physicians performed an apnea test using continuous positive airway pressure without disconnecting the ventilation circuit. The most commonly administered medications during surgery included neuromuscular blocking agents (43%), opioids (42%), inhaled anesthetics (25.5%), propofol (11.5%), and none of the above (3.8%).

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Conclusions This survey reflects the current practices of SIAARTI members when managing DBD. It highlights several areas for improvement, particularly the need for written guidelines and PDTA to be readily accessible at every procurement site. Additionally, while protective mechanical ventilation is generally well understood, there is considerable variability in hemodynamic management, fluid strategies, and hormone replacement therapy (HRT). This emphasizes the importance of enhancing education and conducting more targeted research in these critical areas.

Trial registration Not applicable.

Keywords Organ procurement, Brain death, Protective ventilation, Hemodynamic monitoring, Fluids, Artificial nutrition, Hormonal replacement therapy, Intensive care unit, Transplantation

Background

By the end of 2024, Over 7,800 patients were on the waiting list for organ transplantation in Italy. Due to a shortage of available organs, only 4,200 transplants were performed that year [1].

The majority of organ procurements—approximately 90%—comes from donors after brain death (DBD) primarily due to stroke or traumatic brain injury (TBI), exclusively managed in the intensive care unit (ICU) [2–4].

Patients progressing toward brain death experience well known physiological derangements, with severe hemodynamic instability and endocrine disorders being the most critical issues [5]. Clinicians must carefully manage fluid infusions, administer vasoactive medications, and implement lung-protective strategies [6]. Additionally, they should supplement hormones, provide proper nutrition, and monitor electrolyte and glucose levels [7]. These actions are essential for improving the quantity and quality of organ retrieval [8].

Observational studies indicate that up to 20% of organs can become unsuitable for transplantation due to poor management, a significant concern given the limited availability of organs [9, 10].

In 2015, the Society of Critical Care Medicine aimed to create evidence-based guidelines for organ donation but opted for a consensus-based approach due to limitations in ongoing research [11–13]. This underscores the urgent need for more comprehensive studies. Additionally, the guidelines indicate ongoing discrepancies in donor management strategies across different medical centers [14].

Findings from the University of Pittsburgh suggest that an intensivist-led organ donor support team can significantly enhance the recovery of transplantable organs [15].

It is essential to enhance our understanding of the unique pathophysiology of brain death and its implications for donor care [16]. This knowledge is vital for stabilizing physiological parameters and minimizing preventable organ loss. Therefore, establishing strong policies and procedures to preserve the option of organ donation for every potential donor and their family is important [17].

To achieve this goal, it is essential to obtain an accurate snapshot of current practices and assess whether they align with established guidelines and recommendations. This survey aims to collect critical data on the management of deceased adult brain donors in Italy. Our objective is to analyze specific areas of organ procurement that may require improvement and to identify potential knowledge gaps for future investigation.

Methods

Study design and participants

This survey was conducted as a nationwide online study. Due to the nature of the study, Human Ethics and Consent to Participate declarations were not applicable. On May 4, 2024, we sent email invitation to 10,000 specialists in anesthesia and intensive care medicine, as well as trainees, affiliated with the Italian Society of Anesthesia, Analgesia, and Critical Care (SIAARTI). Personal identification codes were implemented to prevent multiple registrations. The data collection phase concluded on August 30, 2024. During this period, we sent reminder emails every 15 days to encourage participation and maximize the response rate. Clinical trial number: not applicable.

Characteristics of the questionnaire

Our questionnaire was meticulously designed to engage respondents and gather valuable insights on adult (patients ≥ 18 years old) Donors after Brain Death (DBD) management. It effectively captured essential perspectives through a user-friendly layout that allowed participants to provide their feedback easily. The focused questions and relevant topics not only improved the user experience but also streamlined data collection and enhanced our understanding of the subject. This survey targeted all anesthesiologists and critical care physicians in Italy.

We collected general information about respondents, including their region of work, level of experience, and workplace characteristics. This was followed by specific clinical questions on:

-Hemodynamic monitoring in the ICU ("base" includes EKG, invasive arterial pressure, central venous pressure, where "advanced" is represented by tools able to provide cardiac output such as pulmonary artery catheter).
-Hemodynamic management (drugs used as first and second line therapy).
-Types of fluids administered ("crystalloids" means balanced solutions).
-Mechanical ventilation practices.
-Nutrition practices.
-Hormonal therapy.
-Glycemic control.
-Practices during the brain death determination process.

