The Alphabet Soup of Kidney Transplantation: SCD, DCD, ECD—Fundamentals for the Practicing Nephrologist

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There is significant variability in the quality of deceased-donor kidneys that are used for transplantation. The quality of the donor kidney has a direct effect on important clinical outcomes such as acute rejection, delayed graft function, and patient and allograft survival. Expanded-criteria donors (ECDs) refer to older kidney donors (≥60 yr) or donors who are aged 50 to 59 yr and have two of the following three features: Hypertension, terminal serum creatinine >1.5 mg/dl, or death from cerebrovascular accident. By definition, ECD kidneys have a 70% greater likelihood of failure compared with one from a 35-yr-old male donor who died from a motor vehicle accident. Donation after cardiac death (DCD) is a small but rapidly growing fraction of donors. An ECD kidney transplant recipient has a projected average added-life-years of 5.1 yr compared with 10 yr for a kidney recipient from a standard-criteria donor. Kidney transplantation from DCD seems to have similar allograft and patient survival compared with kidney from donation after brain death; however DCD transplantation has a 42 to 51% risk for delayed graft function (need for at least one dialysis treatment during the first week after transplantation) compared with 24% in an standard-criteria donor kidney transplant. Familiarity with the comprehensive allocation rules governing different categories of deceased-donor kidneys by the nephrologists and dialysis team providers is essential to maximizing patient autonomy and to improve the outcomes of kidney transplantation.

should be integrated into the process of organ offer and acceptance to buttress patient autonomy and to ensure that the matching of transplant candidates to transplantable organ is optimized.

**Classification of DDs**

The first codified classification of DD kidneys was implemented in October 2002 (8,9). Under this scheme, DD kidneys were classified into two groups: Standard-criteria donor (SCD) and expanded-criteria donor (ECD). This classification was meant to reflect the quality of the organ, and the definition was driven empirically by the risk for graft loss. An ECD kidney has a 70% greater risk for failure compared with an SCD kidney (8). A parallel classification deals with the sequence and mechanisms of cessation of circulatory and respiratory functions (10). The Organ Procurement and Transplantation Network (OPTN) is charged with developing policies and procedures for DD organ procurement, allocation, and distribution in the United States (11). Figures 1 and 2 show the relationship between the two classifications systems. The definitions and corresponding acronyms are provided next.

**Standard-Criteria Donor**

The classic SCD is a 35-yr-old man who has no history of hypertension or diabetes and for whom the cause of death is a motor vehicle accident. In practice, all DDs who do not meet any of the criteria for an ECD and from whom donation occurred after brain death (donation after brain death [DBD]; see the Donation after Brain Death section) are considered as an SCD.

**Expanded-Criteria Donor**

An ECD is one who, at the time of death, is aged ≥60 or aged 50 to 59 yr and has any two the following three criteria: (1) Cause of death is cerebrovascular accident; (2) preexisting history of systemic hypertension; and (3) terminal serum creatinine >1.5 mg/dl. The criteria for the definition of ECD was based on the presence of variables that increased the risk for graft failure by 70% (relative hazard ratio 1.70) compared with an SCD kidney.

**Donation after Brain Death**

DBD describe a donor who had primary brain death in whom cardiac circulation and respiration remain intact or are maintained by medical measures, including mechanical ventilation, drugs, intra-aortic balloon pump, or extracorporeal machine oxygenation device. A DBD could be an ECD or SCD depending on whether the ECD/SCD criteria are separately fulfilled.

**Donation after Cardiac Death**

The donation after cardiac death (DCD) donor refers to the donor who does not meet the criteria for brain death but in whom cardiac standstill or cessation of cardiac function occurred before the organs were procured. The cessation of cardiac function could have occurred spontaneously or been initiated deliberately. The DCD donor was previously referred to as non–heart-beating donor. The DCD categories encompass four subgroups, depending on the circumstances and manner in which cardiac standstill occurred (Maastricht classification), but only two subtypes of DCD are in common usage (controlled DCD and uncontrolled DCD), which are defined next (12).

