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# Early declaration of death by neurologic criteria results in greater organ donor potential



Shelby Resnick, MD, Mark J. Seamon, MD, Daniel Holena, MD,  
Jose Pascual, MD, PhD, Patrick M. Reilly, MD, and Niels D. Martin, MD\*

Division of Traumatology, Surgical Critical Care and Emergency Surgery, Department of Surgery, Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania

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### ABSTRACT

**Background:** Aggressive management of patients prior to and after determination of death by neurologic criteria (DNC) is necessary to optimize organ recovery, transplantation, and increase the number of organs transplanted per donor (OTPD). The effects of time management are understudied but potentially pivotal component. The objective of this study was to analyze specific time points (time to DNC, time to procurement) and the time intervals between them to better characterize the optimal timeline of organ donation.

**Methods:** Using data over a 5-year time period (2011-2015) from the largest US OPO, all patients with catastrophic brain injury and donated transplantable organs were retrospectively reviewed. Active smokers were excluded. Maximum donor potential was seven organs (heart, lungs [2], kidneys [2], liver, and pancreas). Time from admission to declaration of DNC and donation was calculated. Mean time points stratified by specific organ procurement rates and overall OTPD were compared using unpaired t-test.

**Results:** Of 1719 Declaration of Death by Neurologic Criteria organ donors, 381 were secondary to head trauma. Smokers and organs recovered but not transplanted were excluded leaving 297 patients. Males comprised 78.8%, the mean age was 36.0 ( $\pm 16.8$ ) years, and 87.6% were treated at a trauma center. Higher donor potential ( $>4$  OTPD) was associated with shorter average times from admission to brain death; 66.6 versus 82.2 hours,  $P = 0.04$ . Lung donors were also associated with shorter average times from admission to brain death; 61.6 versus 83.6 hours,  $P = 0.004$ . The time interval from DNC to donation varied minimally among groups and did not affect donation rates.

**Conclusions:** A shorter time interval between admission and declaration of DNC was associated with increased OTPD, especially lungs. Further research to identify what role timing plays in the management of the potential organ donor and how that relates to donor management goals is needed.

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\* Corresponding author. University of Pennsylvania School of Medicine, 51 North 39th st., MOB, Suite 120, Philadelphia, PA 19104. Admin: (215) 662-7323. Tel.: +(215) 662 7320; fax: +(215) 243 4679.

E-mail address: [niels.martin@uphs.upenn.edu](mailto:niels.martin@uphs.upenn.edu) (N.D. Martin).

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## Introduction

Expanding the donor pool and increasing the number of transplantable organs is essential to counter the growing list of transplant candidates. A major target in increasing the donor pool is the critical care management of the patient who progresses to death by neurologic criteria (DNC). Donor management goals (DMGs) and catastrophic brain injury guidelines (CBIGs) have been developed to optimize the potential organ donor to increase the number of organs transplanted per donor (OTPD).<sup>1-4</sup> Studies have shown that a higher compliance with DMGs and CBIGs results in a higher number of OTPD.<sup>5-10</sup>

An area not commonly addressed or included in CBIGs, when considering the management of a DNC donor, is the optimal timing of organ procurement. At time of DNC, a systemic change occurs affecting all organ systems, including cardiovascular, pulmonary, and endocrine.<sup>11</sup> As a result, cardiopulmonary death can occur prior to procurement resulting in a reported loss of 25% of potential donors.<sup>12</sup> Therefore, prevailing logic has been that organ procurement should occur as closely to DNC as possible to avoid complications related to these systemic changes.

However, emerging literature has put this dogma into question, with evidence to suggest that instituting a period of organ optimization prior to procurement may increase OTPD.<sup>13-16</sup> Malinoski *et al.* showed that although few patients met DMGs at the time of consent for donation, a higher number were met at time of procurement, which led to an increased number of OTPD.<sup>17</sup>

The purpose of this study was to study the effect of time on organ donation to better characterize an optimal timeline for organ donation. Our aim was to determine whether procurement should be delayed to allow time to meet more DMGs or if prolongation would place undue risk to the potential organs for donation with an increased risk of somatic death occurring prior to procurement, resulting in a loss of donor potential. We hypothesized that potential donors would benefit from a longer time interval from injury to procurement, allowing for critical care management and optimization of transplantable organs.

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## Methods

Institutional review board approval was obtained for this study. This was a retrospective review using the Gift of Life (GOL) database. GOL is one of the largest organ procurement organizations (OPO) in the nation. A nonprofit organization, it serves the eastern half of Pennsylvania, southern New Jersey, and Delaware. GOL has a recovery facility, but it was not used clinically during the study period; all organs were recovered at the treating acute care hospital. Within the GOL catchment area, there are 15 transplant centers.

Data were reviewed for all nonsmoking adult organ donors from 2011-2015, who suffered head trauma that progressed to DNC. Seven organs were considered in the data collection: heart, two lungs, two kidneys, liver, and pancreas. Smokers

were actively excluded so as not to bias the data against lung transplantation specifically due to tobacco use. Pediatric donors were excluded as the pathophysiology of their injuries and their donor management physiology were likely very different than that of an adult. We also excluded small bowel transplantation from our study because its use is extremely rare in our OPO. Only one patient donated small bowel during our study period.

In 2015, the Society of Critical Care Medicine, the American College of Chest Physicians, and the Association of Organ Procurement Organizations published recommendations for organ donor management.<sup>2</sup> On the basis of these recommendations, and other prospective studies validating critical care endpoints as DMGs,<sup>6,17</sup> seven DMGs were chosen (vasopressor use  $\leq 1$ , mean arterial blood pressure  $> 60$ , ejection fraction  $> 45\%$ , sodium  $< 155$  mEq/L, glucose  $< 150$  mg/dL, PaO<sub>2</sub>:FiO<sub>2</sub> ratio  $> 300$ , and average urine output (UOP) of 0.05-3 mL/kg/h), in addition to the use of hormonal therapy at any time point (T4, steroids, and insulin), serum creatinine, and ventilator settings at time of procurement, as a measure of donor optimization during their time in intensive care. Additional variables obtained from the GOL database included demographics, treatment facilities, and comorbidities of each potential donor.

Different time points (time of patient admission, declaration of DNC, and procurement) were obtained from the GOL database. These time points were used to calculate time from admission to declaration of DNC (AtoD), time from declaration of DNC to procurement (DtoP), and the overall time from admission to procurement (AtoP).

The Health Resources and Science Administration set the national goal for organ donation to be 3.75 organs transplanted per donor. Therefore, the primary outcome measure was having greater than four organs transplanted per donor. We did not capture data on organs that were recovered but never transplanted.

The study populations were compared based on the number of organs transplanted per donor,  $> 4$  and  $\leq 4$ , and by individual organ. Continuous variables were compared using Student's *t*-test, whereas dichotomous variables were compared using chi-square or Fisher's exact test, as appropriate. Values are reported as mean  $\pm$  standard deviation (SD) for continuous variables and as percentages for categorical variables. All statistical analysis was performed using Statistical Package for Social Sciences (SPSS), version 24.0.

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## Results

Over the 5-year period, 1719 DNC organ donors were identified. Three hundred eighty-one were declared secondary to head trauma. Excluding smokers and patients who had non-transplantable organs recovered, 297 patients remained for analysis. The majority of donors were treated at trauma ( $n = 26$ , 87.9%) and transplant ( $n = 154$ , 51.9%) centers. The average age was  $36.0 \pm 16.9$  years, 79.1% ( $n = 235$ ) were male. When comparing the populations of those who donated greater or less than four organs, the two populations were

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