Finally, we inquired about the organizational processes involved in organ procurement in the operating room. Some questions allowed for multiple responses, while others required ordinal numbering for the answers. The complete survey consisted of 30 questions, as detailed in Supplementary Material 1. Participants were expected to complete the questionnaire in less than 10 min. We created the electronic survey form using SurveyMonkey® (https://www.surveymonkey.com).

To ensure the integrity of our data, we excluded any questionnaires submitted by pediatric centers and filtered out duplicate responses provided by participants from the same ICU. This approach allowed us to focus on the insights specifically from practitioners engaged in adult critical care, enhancing the relevance of our findings.

Sample size and statistical analysis

We estimated a response rate of approximately 30% from our target population of 1,500 physicians, primarily associated with high-volume organ procurement centers, as well as over 10,000 members affiliated with SIAARTI. To ensure our findings had robust statistical power and adhered to a 5% margin of error with a 95% confidence level, we determined that a minimum of 306 respondents was necessary for a meaningful and reliable analysis.

The data were downloaded as an Excel file (Microsoft Corp, Redmond, WA, USA) and analyzed using Jamovi software (version 2.5.1.0) for descriptive statistics. Responses were included in the analysis if at least 50% of the questionnaire was completed. The data are presented as numbers and percentages.

Results

General results and respondents' characteristics

From May 4th to August 30th, 2024, a total of 372 Italian anesthesiologists and intensive care physicians participated in our survey. We excluded 8 questionnaires that represented pediatric ICUs, leaving us with 364 responses for the final analysis.

Table 1 presents the characteristics of the primary respondents along with details about their workplaces, while Fig. 1 illustrates their geographical distribution, displaying both absolute numbers (on the left) and percentages (on the right).

A significant majority of respondents (94%) indicated that they manage donation after brain death (DBD) as part of their responsibilities. Furthermore, 54% work in hospitals where solid organ transplants are conducted. Notably, 63% reported that written Diagnostic and Therapeutic Care Pathways for donor management are available in their workplaces, whereas 34.5% indicated that such pathways are not in place (2.5% did not provide a response). The availability of written Diagnostic and Therapeutic Care Pathways was recorded in 63% of academic hospitals and 66% of non-academic hospitals, with no significant difference between the two groups ($p=0.574$). Similarly, when comparing sites that manage less than 10 DBDs per year to those managing more than 10, 64% and 62% respectively reported the availability of written pathways, which also showed no significant difference ($p=0.829$).

Furthermore, when analyzing the level of care provided in Emergency Departments (ED) based on the Italian classification system (1 representing basic care, 2 representing advanced care), respondents from ED level 1 reported following written Diagnostic and Therapeutic Care Pathways in 66% of cases. In comparison, respondents from ED level 2 indicated the use of written protocols in 62% of cases, with no significant difference between the two groups ($p=0.529$).

Hemodynamic monitoring and fluids management

Nearly half of the physicians (49%) use a standard hemodynamic monitoring approach, which includes invasive arterial and central venous pressure recordings, as depicted in Fig. 2. Remarkably, 154 physicians, representing 42% of the respondents, enhance their assessment of hemodynamic status by incorporating cardiac ultrasound along with both basic and advanced invasive hemodynamic monitoring. In terms of vasoactive drugs for managing hypotension, norepinephrine

Table 1 Physicians and places of work characteristics

	N (%)
Physician seniority	
< 5 years	60 (16.5)
5–10 years	227 (62)
> 10 years	59 (16.5)
Resident	18 (5)
Place of work	
Public Hospital	203 (56)
Public Academic Hospital	132 (36)
Institute for Treatment and Research	22 (6)
Private	2 (0.5)
Other	6 (1.5)
Emergency Department Level of care	
1	89 (24)
2	283 (76)
Intensive Care Unit type[a]	
General	267 (73)
NICU	36 (10)
Trauma	26 (7)
Cardiac	20 (6)
Other	15 (4)
Beds available in ICU	
< 9	131 (36)
9–16	143 (39)
> 16	85 (23)
Not available n = 5	
DBD managed per year	
≤ 10	158 (43)
11–20	105 (29)
> 20	68 (19)
Not available n = 32	

[a] Legend:

General ICU ICU where the majority of critically ill patients (due to organ failure, acute brain injury if NICU is not available, trauma patients if no dedicated trauma ICU exists) are admitted

NICU ICU dedicated mainly to the care of neurocritically ill patients (traumatic brain injury, ischemic or hemorrhagic stroke, meningitis, status epilepticus, …);

Trauma ICU ICU dedicated to the care of patients with multiple traumatic injuries;

Cardiac ICU ICU dedicated to the care of patients with cardiogenic shock or admitted after cardiac surgery;

Other includes physicians that work outside the above categories (for example ICU dedicated principally to the infectious disease care, or employed in extra hospital emergency service, …

was the first choice for 64.5% of respondents, as shown in left part of Fig. 3. In addition to norepinephrine (in case of persistent hypotension), vasopressin was preferred by 32% of participants, and dobutamine was chosen by 20%). For fluid resuscitation, balanced crystalloids were used by 64% of respondents, while normal saline and human albumin were used by 11% and 7% respectively as shown in Fig. 3 (right part).

