



Predicting Donor Death: Early Changes in Oxygen Saturation After Withdrawal of Support Predict Successful Donation During Donation After Circulatory Death

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ABSTRACT

Background. We have previously shown that approximately 27% of patients do not progress to death in time to donate organs after attempted donation after circulatory death (DCD). As such, nearly 1000 transplants per year are not possible. One way to convert unsuccessful donations to successful donations is to increase procurement team “stand-down” times; however, increased stand-down times may predispose transplantable organs to increased ischemic damage.

Methods. Hemodynamics for successful and unsuccessful donations, occurring between 2011 and 2014, were characterized to determine if some unsuccessful DCDs could have donated successfully, had procurement teams waited longer.

Results. Analysis of 169 DCDs demonstrated statistically significant differences in hemodynamic profiles after withdrawal of support (WOS) between successful and unsuccessful donations. Early decreases in oxygen saturation were predictive of successful organ donation. We observed that for unsuccessful DCDs, patients who died in more than 2 hours but less than 12 hours were agonal within 10 minutes of WOS, suggesting that increasing stand-down times would result in prohibitive warm ischemia time.

Conclusions. Early changes in oxygen saturation after withdrawal of support predict donor death. Alternative approaches that convert unsuccessful DCDs to successful DCDs but that do not result in low-quality organs should be explored.

DONATION AFTER CIRCULATORY DEATH (DCD) represents the only option for organ donation in patients who are not brain-dead [1–4]. Annually, approximately 15% of donors in the United States donate after circulatory death [5,6]. For DCD protocols, life support is withdrawn in a monitored setting, and, once the donor dies, the organs are rapidly recovered for organ transplantation [1,7]. If hypoxia and hypotension after withdrawal of life support are prolonged, the organs may not be suitable for transplantation [7–9]. As such, maximum “stand-down” times have been established, beyond which organs are deemed unusable and recovery teams abort the procurement. Stand-down times vary by center. In general, maximum stand-down times of 30 minutes to 2 hours are considered acceptable, depending on the organ [5,10].

Hypoxia and hypotension, rather than time alone after withdrawal of life support, probably are major contributing

factors toward donor organ ischemia and damage. Accordingly, recovery teams have attempted to estimate the severity of these hemodynamic perturbations by defining the “agonal time,” or the point beyond which organ function may become compromised. Typically, this is defined by a systolic blood pressure <80 mm Hg and oxygen saturation <80% [5,10]. There is no nation-wide standard for the acceptable agonal times or stand-down times, and therefore these times vary from institution to institution. Regardless of whether or not a transplant center utilizes the time of donor extubation to death or the agonal time to death, the question of how long the recovery team should

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wait for the recovery of DCD organs remains unanswered. A better understanding of risk factors leading to ischemic damage of transplantable organs would help surgeons determine how long to wait for a donor to die after withdrawal of support.

We recently reported [6] that our rate of donation after circulatory death as a proportion of deceased donors was 33% [6]. In general, our center will wait up to 2 hours after the withdrawal of life support for the procurement of kidneys and up to 30 minutes for pancreas, liver, and lungs. In our experience, 27% of donations after circulatory death were unsuccessful. That is, these patients did not die in time for any organs to be recovered for transplantation [6]. Here, we addressed the hemodynamics of successful and unsuccessful donors to determine if we could predict which donors would die quickly after withdrawal of life support.

METHODS

Patients

After obtaining consent from the institutional review board, we undertook a retrospective, single-center study of adult organ transplant donors who donated organs between 2011 and 2014 [6]. The demographics for these patients have been previously published.

Definitions

The time of extubation during the donation after circulatory death process was used as a surrogate for withdrawal of support. Unsuccessful donations are defined by cases in which the patient did not die quickly enough to donate organs. Successful donations are characterized by procedures that yielded at least 1 transplantable organ. Stand-down time refers to the amount of time waited by the recovery team at the donor hospital during an unsuccessful recovery, before aborting the procedure. Time to death refers to the amount of time between extubation and death of the organ donor. The term "agonal" refers to the time, after withdrawal of life support, that a donor's systolic blood pressure drops below 80 mm Hg and/or the oxygen saturation drops below 80% [5]. Twelve hours was chosen as the proposed maximum stand-down time, based on 1) our published experience with DCD donor outcomes, suggesting that 60% of unsuccessful donors died by 12 hours after withdrawal of life support [6], and 2) the assumption that the increase in duration of a DCD procurement would not interfere the logistics of performing a subsequent donor recovery. In the interpretation of our organ procurement directors, surgical staff, and procurement coordinators extending stand-down times by less than 12 hours probably would not yield enough organs to warrant waiting, and waiting longer than 12 hours probably would be too resource intensive.

Hemodynamic Parameters

Oxygen saturation, systolic blood pressure, and FiO_2 (inspired oxygen at extubation) were all recorded by members of the organ procurement organization.

Groups

Patients were separated into 2 groups on the basis of time to death after withdrawal of life support. Patients who died in 12 hours or less were defined as group 1. Patients who died in >12 hours were

defined as group 2. Twelve hours was chosen as the cutoff, as this was determined to be a reasonable maximum amount of time for a potential organ procurement team to wait for a donor to die.

Donation After Circulatory Death

These protocols have been reviewed previously. Our group considers both agonal time as well as predetermined stand-down times. The stand-down time is determined by the surgeon who is accepting the potential DCD organs.

Analysis

The Student *t* test and *Z* test of proportion were used as necessary to compare continuous and non-continuous data, respectively. Analysis of times to death included only patients with a calculable time to death. These data were available for 40 of 46 patients. Data were missing for these 6 patients because, particularly for rapid-recoveries, not all extubation times were recorded.

RESULTS

Patients

As we have previously reported, between January 2011 and September 2014 through our single-center OPO, 169 donors underwent attempted donation after circulatory death [6]. Of these, 46 attempted donations were unsuccessful and 123 were successful [6].

Analysis of Stand-Down Times Among Unsuccessful Donations

Of 46 unsuccessful donations, 42 patients (91.3%) had calculable stand-down times. For these 42 unsuccessful donations, the recovery team waited a mean time of 1 hour and 43 minutes (range, 24 minutes to 3 hours, 0 minutes) after withdrawal of life support but before ending the attempted donation. Stand-down times for unsuccessful donations were separated into 3 groups (<1 hour, 1–2 hours, and >2 hours) and are presented in Fig 1. In the vast majority of cases ($n = 40, 95.2\%$), stand-down times were

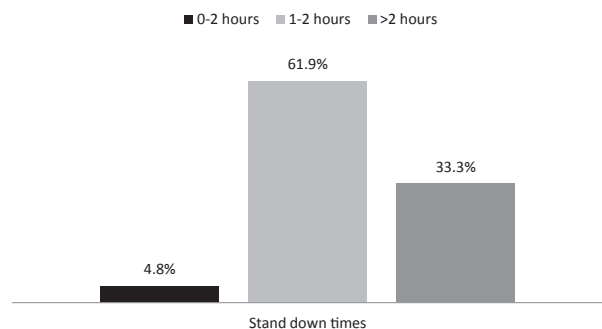


Fig 1. Stand-down times for unsuccessful donations stratified by time. For unsuccessful donations, in 26 of 42 patients (61.9%) the recovery team stood down between 1 and 2 hours after withdrawal of life support, with an average stand-down time of 1 hour, 34 minutes. In 40 of these 42 unsuccessful donations (95.2%), our recovery team waited 1 hour or more before standing down, and, in 14 of 42 unsuccessful donations (33.3%), our recovery team waited 2 hours or more.

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