**Controlled DCD.** The OPTN defines a controlled DCD (cDCD) as “a donor whose life support will be withdrawn and whose family has given written consent for organ donation in the controlled environment of the operating room.” The cDCD describes a situation in which the donor’s hemodynamic stability and respiratory function were maintained until the decedent is extubated in a controlled environment of the operating room or in the intensive care unit.

**Uncontrolled DCD.** The OPTN defines uncontrolled DCD (uDCD) as “a candidate who expires in the emergency room or elsewhere in the hospital before consent for organ donation is obtained and catheters are placed in the femoral vessels and peritoneum to cool organs until consent can be obtained. Also, an uncontrolled Donation after Cardiac Death donor is a candidate who is consented for organ donation but suffers a cardiac arrest requiring CPR during procurement of the organs.”

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**Figure 1.** Categories of deceased kidney donors.

**Figure 2.** Categories within the deceased kidney donor pool: SCD, ECD, and DCD.
Clinical Outcomes of Kidney Transplant with Different Categories of DDs

Inherent to the definition of an ECD kidney is a 70% increased risk for graft failure compared with an SCD kidney (8). Nonetheless, diminished allograft survival does not suggest lack of therapeutic benefits. Although most studies of ECD kidney transplantation confirm lower allograft survival rates, recipients of ECD kidneys generally have improved survival compared with matched dialysis-treated patients (13–15). The improved recipient survival (relative to the dialysis-treated patient) is not uniform for all patient groups. On the basis of data from the US Scientific Registry of Transplant Recipients (SRTR), Merion et al. (16) found that long-term mortality among ECD kidney transplant recipients was 17% lower compared with recipients who did not accept an ECD kidney offer. The survival benefit was apparent only at 3.5 yr after transplantation and was further confined to recipients who were older than 40 yr, were non-Hispanic, did not have diabetes, and were awaiting kidney transplantation in an Organ Procurement Organization service area in which the average waiting time for a kidney was >1350 d (>45 calendar months). Also using US national transplant data (SRTR), Miles et al. (14) found that repeat kidney transplantation candidates who received an SCD kidney had better survival than comparable dialysis-treated patients but had no advantage in survival had they received an ECD kidney for the retransplantation. A useful statistic that can be given to transplant candidates is that the projected average added-life-years after an SCD kidney transplantation is 10 yr compared with 5.1 yr for an ECD kidney transplantation (17,18). ECD kidney transplantation is associated with a significantly increased risk for delayed graft function (need for dialysis treatment during the first week after transplantation) (17,18).

For the DCD kidney, the appropriate comparison is not with ECD but with DBD (see Figure 1). Analysis of clinical outcomes from the US national data by Gagandeep et al. (19) showed that both the allograft and the recipient survival are similar between DCD and DBD (Table 1, Figure 3), but the risk for delayed graft function was 42 to 51% in DCD compared with 24% in DBD kidney transplant recipients. Similarly, Doshi and Hunsicker (13) found no significant difference in the 5-yr patient (DCD versus DBD 81.3 versus 81.8%; \( P = 0.70 \)) and allograft survival (DCD versus DBD 66.9 versus 66.5%; \( P = 0.52 \)) when comparing DCD with DBD kidney transplantation, but there was a significantly higher risk for delayed graft function with DCD kidney transplantation (DCD versus DBD 41 versus 24%; \( P < 0.001 \)). There seems to be no difference in the risk for acute rejection episodes between DBD and DCD kidney transplantation (21). Outcomes of DCD-ECD kidneys, however, are generally poor.

Allocation Process for ECD and DCD Kidneys

ECD kidneys are allocated to patients on the kidney transplant waiting list in accordance with the allocation policy (United Network for Organ Sharing Policy 3.5 Allocation of Cadaveric Kidneys) put in place by the OPTN in October 2002, which states, “Kidneys procured from the ECD will be allocated to patients determined to be suitable candidates: First, for zero antigen mismatched patients among this group of patients with time limitations; and next, for all other eligible patients locally, regionally, and nationally, based on time waiting and not the HLA matching” (21). There are several common misconceptions about the ECD allocations policy. First, opting to receive an ECD kidney does not put the transplant candidate on the transplant waiting list in accordance with the allocation policy.

