Optimization of physiology in organ donors in the intensive care unit: What you need to know

Elizabeth A. Swanson, MD, PhD, Anthony J. Hayes, MD, FACS, *and* **Darren J. Malinoski, MD, FACS,**
Portland, Oregon

ABSTRACT: Optimizing the physiology of organ donors is a critical component of preserving the option for organ donation and addressing the shortage of organs available for transplantation. In this article, we review common physiologic alterations seen in organ donors with a focus on brain-dead organ donors. These physiologic alterations and recommended interventions to optimize the physiology of the brain-dead organ donor are discussed by organ system, providing a framework for trauma surgeons and intensivists involved in the care of organ donors. (*J Trauma Acute Care Surg.* 2025;99: 162–168. Copyright © 2025 Wolters Kluwer Health, Inc. All rights reserved.)

KEY WORDS: Organ donation; brain death; donor management goals.

Organ transplantation is a critical life saving measure for patients with irreversible end organ damage. While transplantation of organs from living donors is a viable option in certain clinical scenarios, transplantation of organs from deceased donors continues to be the source of most organs transplanted in the United States. As is well known, the waitlist for organ transplantation far exceeds the available organs. According to the Organ Procurement and Transplantation Network (OPTN)/Scientific Registry of Transplant Recipients (SRTR) 2022 annual report, there were approximately 162,000 patients on the organ transplant waitlist, with only 10,127 brain-dead organ donors.[1]

Trauma surgeons and intensivists are frequently involved in caring for patients who will become organ donors, often as the result of a traumatic brain injury leading to brain death. The time that elapses between the identification of a potential organ donor and the decision to pursue organ donation can vary considerably. The period that follows initial injury and resuscitation and the decision to pursue organ donation can be a time of profound pathophysiologic derangement, particularly as a patient progresses to brain death. This is the period when optimal management of these patients can have the most impact on limiting organ compromise and increasing the potential for organ donation. This review will summarize the literature regarding best practices for management of the organ donor in the intensive care unit following brain death, recognizing that management of the organ donor following authorization for donation is a multidisciplinary effort involving the critical care team, organ procurement organization (OPO), and recipient transplant team(s) and is subject to regional and institutional variations in practice.

Submitted: December 1, 2024, Revised: January 27, 2025, Accepted: December 2, 2024, Published online: February 27, 2025.

From the Department of Surgery, Division of Trauma, Critical Care and Acute Care Surgery, Oregon Health & Science University, Portland, Oregon.

Supplemental digital content is available for this article. Direct URL citations appear in the printed text, and links to the digital files are provided in the HTML text of this article on the journal's Web site (www.jtrauma.com).

Address for correspondence: Darren J. Malinoski, MD, FACS, 318 SW Sam Jackson Park Road, L102, Portland, OR 97239; email: malinosk@ohsu.edu.

DOI: 10.1097/TA.0000000000004565

BRAIN DEATH

In the United States, organs are recovered for transplantation from deceased donors following brain death or after circulatory death, as well as from living donors. This review focuses on optimizing the physiology of brain-dead organ donors. Brain death, also known as death by neurologic criteria, results in physiologic changes affecting every organ system. The pathophysiology of brain death has been covered in previous reviews.[2,3] In this review, specific physiologic changes and the critical care interventions to address these changes are covered by organ system. In addition to understanding how to optimize the critical care of the brain-dead organ donor, it is important for trauma surgeons and intensivists to understand the diagnosis of brain death and supporting the patient's family during that process. For review of these topics, we refer the reader to the recent "What You Need to Know" review of brain death/death by neurologic criteria.[4]

DONOR MANAGEMENT

Donor Management Goals

Donor management goals (DMGs) are critical care parameters established to optimize the care of deceased organ donors. These parameters can inform critical care management of potential organ donors by clinicians prior to authorization for donation, as well as subsequent management of organ donors by OPO staff. DMGs currently consist of nine critical care parameters that are observed at four specific time points during the process of donor management (Fig. 1). These parameters are recorded at the time of referral to the OPO, the time of authorization for organ donation, the time of organ allocation, and the end of donor management immediately prior to organ recovery. The critical care parameters included in the DMGs represent normal hemodynamic, respiratory, endocrine, acid-base, and renal physiologic values and were originally selected based on a series of Canadian task force recommendations (Table 1).[5]

Achieving DMGs is predictive of a higher number of organs transplanted per donor. In prospective observational studies of standard criteria donors, donors who meet the DMG bundle

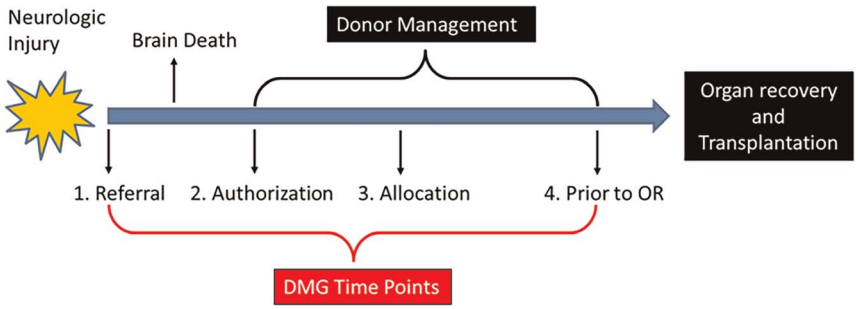

Figure 1. Donor management timeline.