Mechanical ventilation

The most favored approach to mechanical ventilation was selected by 39.5% of respondents, who opted for low tidal volumes (VT ≤ 6 mL/kg) with positive end-expiratory pressure (PEEP) ≤ 10 cm H_2O, alongside other specific measures to optimize conditions. Ninety-nine physicians (27%) preferred VT 6–8 mL/kg with PEEP 8–10 cm H_2O, without considering plateau pressure and lung protective measures. As illustrated in Fig. 4, 15% of respondents do not modify their ventilation settings.

Nutritional support

Among the ICU physicians surveyed, 75% stated that artificial nutrition in DBD is crucial. Table 2 shows the importance of artificial nutrition for improving graft function after transplantation. Responses regarding resting energy expenditure in DBD varied: 31% of respondents believed it is increased, 24.5% thought it is decreased, 19.5% said it remains unchanged, 25% reported being unsure. Table 2 also details how critical care physicians define total caloric targets and the amount of protein to deliver. The preferred route for administering nutrition was enteral alone for 60% of respondents, enteral plus parenteral for 31%, only parenteral for 5%, and none in 4%. When considering enteral nutrition, 57% of physicians reported using continuous infusion. According to 51% of physicians, the intestinal absorptive function was deemed reduced, while it was considered unchanged by 26.5% (67 respondents), as shown in Table 2.

Endocrine management

Additionally, 41% of respondents reported administering hormonal replacement therapy (HRT) almost always to more than 70% of patients. In contrast, 106 physicians (41%) only use HRT in cases of hemodynamic instability. Nearly one in five (21%) never (< 10% of cases) administer HRT to DBD patients, as outlined in Table 3. Among those who do use HRT, steroids alone or in combination with desmopressin and/or thyroid hormones were the most commonly used medications.

The most commonly desired glycemic target among ICU physicians for DBD patients is 141–180 mg/dL (65%), while 34% prefer to maintain glucose levels below 14**1** mg/dL, as indicated in Table 3.

In cases of hypernatremia (Na + > 150 mmol/L), 58.5% of respondents reported administering water through a

