Author has nothing to disclose with regard to commercial support.

PATIENTS WHO ARE DEAD BY NEUROLOGIC CRITERIA (BRAIN DEAD) ARE NOT HOMOGENEOUS

To the Editor:

I read with great interest the article by Jawitz and colleagues¹ regarding survival of hearts transplanted after death by neurologic criteria (brain death). One perhaps key factor was not included in the analysis. Patients who irreversibly lose neurologic function are not pathophysiological homogeneous. Although these patients all arrive at a state of irreversible loss of function, they do not take the same path to that outcome. Perhaps the classic case is that of a patient with a supratentorial mass, such as a hematoma, who has increased intracranial pressure, transtentorial hemorrhage, and resulting brain stem compromise. Other patients have the reverse, with primary brain stem pathology, such as a tumor or a hemorrhage, causing loss of function as a result of direct brain stem damage, with or without hydrocephalus and the resulting increase in intracranial pressure. Another set of patients could have diffuse neuronal but not glial damage as a result of hypoxia or poisoning of some type. In these patients, the loss of neurologic function is due to direct neuronal cell loss, and there may not be a significant elevation in intracranial pressure. It would not be surprising if each of these pathophysiologies results in varied amounts of sympathetic storm and resulting cardiac dysfunction. Furthermore, experimental models show that the velocity of changes in intracranial pressure is predictive of the amount of sympathetic storm.² To obtain as data that are as useful as possible, I suggest that future studies take into account the path to loss of neurologic function and also the rate of changes of intracranial pressure.

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REPLY: WORTH THE WAIT

Reply to the Editor:

In a recent study in *The Journal of Thoracic and Cardiovascular Surgery*, Jawitz and colleagues reported that survival after heart transplantation is not affected by the duration of donor brain death.¹ We commented in our editorial commentary that this supported allowing donor hearts more time to recover from any cardiac dysfunction they might have had, with the ultimate goal being to expand the pool of suitable donor hearts.² In this issue, in a letter to the editor, Stadlan makes the valid point that brain-dead organ donors are not pathophysiologically homogenous, and therefore the paths leading to brain death are different.³ The suggestion is that this might also lead to different degrees of sympathetic storm and resultant cardiac dysfunction.

Numerous studies have validated the observation that patients who become brain dead are commonly subjected to cardiac dysfunction. Up to 90% of these patients have some electrocardiogram abnormalities, whereas 17% to 39% have some enzymatic leak, and approximately 14% to 18% have severe left ventricular dysfunction.⁴ Several mechanisms for cardiac dysfunction after brain death have been proposed, the most prominent of which is a catecholamine or sympathetic storm. A catecholamine surge after brain death has been well documented, and is implicated in the myocardial necrosis, coronary spasms, myofibrillar degeneration, and oxygen-derived free radical generation that can be seen in these hearts.⁴ However, cardiac dysfunction after neurological insult resolves with normalization of catecholamine levels.⁵

Regardless of the mechanism of brain death, what is most relevant regarding the suitability of the heart for donation is its ultimate function at the time of procurement. If, as shown by the article by Jawitz and colleagues, waiting longer before heart donation does not negatively affect

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Dr Mokadam is a consultant and investigator for Abbott, Medtronic, and SynCardia. Dr Lee has nothing to disclose with regard to commercial support.

post-transplant outcomes, then, whenever feasible, it is worth giving the donor heart time to recover from any post brain death-associated cardiac dysfunction, regardless of etiology.^{1,2} Although differences in the progression and recovery of cardiac dysfunction one might see with different etiologies of brain death would be interesting to study, in the end, this might all be just academic. Although the path to dysfunction might very well differ among brain-dead donors, given enough time, many do go down a final common path to recovery. Therefore, let's be patient and let the heart recover. It's well worth the wait.

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**REPLY FROM THE
AUTHORS: WE DO NOT
KNOW WHAT WE DO
NOT KNOW—
MECHANISM OF
DONOR BRAIN DEATH
AND TRANSPLANT**

RECIPIENT OUTCOMES

Reply to the Editor:

We thank Dr Stadlan¹ for his interest in our work and for sharing his expertise regarding the complex physiologic process of brain death. We acknowledge that brain death is a heterogeneous phenomenon,

TABLE 1. Distribution of documented donor causes and mechanism of deaths

	No. (%)
Donor cause of death	
Head trauma	12,235 (53.3)
Anoxia	5440 (23.7)
CVA/stroke	4626 (20.1)
Other	516 (2.2)
CNS tumor	143 (0.6)
Donor mechanism of death	
Blunt injury	7486 (32.6)
Intracerebral hemorrhage/stroke	5067 (22.1)
Gunshot wound	4371 (19.0)
Drug intoxication	2100 (9.1)
Cardiovascular	1569 (6.8)
Asphyxiation	1032 (4.5)
Other	529 (2.3)
Natural causes	379 (1.7)
Seizure	218 (0.9)
Drowning	130 (0.6)
Stab	62 (0.3)
Electrical	17 (0.1)

CVA, Cerebrovascular accident; CNS, central nervous system.

attributable to varying neurologic pathologies with differential systemic consequences, including autonomic storm and cardiovascular dysfunction. Although there is evidence to suggest an association between the mechanism of brain death and the degree of subsequent myocardial dysfunction, the literature is limited because most animal models use subdural balloon expansion to cause brain death by increasing intracerebral pressure, and because there is a lack of observational studies examining differential systemic effects of various pathologic etiologies of brain death.²⁻⁵

In our cohort (Table 1), the most common documented causes of brain death included head trauma (53.3%), followed by anoxia (23.7%) and stroke (20.1%). The most common documented mechanisms of brain death included blunt injury (32.6%) intracerebral hemorrhage or stroke (22.1%), and gunshot wound (19.0%). Unfortunately, the United Network for Organ Sharing Registry is limited by lack of documentation pertaining to donor intracerebral pressure, neuropathology including imaging findings suggestive of intracerebral hemorrhage versus diffuse axonal injury, and the timing of the inciting event in relation to the eventual declaration of brain death. As such, a more granular analysis of brain death pathophysiology and intracerebral pressure trajectory is not currently possible with the aforementioned data set. We agree that the inability to examine these data more closely may have introduced variability into our study and that future analyses would be strengthened by taking this into account.