(defined as achieving seven or more of the nine DMGs) are more likely to have four or more organs transplanted.[6,7] Similarly, a prospective observational study of expanded criteria donors found that meeting the DMG bundle at the conclusion of donor management is associated with three or more organs transplanted per donor.[8]

Hemodynamic Management

Hypovolemia is common following brain death and can compromise perfusion of potentially transplantable organs. The goal of fluid resuscitation in the organ donor is to correct hypovolemia to allow adequate intravascular volume and cardiac output for organ preservation. Placement of a central venous catheter or pulmonary artery catheter allows fluid resuscitation to be guided by central venous pressure (CVP) or pulmonary artery occlusion pressure (PAOP), respectively.[9] Alternatively, minimally invasive hemodynamic monitors such as FloTrac (Edwards Lifesciences, Irvine, CA) can be used to guide fluid resuscitation. In a small prospective observational trial, an algorithm based on stroke volume variation and stroke volume index measured by FloTrac was used to guide fluid resuscitation of organ donors and found to be associated with increased thoracic (1.3 vs. 0.4, $p = 0.004$) and overall (4.3 vs. 2.7, $p = 0.002$) organs transplanted per donor.[10] Conversely, a multi-site randomized clinical trial using the LiDCO monitor (Masimo, Irvine, CA) to guide organ donor resuscitation based on pulse pressure variation did not find an increase in organs transplanted per donor.[11] The donor management goals for mean arterial pressure (60–110 mm Hg), urine output (>0.5 mL·kg^{-1}·h^{-1}), left ventricular ejection fraction (>50%), and vasopressors (≤1 low-dose vasopressor) also inform fluid resuscitation.

Historically, it was thought that the goal of fluid resuscitation differed for kidneys and lungs with aggressive fluid resuscitation benefiting the kidneys and conservative fluid resuscitation benefiting the lungs. However, a retrospective analysis of 404 kidney transplant recipients found that a negative or equalized fluid balance in the donor with central venous pressure ≤6 mm Hg was not associated with development of delayed graft function or reduced graft survival.[12] In addition, in a study of 308 brain-dead donors, 44% more hearts, 95% more lungs, and 13% more kidneys were transplanted when a final CVP < 10 mm Hg was achieved.[13]

When the correction of hypovolemia fails to achieve the desired hemodynamic parameters, vasopressor agents should be used. There have been no large randomized clinical trials to evaluate selection of vasopressor agents during donor management and thus the optimal first-line agent remains uncertain. Historically, dopamine was the first-line vasopressor during donor management.[9] Schnuelle et al. investigated the use of fixed, low-dose dopamine (4 μg·kg^{-1}·min^{-1}) in brain-dead donors who were stable while receiving a norepinephrine dose ≤0.4 μg·kg^{-1}·min^{-1}. Recipients of kidneys from brain-dead donors randomized to receive dopamine were less likely to require multiple dialysis sessions during the first week after transplant (24.7% vs. 35.4%, $p = 0.01$).[14] Conversely, administration of epinephrine and phenylephrine during donor management independently predicts development of delayed graft function in kidney transplant recipients.[15,16] In heart transplantation, a retrospective analysis of 45,198 adult heart transplant recipients found that recipients of hearts from donors who received either dopamine or epinephrine as the sole vasopressor agent had increased 1 year mortality (for dopamine: odds ratio [OR], 1.11; $p = 0.042$; for epinephrine: OR, 1.59; $p = 0.004$).[17] In pancreas transplantation, use of norepinephrine during donor management was found to be an independent predictor of improved graft survival in a retrospective analysis of 2,183 pancreas transplant recipients (HR 0.77, $p = 0.01$).[18] Taken together, these data suggest that norepinephrine should be used as the first-line vasopressor during donor management, with low-dose dopamine also being an option for potential kidney donors. Administration of epinephrine and phenylephrine should be avoided when feasible. Consideration should also be given to use of vasopressin as a

TABLE 1. Donor Management Goals

Benchmarks	Parameters
MAP	60–110 mm Hg
CVP/SVV/PPV	CVP: 4–12 mm Hg SVV: <13% PPV: <13%
EF/SF	EF ≥ 50% or SF ≥ 30%
ABG	pH: 7.3–7.5
PO_2/FiO_2 ratio	≥300
Sodium	≤155 meq/L
Glucose	≤180 mg/dL
Urine output	≥0.5 cc/kg/hr
Low-dose vasopressors	≤1 pressor used and low-dose: Dopamine ≤10 μg/kg/min, Neosynephrine ≤1 μg/kg/min, or Norepinephrine ≤0.2 μg/kg/min

component of hormonal resuscitation as discussed below in Endocrine Management.

Respiratory Management

Brain death can compromise respiratory physiology due to the same neurohormonal disruptions that affect other aspects of patient physiology. Concomitant traumatic injuries such as pulmonary contusion or hemopneumothorax can further exacerbate pulmonary physiology, culminating in lung injury that disrupts normal oxygenation and ventilation. Potential lung donors are also subject to the complications of mechanical ventilation and potential ventilator-induced lung injury. Historically, the rate of recovery of lungs for transplantation has been low, with recent data demonstrating recovery of lungs from 10% to 30% of eligible brain-dead donors depending on donor age.[19] Of the criteria that may define the "ideal" lung donor, a threshold PaO_2/FiO_2 ratio >300 or 350 is the only one that is modifiable.[20]

Multiple studies have investigated the use of lung protective ventilation (LPV), defined as tidal volume of 6 to 8 $mL \cdot kg^{-1}$ ideal body weight and positive end-expiratory pressure ≥8 cm H_2O, to increase donor lung use.[21–26] These studies assessed LPV as a part of a comprehensive donor management protocol focused on improving the rate of recovery of lungs for transplantation. Several small observational studies, as well as a small randomized clinical trial, demonstrated increased donor lung use when utilizing LPV compared with conventional mechanical ventilation, without negatively affecting the recovery of other organs, lung graft survival, or 30-day recipient survival.[23–26] A retrospective database review of a program using LPV as a part of a donor management protocol demonstrated an increase in lung donation from 19.8% pre-protocol to 33.9% following protocol implementation.[21] A prospective observational study of 1,109 potential lung donors in France found that LPV at the time of organ allocation resulted in an increased likelihood of lung recovery for transplantation.[22] In addition to LPV, the protocols used in these studies included additional interventions such as lung recruitment maneuvers, limiting plateau and peak inspiratory pressures, therapeutic bronchoscopy, fluid resuscitation guided by hemodynamic parameters to avoid fluid overload, and apnea testing using continuous positive airway pressure while connected to the ventilator.