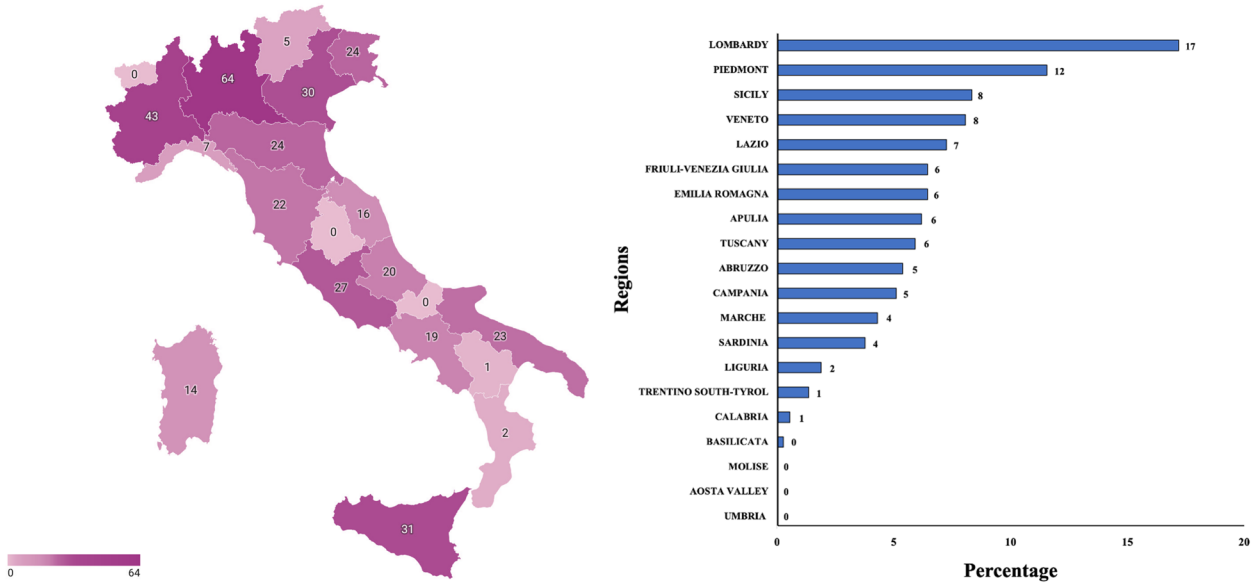

Fig. 1 Geographical distribution of respondents to the survey. The figure illustrates respondents' geographical distribution, displaying both absolute (on the left) and percentage (on the right) number of answers received for each Italian Region

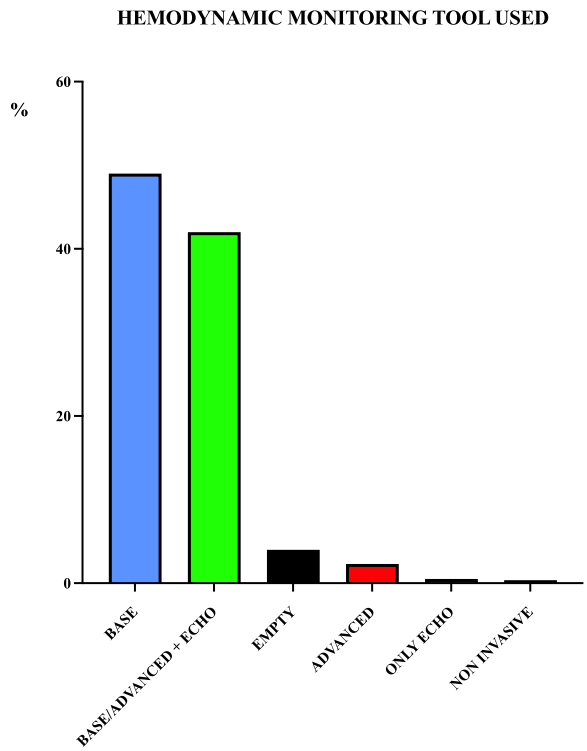

Fig. 2 Hemodynamic monitoring. Base hemodynamic monitoring that includes invasive arterial pressure and central venous pressure is the most reported one among respondents (49%). Notably, 42% of the respondents enhance their assessment of hemodynamic status by incorporating cardiac ultrasound along with both basic and advanced invasive hemodynamic monitoring

nasogastric tube, 22.5% provided hypotonic fluids parenterally, and 17% administered intravenous glucose.

For polyuria (diuresis > 3 mL/kg/h), the majority of ICU doctors prescribed desmopressin as a bolus (60%) and crystalloids to replace lost fluids (42%).

Apnea test conduction

Regarding the determination of brain death, 43% of physicians performed an apnea test using continuous positive pressure (C-PAP) with a mechanical ventilator without disconnecting the circuit. Meanwhile, 33% preferred to disconnect the patient from the ventilator and apply a continuous oxygen flow equal to or greater than 6 L/min, and 21% opted to disconnect the patient from the ventilator and use a bag-mask valve. Almost 40% of respondents did not provide an answer.

Anesthesia management in operating room for organ procurement

In the complex landscape of operating room management, the majority of oversight is provided by anesthesiologists who are readily available on-site during emergencies, accounting for 60% of cases. A smaller portion, 13%, consists of anesthesiologists who remain home on call.

Additionally, 12% of the anesthesiologists involved in surgical procedures are sourced from the Intensive Care Unit (ICU), bringing their specialized knowledge to the operating room. In 10% of situations, the anesthesiologist

