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Clinical paper

Patterns of organ donation among resuscitated patients at a regional cardiac arrest center☆,☆☆

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ABSTRACT

Introduction: As organ demand outpaces supply in the United States, donation after cardiac death (DCD) is increasing, and the leading cause of death among donors is now cardiovascular/cerebrovascular disease. Selected patients resuscitated from cardiac arrest may be an under-recognized donor pool. Regional cardiac arrest centers are expected to address organ donation, but there are few guidelines available and the yield from this population is not fully known.

Methods: We characterized the progression of resuscitated cardiac arrest patients at a regional cardiac arrest center and transplant center from organ procurement organization (OPO) referral through procurement. We determined characteristics associated with donation, assessed temporal trends in referral and donation, and calculated the yield of organs from this cohort.

Results: Of 991 patients admitted between 2005 and 2011, 560 did not survive to hospital discharge. Of these, 530 (94.6%) were referred to the OPO and 75 (13.4%) had organs procured. Family refusal of otherwise suitable candidates precluded 71 procurements. Age, sex, arrest location, designated donor status, and family consent were associated with donation. The absolute number of admissions, referrals, and donors increased over the study period. The probability of OPO referral did not change, but the probability of donation increased. The overall yield was 1.8 solid organs and 1.3 eyes per donor, with the majority being transplanted.

Conclusions: Post-cardiac arrest patients represent a potential donor pool to help fill the widening gap between organ supply and demand in the United States. Formal multi-modal neurologic assessment may expedite referral to an organ procurement organization. These components should be considered as cardiac arrest center designation criteria.

1. Introduction

With demand outpacing supply, the pattern of organ donation is changing. As the number of donations after cardiac death increased by 20% (33,000–40,000) between 2001 and 2010, the leading cause of death among all donors shifted from head trauma to cardiovascular and cerebrovascular disease. With this shifting pattern away from traditional brain dead donors, there has been a commensurate increase in the organ discard rate from 11.5% to 13.7%, especially in donation after cardiac death.[1]

Cardiac arrest centers are an increasingly recognized regional resource for tertiary post-resuscitation care.[2] Along with capabilities to induce therapeutic hypothermia and perform urgent cardiac catheterization with revascularization, cardiac arrest centers are expected to have protocols addressing organ donation.[3]

Patients resuscitated from cardiac arrest may be an under-recognized donor pool to help fill the widening gap between organ supply and demand. Historically, donors suffering cardiac arrest have had more hemodynamic instability and lower procurement rates.[4,5] However, there is a growing body of literature suggesting that graft function from select donors suffering cardiac arrest may be comparable to those from donors not suffering cardiac arrest.[4,6–8]

Since 2008, we have provided clinical consulting services for resuscitated cardiac arrest patients at our regional cardiac arrest center.[9] Along with coordinating multi-disciplinary care across the spectrum of inpatient care, we utilize a defined multi-modal

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process for neurologic evaluation and prognostication.[10] Life-sustaining treatment is withdrawn in the majority of patients with poor neurologic prognosis approximately one week after resuscitation.[11]

Patients with a poor neurological prognosis are routinely evaluated by the Center for Organ Recovery and Education (CORE), our regional organ procurement organization. Even though cardiac arrest centers are expected to have protocols addressing organ donation, there are no specific guidelines in place, and the yield of organs from this patient cohort is not fully known. In order to promote awareness of this key component of a cardiac arrest center, we aimed to describe the patterns of progression from CORE evaluation through organ disposition, determine the yield of organs from this patient cohort, and assess temporal trends within our institution.

2. Methods

The University of Pittsburgh Committee for Oversight of Research and Clinical Training Involving Decedents (CORID) approved this study.

We performed a retrospective cohort study of resuscitated cardiac arrest patients admitted to an urban, university, tertiary, regional cardiac arrest center between 2005 and 2011, who subsequently expired during the initial hospitalization. We included any initial rhythm and arrest location. We excluded traumatic arrest, or promptly recognized surgical etiology of arrest. We abstracted patient characteristics (age, sex, date of consult, arrest location, initial rhythm, organ donor designation, family consent), CORE process measures, and outcome (donation type, organs procured, yield, disposition) from our internal post-cardiac arrest service (PCAS) database and the CORE database. Patients were matched across databases manually (Reynolds) by name, date of service, and medical record number.

We characterized the progression of patients from initial CORE referral through the evaluation process and final decision to procure. For initial classification purposes, we defined 'organs' broadly to include solid organs, eyes, and tissue. Subsequent analyses distinguish into these three classifications. We then characterized the changes in post-cardiac arrest admissions, organ donors, and yield of organs procured over the six-year study period.