These studies contrast with a recent observational study of prospectively collected data from several OPOs across multiple OPTN regions that examined the effect of multiple factors on donor lung use. The authors found that high positive end-expiratory pressure and lung protective tidal volumes were negative predictors of donor lung use but had no effect on lung graft survival.[27] There was no standard LPV protocol followed by the OPOs in this study; thus, it is likely that OPOs implemented higher positive end-expiratory pressures and lower tidal volumes in donors with worse lung physiology and this finding represents an association rather than causation.

Few studies have examined the impact of specific modes of mechanical ventilation on donor lung use. A small observational study examined the effect of airway pressure release ventilation compared with conventional assist control ventilation and found that use of airway pressure release ventilation resulted in a higher PaO_2/FiO_2 ratio following an oxygen challenge and an increase in donor lung use (18% vs. 84%).[28] This contrasts with the study by Swanson and colleagues that found use of airway pressure release ventilation, as well as pressure-regulated volume control and pressure control, as independent negative predictors of donor lung use.[27]

Another modality to improve oxygenation in potential lung donors is the use of prone positioning. A small observational study examined the effects of prone position ventilation (minimum, 12 hours) on brain-dead donors with baseline hypoxemia (PaO_2 < 300 mm Hg on arterial blood gas) and atelectasis.[29] A rapid and sustained increase in PaO_2 was observed in donors in the prone positioning group. A subset of donors underwent computed tomography imaging before and after prone positioning and this demonstrated improvement in atelectasis. While the final PaO_2 in the prone positioning group was not significantly different from the control group (344 vs. 306, $p = 0.12$), more lungs were transplanted from the prone position group (45% vs. 24%, $p = 0.03$).

In summary, respiratory compromise following brain death is expected and may be exacerbated by concomitant injuries in trauma patients. The available literature indicates there is a benefit to using LPV for potential lung donors, an approach endorsed by other published guidelines.[9,30] Other aspects of previously studied lung donor management protocols can be easily instituted as well, with emphasis on the use of recruitment maneuvers to mitigate and treat atelectasis. Strong consideration should be given to use of prone position ventilation to increase the number of potential lung donors. This is a treatment modality that trauma surgeons and intensivists are familiar with given its use and proven benefit in the management of ARDS.[31] There is no strong evidence to support the use of one ventilator mode compared with another. Trauma surgeons and intensivists should utilize a ventilation mode they are familiar with to achieve LPV.

Endocrine Management

Endocrine derangements are a common sequelae of brain death.[2] Depletion of vasopressin and development of diabetes insipidus occurs in up to 80% of brain-dead donors and results in hypovolemia, hyperosmolality, and hypernatremia. Impaired secretion of thyroid-stimulating hormone and adrenocorticotropic hormone results in decreased triiodothyronine (T3) and cortisol, respectively. In addition to these derangements of the hypothalamic-pituitary axis, activation of the sympathetic-adrenal-medullary axis results in increased gluconeogenesis and insulin resistance and decreased insulin release by the pancreas, resulting in systemic hyperglycemia with decreased intracellular glucose.[32]

Administration of vasopressin during donor management can address diabetes insipidus and improve hemodynamic parameters. In a small randomized clinical trial of 24 brain-dead donors, administration of vasopressin resulted in decreased plasma hyperosmolality and increased mean arterial pressure.[33] In addition, brain-dead donors randomized to receive vasopressin required less dopamine to maintain hemodynamic stability. In a retrospective analysis of 10,431 brain-dead donors, administration of vasopressin was found to be an independent predictor of four or more organs transplanted per donor.[34]

In retrospective studies, administration of thyroid hormone during donor management has been consistently identified as an

independent predictor of increased recovery of organs for transplantation.[35–38] In addition, a retrospective analysis of 3,433 brain-dead donors in the DMG Registry found that increased thyroid hormone dose at the time of organ allocation is an independent predictor of long-term cardiac graft survival (OR, 1.04 per $\mu g \cdot hour^{-1}$; $p = 0.01$).[39] However, meta-analysis of placebo-controlled randomized clinical trials found that administration of thyroid hormone in brain-dead donors did not affect the need for vasopressor agents during donor management or cardiac index at the time of organ procurement.[40] The authors note that most brain-dead donors enrolled in these trials were hemodynamically stable and thus the meta-analysis does not exclude the possibility that administration of thyroid hormone may be beneficial in hemodynamically unstable donors. In a recent randomized clinical trial of levothyroxine treatment in 838 hemodynamically unstable brain-dead potential heart donors, administration of fixed-dose levothyroxine (30 $\mu g \cdot hour^{-1}$ for a minimum of 12 hours) did not impact the rate of recovery of hearts for transplantation, weaning from vasopressor therapy, ejection fraction, organs transplanted per donor, or 30-day heart transplant recipient survival.[41] Donors in this study randomized to receive levothyroxine had more cases of severe hypertension and tachycardia which may be the result of a fixed dose of levothyroxine administered regardless of hemodynamic parameters. Differences between this clinical trial and the retrospective analysis of the DMG Registry may explain the discordant findings. Whereas this clinical trial examined 30-day heart transplant recipient survival, the retrospective analysis of the DMG Registry examined long-term graft survival. In addition, in the clinical trial, the potential heart donors randomized to the thyroid hormone group received a fixed dose of 30 $\mu g \cdot hour^{-1}$ levothyroxine regardless of blood pressure or volume status, which does not reflect how thyroid hormone is used in practice.