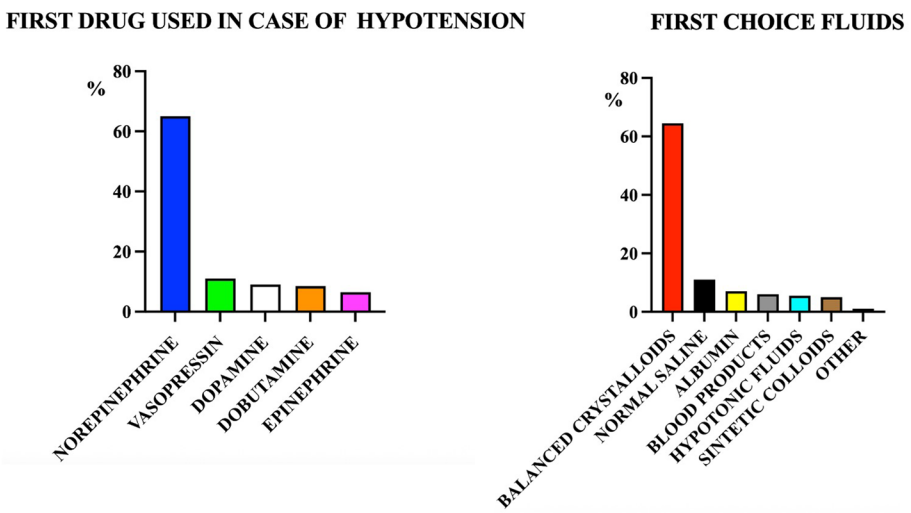

Fig. 3 Drugs and fluids used in case of hypotension. Norepinephrine is the first choice to treat hypotension for 64.5% of respondents as shown on the left part of Fig. 3, while balanced solutions is the preferred fluid for volemic resuscitation during hypotension as shown in the right part of Fig. 3

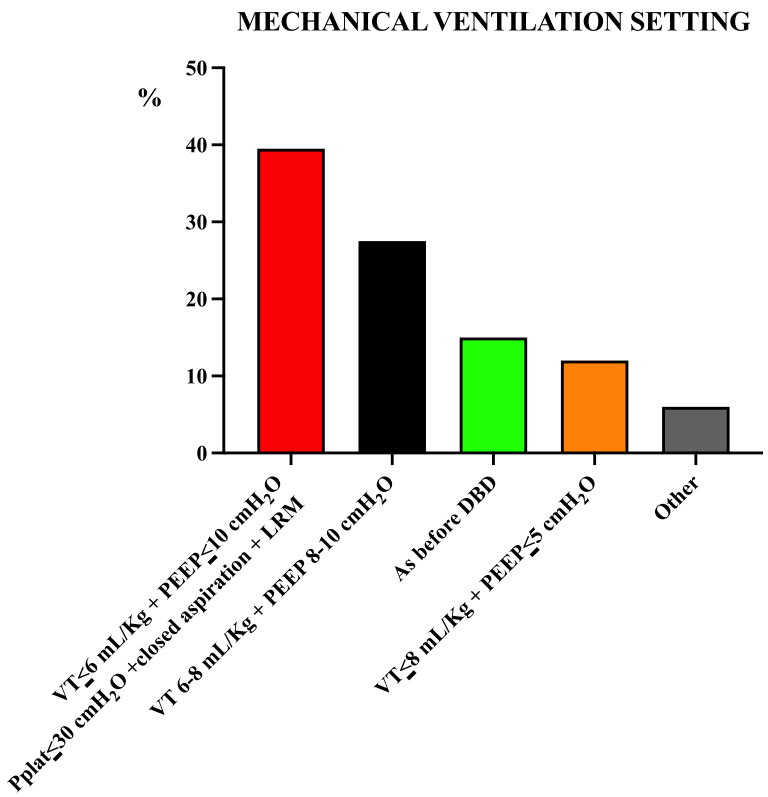

Fig. 4 Mechanical ventilation settings. Protective mechanical ventilation (with closed aspiration and lung recruiting maneuvers) was selected by 39.5% of respondents. Ninety-nine physicians (27%) preferred VT 6–8 mL/kg with PEEP 8–10 cm H_2O, without considering plateau pressure and lung protective measures. Finally, 15% of respondents do not modify their ventilation settings

Table 2 Nutrition practices in DBD

	N (%)
Perceived importance of nutrition in DBD	
Little	38 (14.5)
High	194 (75)
I don't know	27 (10.5)
Not available n = 105	
Perceived role of nutrition on graft recovery	
Nothing	8 (3.5)
Relative	97 (44.5)
Very important	79 (35.5)
I don't know	37 (16.5)
Not available n = 143	
Supposed REE in DBD	
Reduced	61 (24.5)
Increased	77 (31)
Unchanged	49 (19.5)
I don't know	62 (25)
Not available = 115	
Tools for REE estimation	
Indirect calorimetry	57 (23)
Fixed amount of Kcal/kg	125 (50)
Esteemed with formula	15 (6)
VCO_2	30 (12)
Other	22 (9)
Not available n = 115	
Protein intake prescribed	
< 1 g/Kg	76 (34)
1–2 g/Kg	61 (28)
> 2 g/Kg	84 (38)
Not available n = 143	
Nutrition route n (%)	
Exclusively Enteral	149 (60)
Exclusively Parenteral	13 (5)
Combined EN + PN	78 (31)
None	9 (4)
Not available n = 115	
Supposed intestinal absorptive capacity n (%)	
Reduced	128 (51)
Increased	11 (4)
Unchanged	67 (26.5)
I don't know	47 (18.5)
Not available n = 113	