2.1. Data analysis

We used STATA 12.1 (StataCorp, College Station, TX) to analyze the data. After tabulating patient characteristics and process measures, we compared these variables between patients with and without organs procured with a two-sample *t*-test, chi-square, or Fisher's exact test. We then used multiple variable logistic regression to identify patient characteristics associated with organ procurement. We included those candidate variables that had $p < 0.1$ on univariate analysis. We examined temporal trends in absolute numbers of annual post-cardiac arrest admissions, CORE referrals, organ donors, and organs procured. We then used logistic regression to assess temporal trends in the probabilities of CORE referral and organ donation. We calculated the yield of organs procured, stratified by procurement type and disposition.

3. Results

Overall, $n = 991$ resuscitated cardiac arrest patients were admitted between 2005 and 2011. The number of annual admissions increased over time (coefficient 26.2; 95%CI 17.0, 35.4; $p = 0.001$). Of these 991 admitted patients, 560 (56.5%) did not survive to hospital discharge, most (94.6%) non-surviving patients were referred to CORE, and 75 (13.4%) of non-survivors ultimately had organs procured. The progression of non-surviving patients through the CORE evaluation process is presented in Fig. 1. Additionally, family refusal of an otherwise suitable patient resulted in a loss of nearly half (48.6%) of the suitable donor pool. Clinical characteristics for patients that had potential for procurement after initial screening are presented in Table 1.

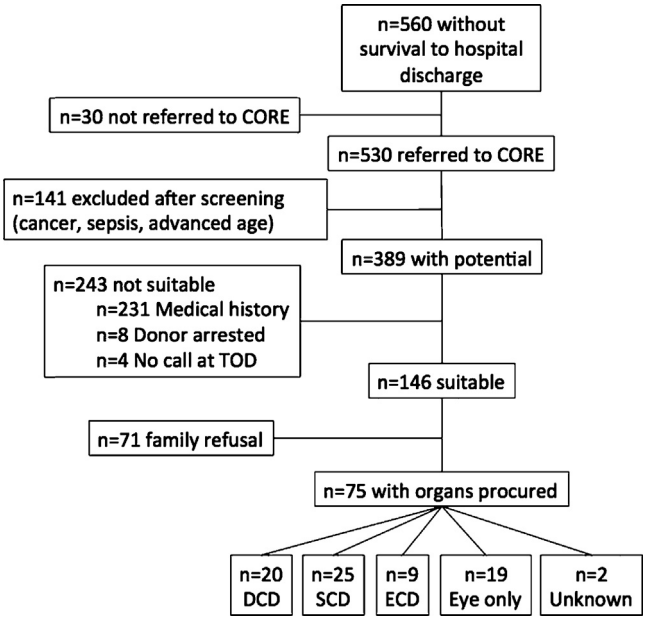

Fig. 1. Flow diagram of the CORE evaluation process. CORE: center for recovery and education. TOD: time of death; DCD: donation after cardiac death; SCD: standard criteria donor; ECD: extended criteria donor.

In unadjusted analysis, age (OR 0.94; 95%CI 0.92, 0.96; $p < 0.001$), male sex (OR 0.54, 95%CI 0.33, 0.90; $p = 0.02$), out-of-hospital cardiac arrest (OR 5.60; 95%CI 2.73, 11.51; $p < 0.001$), and PCAS consult (OR 2.02; 95%CI 1.02, 4.02; $p = 0.04$) were associated with organ procurement. Based on the univariate analysis, we included these same four variables in the multiple variable analysis for organ procurement. We excluded family consent, since its absence perfectly predicted outcome. In the multiple variable model, age (OR 0.94; 95%CI 0.93, 0.96; $p < 0.001$), male sex (OR 0.62; 95%CI 0.35, 1.09; $p = 0.10$), out-of-hospital cardiac arrest (OR 3.96; 95%CI 1.82, 8.58; $p = 0.001$), and PCAS consult (OR 1.34; 95%CI 1.82, 8.58; $p = 0.45$) were associated with organ procurement.

The number of CORE referrals, and organs procured all increased over the seven-year study period (Fig. 2). Additionally, the probability of CORE referral (OR 0.9; 95%CI 0.8, 1.2; $p = 0.57$) did not change, but the probability of organ donation (OR 1.2; 95%CI 1.0, 1.4; $p = 0.02$) increased over the study period in unadjusted analysis. This corresponds with the deployment of a formal consult service to address the multi-disciplinary care needs of this patient population.

Procurement, yield, and disposition or solid organs, eyes, and tissue from $n = 75$ donors are presented in Table 2. Tissue types recovered and tissue disposition were unclear from the database. There was an overall yield of 138 solid organs and 97 eyes, of which the majority were transplanted. Tissue was procured from 38 patients. There was an overall yield (transplantation and education) of 1.8 solid organs per donor and 1.3 eyes per donor. For those transplanted, there was a yield of 1.5 solid organs per donor and 0.9 eyes per donor.

4. Discussion

During the seven-year study period, the vast majority of resuscitated cardiac arrest patients admitted to our tertiary care center