Relative cortisol deficiency and decreased responsiveness to adrenocorticotropic hormone are common sequelae of brain death.[42] Multiple observational studies have found beneficial effects of corticosteroid administration during donor management on donor hemodynamic parameters and increased recovery of organs for transplantation.[43] A randomized clinical trial of methylprednisolone treatment (250 mg at the time of authorization for donation followed by 100 $mg \cdot hour^{-1}$ infusion until organ recovery) in 100 brain-dead donors found a lower rate of acute rejection in recipients of livers from donors who received methylprednisolone (22% vs. 36%, $p < 0.05$).[44] However, systemic reviews and meta-analyses of randomized clinical trials assessing corticosteroid administration during donor management have found no evidence of benefit of corticosteroids for vasopressor use, organ recovery, acute graft rejection, or graft dysfunction.[43,45] A more recent prospective multicenter study of hydrocortisone treatment in 259 brain-dead donors found that hydrocortisone increased the probability of weaning norepinephrine, but did not affect the number of organs recovered for transplantation or graft function in transplant recipients.[46]

Hormonal resuscitation of brain-dead donors refers to the administration of vasopressin, thyroid hormone, and steroids. In brain-dead donors with diabetes insipidus or hemodynamic instability, administration of vasopressin has both physiological rationale, as well as evidence that vasopressin can improve hemodynamic stability and is associated with an increase in the number of organs transplanted per donor. Regarding the administration of thyroid hormone and steroids, the beneficial effects seen in observational studies have not been replicated in randomized clinical trials. Thus, there is no evidence to support routine administration of these hormones. However, in a hemodynamically unstable donor requiring escalating vasopressor support despite adequate fluid resuscitation, trauma surgeons and intensivists can consider use of thyroid hormone and steroids to stabilize the donor and maintain perfusion of potentially transplantable organs.

The release of epinephrine, corticosteroids, and glucagon associated with the activation of the central nervous system during brain death results in increased gluconeogenesis, insulin resistance, and systemic hyperglycemia in brain-dead donors.[32] A retrospective analysis of 1,611 brain-dead donors found that achieving blood glucose <180 $mg \cdot dL^{-1}$ is an independent predictor of four or more organs transplanted per donor.[47] A target blood glucose <180 $mg \cdot dL^{-1}$ is aligned with widely adopted protocols for glycemic management in critically ill patients and is included in guidelines for management of potential organ donors.[9]

Hematologic Management

A restrictive red blood cell transfusion strategy to maintain hemoglobin >7 $g \cdot dL^{-1}$ has been found noninferior to a liberal red blood cell transfusion strategy in randomized controlled trials of critically ill pediatric and adult patients.[48] Whether the same transfusion threshold should be applied to organ donors is unclear as randomized clinical trials of transfusion strategies in organ donors have not been conducted.[9] In practice, transfusion of packed red blood cells is common in organ donors with one study finding 69% of donors received packed red blood cells.[49] The effects of transfusion on transplant outcomes may be organ specific. Transfusion of the organ donor is associated with decreased risk of delayed graft function in kidney transplant recipients.[50] However, in lung transplant recipients, massive transfusion of the organ donor is associated with increased 90-day mortality.[51,52] In the absence of evidence specific to organ donors to guide transfusion practices, trauma surgeons and intensivists should follow established transfusion practices for other critically ill patients.

Brain death is associated with activation of hemostasis and dysregulated fibrinolysis characterized by platelet activation, dysregulation of the von Willebrand factor/ADAMTS13 axis, and activation of secondary hemostasis with fibrin formation.[53] These changes result in a prothrombotic state. Disseminated intravascular coagulation may affect up to 38% of organ donors who suffered severe cranial trauma but is not a contraindication to organ transplantation.[54] Disseminated intravascular coagulation in the organ donor is not associated with primary graft failure in heart or lung transplant recipients and is not associated with delayed graft function, long-term graft function, or allograft survival in kidney transplant recipients.[54–56] Clinical evidence for transfusion of clotting factors and platelets to correct coagulopathy in organ donors is lacking. However, transfusion to achieve an international normalized ratio of <1.5 and a platelet count of >50,000/$\cdot \mu L^{-1}$ prior to organ recovery has been proposed.[57]

Infectious Disease Management

Identification of infectious diseases in potential organ donors is important first to provide the appropriate treatment to the

potential organ donor and second, to determine the safety and feasibility of treating donor-derived infections in the recipients. It is important for trauma surgeons and intensivists to recognize that the presence of an infectious disease in a potential organ donor does not automatically preclude organ donation. A potential organ donor with an infectious disease should be resuscitated and stabilized and a referral made to the local OPO as would be done for other potential organ donors.