Table 3 Endocrine disorders management

	N (%)
Hormonal replacement therapy prescription n (%)	
Never (< 10% cases)	55 (21)
Almost always (> 70% cases)	106 (41)
Only in case of hemodynamic instability	98 (38)
Not available n = 105	
Type of HRT prescription n (%)	
Only desmopressin	52 (22)
Only thyroid hormones	44 (19)
Only steroids	53 (22)
Desmopressin + thyroid hormones + steroids	31 (13)
Other	55 (24)
Not available n = 129	
Glycemic target adopted n (%)	
≤ 140 mg/dL	75 (34)
141–180 mg/dL	146 (65)
≥ 180 mg/dL	2 (1)
Not available n = 141	
Hypernatremia management n (%)	
Free water through NGT	130 (58.5)
Glucose solution iv or via *enteral route*	38 (17)
Parenteral hypotonic solution	50 (22.5)
Other	4 (2)
Not available n = 142	
Polyuria management n (%)[a]	
Desmopressin iv as bolus	175 (60)
Desmopressin iv continuous infusion	50 (17)
Glucose solution as diuresis replacement	18 (6)
Cristalloid solution as diuresis replacement	122 (42)
Other	6 (2)
Not available n = 72	

[a] More than one answer possible

is a trusted member of the local coordination staff, ensuring seamless teamwork and collaboration. Notably, 155 respondents chose not to answer this particular question, leaving a gap in the data.

When it comes to the pharmacological agents used during surgeries, the most commonly administered drugs reflect the critical needs of the patients. Neuromuscular blocking agents lead the list, being utilized in 43% of procedures, closely followed by opioids at 42%, which are essential for pain management. Inhaled anesthetics are employed in 25.5% of cases, providing the required sedation for surgical interventions. Propofol, widely recognized for its rapid-acting properties, is used in 11% of surgeries. Interestingly, a small fraction, 3.8%, indicated that none of the aforementioned drugs were used during their procedures.

Discussion

The main findings of this survey are as follows: i) 63% of respondents reported using written Diagnostic and Therapeutic Care Pathways for managing Donation after Brain Death (DBD) in their hospitals; ii) Invasive arterial and central venous pressure monitoring are the primary

tools employed, used by 49% of respondents, often with or without ultrasound assistance (42%); iii) Norepinephrine is the most commonly administered first-line vasoactive medication, followed by vasopressin and dobutamine; iv) Mechanical protective ventilation is widely adopted in clinical practice. v) Nutritional strategies vary significantly among practitioners; vi) Hormone Replacement Therapy (HRT), which includes thyroid hormones and corticosteroids, is utilized as a standard treatment in 41% of cases, often in conjunction with vasopressin. In contrast, 38% of critical care physicians report that hemodynamic instability primarily drives the use of HRT, while 21% do not use it at all; vii) The apnea test during DBD determination is performed in various ways; 33% of physicians disconnect the patient from the ventilator and provide a continuous oxygen flow of 6 L/min or greater; viii) Opioids are the most frequently used medications during organ procurement in the operating room.

Managing DBD is a complex process that demands a diverse set of skills and coordinated efforts to improve graft retrieval and post-transplant outcomes [18]. Although national guidelines exist to assist clinicians in handling these ICU patients, there is a clear need for localized PDTA to optimize local resources and reduce organ loss [10, 11, 16, 19–21]. A significant 37% of respondents are either unaware of or do not have the necessary PDTA, highlighting the need for a concerted effort to address this gap.

This survey clearly indicates that effective hemodynamic management of donors necessitates a comprehensive understanding of the "dying brain" process that begins with a "sympathetic storm," followed by severe hypotension due to a complete loss of endogenous catecholamine production [6, 21, 22]. The first phase is delicate, and organs may be at risk of damage due to prolonged hypertensive crises, which must be treated appropriately [23–26]. Similarly, the hypotensive phase can lead to reduced blood flow to organs, increasing the risk of delayed function in the transplanted organ, or worse, loss of organs [27]. At this stage, it is essential to understand that normalizing mean arterial blood pressure and central venous pressure (CVP), as suggested by guidelines, does not necessarily correlate to restoring tissue perfusion unless cardiac output is also measured [28–30]. Few centers implement hemodynamic optimization with the support of invasive hemodynamic monitoring. Our survey results partially explain this trend, highlighting the growing reliance on ultrasound as an essential monitoring tool. Ultrasound is used to assess potential ventricular dysfunction, monitor cardiac output, and guide fluid and vasopressor administration [31, 32].