Although donor-derived infections are rare, they can be associated with significant morbidity and mortality.[58,59] Strategies to mitigate the risk of donor-derived infections include risk stratification from the donor medical and social history, physical assessment of the donor, and laboratory evaluation of the donor.[60] A careful review of the donor's medical and social history should include review of past infections, travel, animal and environmental exposures, sexual contacts, and intravenous drug use.[61] United States Public Health Service guidelines should be used to identify donors with risk criteria for acute transmission of human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV).[62] Careful physical examination of the donor should include assessment of infections as well as risk factors for infections, including abscesses, ulcers, anogenital trauma, unexplained rashes, lymphadenopathy, and evidence of drug use.[60]

As of October 2024, required deceased donor infectious disease testing includes blood and urine cultures as well as testing for HIV antibody or HIV antigen/antibody, HIV ribonucleic acid (RNA) by donor screening or nucleic acid test (NAT), HBV surface antigen, HBV core antibody, HBV deoxyribonucleic acid (DNA) by donor screening or NAT, HCV antibody, HCV RNA by donor screening or NAT, cytomegalovirus antibody, Epstein-Barr virus antibody, syphilis, and toxoplasma immunoglobulin G antibody.[63] Additional infectious disease screening should be guided by donor medical and social history and may include endemic fungi, parasites, and epidemic pathogens.[61]

Estimates for the prevalence of bacteremia in organ donors range from 5% to 21%.[64–66] When recipients of organs from donors with bacteremia receive appropriate antimicrobial treatment, the risk of infection and allograft dysfunction can be mitigated.[67] Thus, bacteremia in the donor is not an absolute contraindication to organ donation. Organ donors with bacteremia should receive antimicrobial treatment guided by culture and sensitivity data and be monitored for clinical response.[60] Consideration should be given to delaying organ recovery until the organ donor has received appropriate antimicrobial treatment for 48 hours.[9]

The safety of transplantation from donors with meningitis has been evaluated in several single-center case series.[68–71] In these series, donors received appropriate antimicrobial treatment, and this treatment was continued in organ recipients. No cases of donor-derived infection were reported. As with donor bacteremia, delaying organ recovery until the donor has received appropriate antimicrobial treatment for 24 hours to 48 hours has been suggested.[9]

Transplantation of organs from HIV-infected donors was historically prohibited in the United States. This prohibition was reversed in 2013 with the passage of the HIV Organ Policy Equity (HOPE) Act. The Department of Health and Human Services subsequently revised federal regulations to comply with the HOPE Act, permitting organ transplantation from HIV-infected donors to HIV-infected recipients under the HOPE Safeguards and Research Criteria published by the National Institutes of Health. The OPTN modified their policies to allow for HIV-to-HIV transplantation in a research setting. Although barriers to HIV-to-HIV transplantation remain, 29 transplant centers are approved to perform HIV-to-HIV transplants as of May 2024.[72–74] As the presence of HIV infection is no longer an absolute contraindication to organ donation, HIV-infected donors should be managed similarly to other donors to optimize organ health for transplantation.

TABLE 2. Management of the Potential Organ Donor

	Relevant DMGs	Recommendations
Hemodynamic	MAP 60–110 mm Hg CVP 4–12 mm Hg SVV < 13% PPV < 13% EF ≥ 50% pH 7.3–7.5 UOP ≥ 0.5 cc·kg^{-1}·hr^{-1} ≤ 1 vasopressor used and low-dose	Judicious fluid resuscitation to correct hypovolemia and allow adequate intravascular volume and cardiac output for organ preservation. Norepinephrine as the first-line vasopressor during donor management, with low-dose dopamine also being an option for potential kidney donors.
Respiratory	CVP 4–12 mm Hg SVV < 13% PPV < 13% pH 7.3–7.5 PaO_2/FiO_2 ≥ 300	Lung protective ventilation with tidal volume 6 to 8 mL·kg^{-1} and positive end-expiratory pressure ≥8 cm H_2O. Use of a ventilator mode one is familiar with to achieve lung protective ventilation. Strong consideration to the use of proning.
Endocrine	Sodium ≤155 mEq·L^{-1} Glucose ≤180 mg·dL^{-1}	Strong consideration to the use of vasopressin to address diabetes insipidus and improve hemodynamic parameters. Consideration for use of thyroid hormone and steroids in hemodynamically unstable donors requiring escalating vasopressor support despite adequate fluid resuscitation. Use of insulin to target blood glucose ≤180 mg·dL^{-1}.
Hematologic	—	Transfusion as for other critically ill patients.
Infectious disease	—	Antimicrobial treatment guided by culture and sensitivity data in potential organ donors with bacteremia. Management of potential organ donors with HCV and HIV like other potential organ donors as these infections are not absolute contraindications to organ donation.

Organs from anti-HCV positive donors have been transplanted into anti-HCV positive recipients since the early 1990s.[75] In addition, the development of direct-acting antiviral agents allows for transplantation from anti-HCV positive donors into anti-HCV negative recipients without adversely affecting short-term transplant outcomes.[75–78] In the case of viremic donors, early treatment of the recipient with a direct-acting antiviral agent is recommended.[75,79] However, recipients of organs from non-viremic donors can undergo close monitoring and only require treatment with direct-acting antiviral agents in the event of transmission.[80] HCV infection is not a contraindication to organ donation and anti-HCV positive donors should be managed similarly to other donors.

CONCLUSION

In the United States, approximately 170 million people are registered organ donors, representing >50% of the adult population, and 75% of families authorize organ donation when the intent of the potential donor is unknown.[81] As the organ transplant waitlist is expected to continue to exceed the availability of donor organs, trauma surgeons, intensivists, and other clinicians will find themselves in the position of caring for patients with catastrophic brain injuries who go on to meet criteria for brain-death. Even without knowing a patient's organ donor registry status, we know that most patients and their families want to facilitate organ donation in the event of their death and preserving the option for organ donation is a fundamental tenant of quality end of life care. Management of the brain-dead organ donor to optimize physiology in many regards follows the same principles of management of other critically ill patients, with circumstances specific to the physiologic derangements of brain death noted (Table 2). With careful attention to managing these specific derangements, the potential for organ donation can be maintained and optimized.

DISCLOSURE

Author Disclosure forms have been supplied and are provided as Supplemental Digital Content (http://links.lww.com/TA/E274).

REFERENCES

1. Schladt DP, Israni AK. OPTN/SRTR 2022 Annual Data Report: Introduction. *Am J Transplant*. 2024;24(2S1):S10–S18.
2. Smith M. Physiologic changes during brain stem death—lessons for management of the organ donor. *J Heart Lung Transplant*. 2004;23(9 Suppl): S217–S222.
3. Yoshikawa MH, Rabelo NN, Welling LC, Telles JPM, Figueiredo EG. Brain death and management of the potential donor. *Neurol Sci*. 2021;42(9):3541–3552.
4. Larson NJ, Dries DJ, Blondeau B, Rogers FB. Brain death/death by neurologic criteria: what you need to know. *J Trauma Acute Care Surg*. 2024; 97(2):165–174.
5. Shemie SD, Ross H, Pagliarello J, et al. Organ donor management in Canada: recommendations of the forum on medical management to optimize donor organ potential. *CMAJ*. 2006;174(6):S13–S32.
6. Malinoski DJ, Patel MS, Daly MC, Oley-Graybill C, Salim A, UNOS Region 5 DMG workgroup. The impact of meeting donor management goals on the number of organs transplanted per donor: results from the United Network for Organ Sharing Region 5 prospective donor management goals study. *Crit Care Med*. 2012;40(10):2773–2780.
7. Patel MS, De La Cruz S, Sally MB, Groat T, Malinoski DJ. Active donor management during the hospital phase of care is associated with more organs transplanted per donor. *J Am Coll Surg*. 2017;225(4):525–531.
8. Patel MS, Zatarain J, De La Cruz S, et al. The impact of meeting donor management goals on the number of organs transplanted per expanded criteria donor: a prospective study from the UNOS region 5 donor management goals workgroup. *JAMA Surg*. 2014;149(9):969–975.
9. Kotloff RM, Blosser S, Fulda GJ, et al. Management of the Potential Organ Donor in the ICU: Society of Critical Care Medicine/American College of Chest Physicians/Association of Organ Procurement Organizations Consensus Statement. *Crit Care Med*. 2015;43(6):1291–1325.
10. Bergstrom B, de la Cruz JS, Sally M, et al. The use of stroke volume variation to guide donor management is associated with increased organs transplanted per donor. *Prog Transplant*. 2017;27(2):200–206.
11. Al-Khafaji A, Elder M, Lebovitz DJ, et al. Protocolized fluid therapy in brain-dead donors: the multicenter randomized MOnITeR trial. *Intensive Care Med*. 2015;41(3):418–26.
12. Minambres E, Rodrigo E, Ballesteros MA, et al. Impact of restrictive fluid balance focused to increase lung procurement on renal function after kidney transplantation. *Nephrol Dial Transplant*. 2010;25(7):2352–2356.
13. Abdelnour T, Rieke S. Relationship of hormonal resuscitation therapy and central venous pressure on increasing organs for transplant. *J Heart Lung Transplant*. 2009;28(5):480–485.
14. Schnuelle P, Gottmann U, Hoeger S, et al. Effects of donor pretreatment with dopamine on graft function after kidney transplantation: a randomized controlled trial. *JAMA*. 2009;302(10):1067–1075.
15. Giral M, Bertola JP, Foucher Y, et al. Effect of brain-dead donor resuscitation on delayed graft function: results of a monocentric analysis. *Transplantation*. 2007;83(9):1174–1181.
16. Swanson EA, Patel MS, Groat T, et al. Vasopressor selection during critical care management of brain dead organ donors and the effects on kidney graft function. *J Trauma Acute Care Surg*. 2020;88(6):783–788.
17. Blitzer D, Baran DA, Lirette S, Copeland JG, Copeland H. Does donor treatment with inotropes and/or vasopressors impact post-transplant outcomes? *Clin Transplant*. 2023;37(4):e14912.
18. Shapey IM, Summers A, Yiannoullou P, et al. Donor noradrenaline use is associated with better allograft survival in recipients of pancreas transplantation. *Ann R Coll Surg Engl*. 2024;106(1):19–28.
19. Valapour M, Lehr CJ, Schladt DP, et al. OPTN/SRTR 2022 Annual Data Report: Lung. *Am J Transplant*. 2024;24(2S1):S394–S456.
20. Chaney J, Suzuki Y, Cantu E 3rd, van Berkel V. Lung donor selection criteria. *J Thorac Dis*. 2014;6(8):1032–1038.
21. Chang SH, Kreisel D, Marklin GF, et al. Lung focused resuscitation at a specialized donor care facility improves lung procurement rates. *Ann Thorac Surg*. 2018;105(5):1531–1536.
22. Mal H, Santin G, Cantrelle C, et al. Effect of lung-protective ventilation in organ donors on lung procurement and recipient survival. *Am J Respir Crit Care Med*. 2020;202(2):250–258.
23. Mascia L, Pasero D, Slutsky AS, et al. Effect of a lung protective strategy for organ donors on eligibility and availability of lungs for transplantation: a randomized controlled trial. *JAMA*. 2010;304(23):2620–2627.
24. Minambres E, Coll E, Duerto J, et al. Effect of an intensive lung donor-management protocol on lung transplantation outcomes. *J Heart Lung Transplant*. 2014;33(2):178–184.
25. Minambres E, Perez-Villares JM, Chico-Fernandez M, et al. Lung donor treatment protocol in brain dead-donors: a multicenter study. *J Heart Lung Transplant*. 2015;34(6):773–780.
26. Minambres E, Perez-Villares JM, Terceros-Almanza L, et al. An intensive lung donor treatment protocol does not have negative influence on other grafts: a multicentre study. *Eur J Cardiothorac Surg*. 2016;49(6):1719–1724.
27. Swanson EA, Patel MS, Hutchens MP, et al. Critical care and ventilatory management of deceased organ donors impact lung use and recipient graft survival. *Am J Transplant*. 2021;21(12):4003–4011.
28. Hanna K, Seder CW, Weinberger JB, Sills PA, Hagan M, Janczyk RJ. Airway pressure release ventilation and successful lung donation. *Arch Surg*. 2011; 146(3):325–328.
29. Marklin GF, O'Sullivan C, Dhar R. Ventilation in the prone position improves oxygenation and results in more lungs being transplanted from organ donors with hypoxemia and atelectasis. *J Heart Lung Transplant*. 2021;40(2):120–127.
30. Ball IM, Hornby L, Rochwerg B, et al. Management of the neurologically deceased organ donor: a Canadian clinical practice guideline. *CMAJ*. 2020; 192(14):E361–E369.
31. Guerin C, Reignier J, Richard JC, et al. Prone positioning in severe acute respiratory distress syndrome. *N Engl J Med*. 2013;368(23):2159–2168.
32. Marvin MR, Morton V. Glycemic control and organ transplantation. *J Diabetes Sci Technol*. 2009;3(6):1365–1372.
33. Pennefather SH, Bullock RE, Mantle D, Dark JH. Use of low dose arginine vasopressin to support brain-dead organ donors. *Transplantation*. 1995; 59(1):58–62.