Norepinephrine is the preferred catecholamine, followed by vasopressin, which aligns with the septic shock algorithm recommended by the Surviving Sepsis Campaign [33]. Studies from the late 2000 s highlighted a potential positive effect of dopamine on kidney grafts [34]; however, subsequent evidence indicated better long-term survival in a subset of heart transplant patients treated with norepinephrine [35, 36]. Future large randomized trials should be conducted to determine whether one vasopressor is superior to another.

In addition to ensuring adequate organ perfusion, it is crucial to minimize the injury caused by mechanical ventilation in the ICU [37].

Mascia et al. demonstrated that employing protective mechanical ventilation (with tidal volumes of 6–8 mL/Kg and PEEP of 8–10 cmH_2O) during donation after brain death (DBD) significantly increases the number of lungs eligible for harvesting compared to the conventional approach (which uses tidal volumes of 10–12 mL/Kg and PEEP of 3–5 cmH_2O) [38]. Our results show that most physicians who participated in this survey utilize a protective mechanical ventilation strategy by setting tidal volumes (VT) at less than 6 mL/kg and applying PEEP levels between 8 and 10 cm H2O. However, it's important to note that 15% of respondents do not adjust their ventilator settings. Protective lung ventilation should be considered the standard of care during lung procurement, despite recent studies questioning its positive effects [39, 40].

Nutrition in donation after brain death (DBD) is not well studied. Current guidelines recommend continuing nutritional support based on expert consensus [11, 16]. Evidence suggests that the nutritional status and provision of artificial nutrition can improve the function of various organs (such as the heart, liver, and kidneys) and enhance graft viability [41]. Additionally, the nutritional status of the donor appears to reduce the severity of ischemia and reperfusion injury, which are among the many factors contributing to early allograft dysfunction (EAD) and primary non-function (PNF) in liver transplantation [42, 43]. In a recent study, we demonstrated that a donor's nutritional intake in the 48 h prior to organ procurement correlates with graft function, suggesting that nutrition likely plays a positive role in the functional recovery of the graft [44]. Survey results indicate that most ICU physicians consider artificial nutrition very important for maintaining the donor, but only 21% regard it as very important for graft recovery. The preferred method of delivering nutrition was enteral feeding, which was chosen by 60% of respondents. However, half of respondents expressed concern that the intestinal absorptive capacity might be reduced. Evidence does not support this concern:

in fact, Hergenroeder et al., demonstrated that enteral feeding is safe for donors and that they can effectively absorb and metabolize enteral feedings [45]. The lack of strong evidence and likely insufficient focus on nutrition in the ICU may explain the high rate of unavailability regarding the perceived importance of nutrition in Donation after Brain Death (DBD) and its perceived role in graft recovery. It is essential to study nutritional aspects more thoroughly in this specific area.

Another significant topic in managing DBD is Hormone Replacement Therapy (HRT). Nearly 41% of respondents to our study reported that they prescribe HRT almost always, without considering the hemodynamic status of the patient, while 21% stated that they never prescribe this therapy. Additionally, hemodynamic instability influences the decision to prescribe HRT for 38% of respondents.

Traditionally, it was common belief that neuroendocrine function ceases after brain death (BD), necessitating supplementation [46]. But not all DBDs have low levels of effector hormones [47]. This is likely the main reason why intravenous levothyroxine supplementation has failed to increase the number of hearts transplanted from unstable DBD [48]. Interestingly, the same study found that among the group treated with levothyroxine, there were more adverse events, including cardiac arrest and premature donor loss due to hemodynamic instability. Therefore, a tailored approach is recommended when prescribing hormone replacement therapy (HRT).

Additionally, steroids and desmopressin should be considered for cases of severe vasoplegia that do not respond to pressors, and for managing polyuria accompanied by progressive hypernatremia [18]. Once again, ultrasound can be a valuable tool in determining the cause of hemodynamic instability, whether it stems from cardiac dysfunction, hypovolemia, vasoplegia, or a combination of these factors.

It is also important to note that hemodynamic instability may occur during the apnea test conducted for brain death determination, and there is considerable variability in how this test is performed [49, 50]. Guidelines from the CCM in 2015 recommend disconnecting the patient from the ventilator and administering oxygen at a flow rate of 6 L/min through a suction catheter placed at the level of the carina, or using a T-piece with CPAP set at 10 cm H_2O [11]. However, disconnecting the ventilator can lead to serious complications, including severe hypoxia resulting from the removal of PEEP, atelectasis formation, hypotension, and even cardiac arrest [51]. For this reason, Lambeck et al. demonstrated the safety and effectiveness of a modified apnea test that does not require disconnection from the ventilator [52]. In our study, only 43% of respondents performed the apnea test in the recommended way, while over 50% preferred to disconnect patients from the ventilation machine. This highlights an area where a quality improvement program should focus to support physicians treating Donation after Brain Death (DBD) patients.

The conclusion of the donation process occurs in the operating room, where organs are procured. While some national guidelines exist to standardize management, they are primarily based on expert opinion rather than evidence-based practices [53–55].

In our survey, the most commonly involved anesthesiologist in organ procurement is the one dedicated to surgical emergencies available in the hospital. Furthermore, neuromuscular blockers were the most frequently administered drugs, accounting for 43% of the cases. This was followed by opioids at 42%, and hypnotics, which included inhaled anesthetics (25.5%) and propofol (11%). Interestingly, a minority of respondents indicated that they administered no drugs at all.

Our findings are consistent with a recent French national survey that also reported a high frequency of neuromuscular blocking agents and opioids during surgeries [56].

It is not surprising the high use rate of neuromuscular blocker since they abolish intact spinal reflexes and allow surgeon easier surgical maneuvers as reported in a recent large study from Seattle [57].

Opioid administration during organ retrieval may improve organ quality, have a potential effect on reducing catecholamine levels and smoothing ischemia–reperfusion injury [58]. In our survey the limited use (42%) of opioids probably reflects the limited evidence favoring their use [59].

Sevoflurane demonstrated to be protective against graft dysfunction in liver transplantation [60]. Proposed mechanisms include lowering ischemia–reperfusion injury, reduced pro-inflammatory molecules such as TNF-α and reduced catecholamine concentration [61].

However, despite promising results on early studies, there is no large randomized controlled trial that have demonstrated benefit of using anesthetics and/or opioids for every organ procurement procedure [59, 61–63].

Limitations

This survey has several limitations. It was exclusively directed at members of SIAARTI, which means the pool of respondents was limited. As a result, the findings may not accurately reflect the attitudes and beliefs of the entire population of Italian anesthesiologists and intensive care physicians. However, compared to other surveys [60], this one gathered response from the largest number of participants and addressed nearly all topics related to the management of deceased donor brain death (DBD),

from the intensive care unit (ICU) to the operating room (OR).

Second, the lack of local protocols for DBD management could have influenced the results and it should be considered by local coordinators or health managers.

Third, some questions (for example the one regarding mechanical ventilation) have multiple predefined answers that could include not all the possible options expected by respondent. Although this could be potentially limiting, survey participants probably choose the one which reflected best their option.

Another limitation is that some questions received an unexpectedly high number of unavailable responses. This may be attributed to certain questions lacking appropriate answer choices. However, it is more likely that these questions pertained to poorly understood and studied topics, such as nutrition, highlighting areas needing future improvement and investigation. Finally, we acknowledge that survey results may not accurately represent real-life situations.

Conclusions

In conclusion, the national survey on managing brain-dead donors in the ICU identifies several critical areas requiring improvement, particularly the need for written Diagnostic and Therapeutic Care Pathways to be accessible at every procurement site. The findings indicate that while protective mechanical ventilation is generally well understood, there remains significant variability in hemodynamic management, fluid strategies, and hormone replacement therapy (HRT). These findings underscore the need for standardized protocols and further research to optimize organ donor management and improve transplantation outcomes.

Abbreviations

DBD	Donors after brain death
VT	Tidal volume
PEEP	Positive end expiratory pressure
PDTA	Diagnostic and therapeutic care pathways
HRT	Hormone replacement therapy
TBI	Traumatic brain injury
ICU	Intensive care unit
ED	Emergency department
C-PAP	Continuous positive pressure

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s44158-025-00292-5.

Supplementary Material 1

Clinical trial number
Not applicable.

Authors' contributions
CD, MZ and LV designed the study, analyzed data, drafted manuscript and gave important intellectual content. DGB, GB, LM and EGB analyzed data, drafted manuscript and gave important intellectual content. MU helped in designing the questionnaire, analyzed data and drafted manuscript. All Authors read and approved the final manuscript.

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None.

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
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Competing interests
The authors declare no competing interests.

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