34. Plurad DS, Bricker S, Neville A, Bongard F, Putnam B. Arginine vasopressin significantly increases the rate of successful organ procurement in potential donors. *Am J Surg* 2012;204(6):856–60; discussion 860–1.
35. Joseph B, Aziz H, Pandit V, et al. Levothyroxine therapy before brain death declaration increases the number of solid organ donations. *J Trauma Acute Care Surg*. 2014;76(5):1301–1305.
36. Novitzky D, Mi Z, Collins JF, Cooper DK. Increased procurement of thoracic donor organs after thyroid hormone therapy. *Semin Thorac Cardiovasc Surg*. 2015;27(2):123–132.
37. Novitzky D, Mi Z, Sun Q, Collins JF, Cooper DK. Thyroid hormone therapy in the management of 63,593 brain-dead organ donors: a retrospective analysis. *Transplantation*. 2014;98(10):1119–1127.
38. Salim A, Martin M, Brown C, et al. Using thyroid hormone in brain-dead donors to maximize the number of organs available for transplantation. *Clin Transplant*. 2007;21(3):405–409.
39. Swanson EA, Adams T, Patel MS, et al. Impact of deceased donor management on donor heart use and recipient graft survival. *J Am Coll Surg*. 2020; 231(3):351–360.e5.
40. Macdonald PS, Aneman A, Bhonagiri D, et al. A systematic review and meta-analysis of clinical trials of thyroid hormone administration to brain dead potential organ donors. *Crit Care Med*. 2012;40(5):1635–1644.
41. Dhar R, Marklin GF, Klinkenberg WD, et al. Intravenous levothyroxine for unstable brain-dead heart donors. *N Engl J Med*. 2023;389(22):2029–2038.
42. Dimopoulou I, Tsagarakis S, Anthi A, et al. High prevalence of decreased cortisol reserve in brain-dead potential organ donors. *Crit Care Med*. 2003; 31(4):1113–1117.
43. Dupuis S, Amiel JA, Desgroseilliers M, et al. Corticosteroids in the management of brain-dead potential organ donors: a systematic review. *Br J Anaesth*. 2014;113(3):346–359.
44. Kotsch K, Ulrich F, Reutzel-Selke A, et al. Methylprednisolone therapy in deceased donors reduces inflammation in the donor liver and improves outcome after liver transplantation: a prospective randomized controlled trial. *Ann Surg*. 2008;248(6):1042–1050.
45. D'Aragon F, Belley-Cote E, Agarwal A, et al. Effect of corticosteroid administration on neurologically deceased organ donors and transplant recipients: a systematic review and meta-analysis. *BMJ Open*. 2017;7(6):e014436.
46. Pinsard M, Ragot S, Mertes PM, et al. Interest of low-dose hydrocortisone therapy during brain-dead organ donor resuscitation: the CORTICOME study. *Crit Care*. 2014;18(4):R158.
47. Sally MB, Ewing T, Crutchfield M, et al. Determining optimal threshold for glucose control in organ donors after neurologic determination of death: a united network for organ sharing region 5 donor management goals workgroup prospective analysis. *J Trauma Acute Care Surg* 2014;76(1): 62–8; discussion 68–9.
48. Hebert PC, Carson JL. Transfusion threshold of 7 g per deciliter–the new normal. *N Engl J Med*. 2014;371(15):1459–1461.
49. Coberly EA, Booth GS. Ten-year retrospective review of transfusion practices in beating-heart organ donors. *Transfusion*. 2016;56(2):339–343.
50. de la Cruz JS, Sally MB, Zatarain JR, et al. The impact of blood transfusions in deceased organ donors on the outcomes of 1,884 renal grafts from united network for organ sharing region 5. *J Trauma Acute Care Surg*. 2015;79(4 Suppl 2):S164–S170.
51. Said SA, Okamoto T, Nowacki AS, et al. The effect of blood transfusion in lung donors on recipient survival. *Ann Thorac Surg*. 2021;112(4): 1109–1117.
52. Borders CF, Suzuki Y, Lasky J, et al. Massive donor transfusion potentially increases recipient mortality after lung transplantation. *J Thorac Cardiovasc Surg*. 2017;153(5):1197–1203.e2.
53. Lisman T, Leuvenink HG, Porte RJ, Ploeg RJ. Activation of hemostasis in brain dead organ donors: an observational study. *J Thromb Haemost*. 2011;9(10):1959–1965.
54. Valdivia M, Chamorro C, Romera MA, Balandin B, Perez M. Effect of posttraumatic donor's disseminated intravascular coagulation in intrathoracic organ donation and transplantation. *Transplant Proc*. 2007;39(7):2427–2428.
55. Hefty TR, Cotterell LW, Fraser SC, Goodnight SH, Hatch TR. Disseminated intravascular coagulation in cadaveric organ donors. Incidence and effect on renal transplantation. *Transplantation*. 1993;55(2):442–443.
56. Garrouste C, Baudenon J, Gatault P, et al. No impact of disseminated intravascular coagulation in kidney donors on long-term kidney transplantation outcome: a multicenter propensity-matched study. *Am J Transplant*. 2019; 19(2):448–456.
57. Dictus C, Vienenkoetter B, Esmaeilzadeh M, Unterberg A, Ahmadi R. Critical care management of potential organ donors: our current standard. *Clin Transplant*. 2009;23(Suppl 21):2–9.
58. Ison MG, Nalesnik MA. An update on donor-derived disease transmission in organ transplantation. *Am J Transplant*. 2011;11(6):1123–1130.
59. Ison MG, Hager J, Blumberg E, et al. Donor-derived disease transmission events in the United States: data reviewed by the OPTN/UNOS disease transmission advisory committee. *Am J Transplant*. 2009;9(8):1929–1935.
60. Wolfe CR, Ison MG, AST Infectious Diseases Community of Practice. Donor-derived infections: guidelines from the American Society of Transplantation infectious diseases Community of Practice. *Clin Transplant*. 2019;33(9):e13547.
61. Fishman JA, Greenwald MA, Grossi PA. Transmission of infection with human allografts: essential considerations in donor screening. *Clin Infect Dis*. 2012;55(5):720–727.
62. Seem DL, Lee I, Umscheid CA, Kuehnert MJ, United States Public Health Service. PHS guideline for reducing human immunodeficiency virus, hepatitis B virus, and hepatitis C virus transmission through organ transplantation. *Public Health Rep*. 2013;128(4):247–343.
63. OPTN Policies. Updated October 31, 2024. Accessed November 3, 2024. https://optn.transplant.hrsa.gov/media/eavh5bf3/optn_policies.pdf.
64. Lumbreras C, Sanz F, Gonzalez A, et al. Clinical significance of donor-unrecognized bacteremia in the outcome of solid-organ transplant recipients. *Clin Infect Dis*. 2001;33(5):722–726.
65. Paredes D, Gambra MP, Cervera C, et al. Characterization of the organ donor with bacteremia. *Transplant Proc*. 2007;39(7):2083–2085.
66. Cerutti E, Stratta C, Romagnoli R, et al. Bacterial- and fungal-positive cultures in organ donors: clinical impact in liver transplantation. *Liver Transpl*. 2006;12(8):1253–1259.
67. Singh N. Impact of donor bacteremia on outcome in organ transplant recipients. *Liver Transpl*. 2002;8(10):975–976.
68. Lopez-Navidad A, Domingo P, Caballero F, Gonzalez C, Santiago C. Successful transplantation of organs retrieved from donors with bacterial meningitis. *Transplantation*. 1997;64(2):365–368.
69. Paig i JM, Lopez-Navidad A, Lloveras J, et al. Organ donors with adequately treated bacterial meningitis may be suitable for successful transplantation. *Transplant Proc*. 2000;32(1):75–77.
70. Satoi S, Bramhall SR, Solomon M, et al. The use of liver grafts from donors with bacterial meningitis. *Transplantation*. 2001;72(6):1108–1113.
71. Bahrami T, Vohra HA, Shaikhrezai K, et al. Intrathoracic organ transplantation from donors with meningitis: a single-center 20-year experience. *Ann Thorac Surg*. 2008;86(5):1554–1556.
72. Boyarsky BJ, Durand CM, Palella FJ Jr., Segev DL. Challenges and clinical decision-making in HIV-to-HIV transplantation: insights from the HIV literature. *Am J Transplant*. 2015;15(8):2023–2030.
73. Doby BL, Tobian AAR, Segev DL, Durand CM. Moving from the HIV organ policy equity act to HIV organ policy equity in action: changing practice and challenging stigma. *Curr Opin Organ Transplant*. 2018;23(2):271–278.
74. Hope Act. Accessed September 8, 2024. https://optn.transplant.hrsa.gov/professionals/by-topic/hope-act/
75. Weinfurtner K, Reddy KR. Hepatitis C viraemic organs in solid organ transplantation. *J Hepatol*. 2021;74(3):716–733.
76. Bekki Y, Crismale JF, Myers B, Schiano TD, Florman S. Varying utilization rates but superior outcomes in liver transplantation from hepatitis C-positive donors in the United States: an analysis of the OPTN/UNOS database. *Transplantation*. 2022;106(9):1787–1798.
77. Kwon JH, Hill MA, Patel R, et al. Outcomes of over 1000 heart transplants using hepatitis C-positive donors in the modern era. *Ann Thorac Surg*. 2023; 115(2):493–500.
78. Ruck JM, Zeiser LB, Zhou AL, et al. Trends in use and three-year outcomes of hepatitis C virus-viremic donor lung transplants for hepatitis C virus-seronegative recipients. *J Thorac Cardiovasc Surg*. 2023;165(4):1587–1595.e2.
79. Aleyadeh W, Verna EC, Elbeshbeshy H, et al. Outcomes of early vs late treatment initiation in solid organ transplantation from hepatitis C virus nucleic acid test-positive donors to hepatitis C virus-uninfected recipients: results from the HCV-TARGET study. *Am J Transplant*. 2024;24(3):468–478.
80. Te H, Doucette K. Viral hepatitis: guidelines by the American Society of Transplantation Infectious Disease Community of Practice. *Clin Transplant*. 2019;33(9):e13514.
81. Mone T, Danovitch G. US organ procurement organization donation principles, laws, and practices. *Am J Kidney Dis*. 2020;76(5):735–738.