Table 1. Clinical outcomes of kidney transplantation performed with the different categories of DD organ (13,19,23,24)

<table>
<thead>
<tr>
<th>Clinical Outcome Variable</th>
<th>SCD (%)</th>
<th>ECD (%)</th>
<th>DBD (%)</th>
<th>DCD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute rejection episode</td>
<td>14&lt;sup&gt;a&lt;/sup&gt;</td>
<td>15&lt;sup&gt;a&lt;/sup&gt;</td>
<td>37&lt;sup&gt;b&lt;/sup&gt;</td>
<td>38&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Delayed graft function</td>
<td>21</td>
<td>11</td>
<td>24</td>
<td>41</td>
</tr>
<tr>
<td>1-yr graft survival</td>
<td>90</td>
<td>82</td>
<td>91</td>
<td>89</td>
</tr>
<tr>
<td>5-yr graft survival</td>
<td>65</td>
<td>49</td>
<td>67</td>
<td>67</td>
</tr>
<tr>
<td>1-yr patient survival</td>
<td>95</td>
<td>91</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>5-yr patient survival</td>
<td>82</td>
<td>70</td>
<td>82</td>
<td>81</td>
</tr>
</tbody>
</table>

<sup>a</sup>Acute rejection episode rate at 1 yr after transplantation based on data from Stratta et al. (24).

<sup>b</sup>Acute rejection rate at 2 yr after transplantation based on data from Schadde et al. (23).

a separate waiting list, as is commonly misconstrued. There is no separate waiting list for ECD kidneys. When a patient expresses an interest in an ECD kidney, this willingness is recorded as an option so that when an ECD kidney becomes available, only patients who have expressed a recorded interest will be considered and included in the “match run.” The match run is a computerized nationwide algorithm that is driven by specified allocation rules and is used to allocate all DD organs. The allocation rules or algorithm is not affected by the ECD option. Whether a patient opts for an ECD does not affect his or her status or probability of receiving an SCD kidney. The ECD option is open to all waiting list registrants. Second, a patient on the waiting list may change his or her desire to be considered for an ECD kidney at any time and may choose not to accept one particular ECD kidney when offered without jeopardizing his or her status on the waiting list or the chances of being offered another ECD kidney. Third, an ECD kidney is awarded only on the basis of the numbers of points accrued as a result of the time that the candidate has spent on the waiting list or since initiation of dialysis when applicable. This means that allocation points accrued for HLA DR match, panel-reactive antibody levels, and other factors in the SCD allocation process do not count toward the ranking for an ECD kidney offer. Although several allocation policies deal with DCD, these policies do not have a direct implication on the candidate’s decision to accept a DCD kidney. The option of accepting a DCD kidney is not recorded at the time of waiting list registration, and such kidneys are not reserved for any particular group of candidates. Providers generally discuss the DCD status with the transplant candidates at the time the offer is made. Figure 4 shows the graft survival rates for different types of kidney transplantation.

Living-Donor Kidney Transplantation

The shortage of organs has led to a more expansive use of live donors in kidney transplantation beyond biologic relatives and spouses. Individuals can now donate to an anonymous recipient, and transplant candidates can exchange their live kidney donor with another candidate when there is biologic incompatibility between the donor candidate and the originally intended recipients. The different categories of live kidney donors that are commonly recognized today are described next.

Related Donor. The donor and the recipient have a biologic relationship (e.g., siblings and parents).

Unrelated Donor. The live kidney donor is not biologically related to the donor, although an enduring emotional relationship exists between the donor and the recipient. Donation between casual acquaintances is now included in this category (e.g., school mate, co-workers, religious congregants).

Directed Anonymous Donor. The live kidney donor has no previous relationship with the recipient. A donor who learns of someone in need of a kidney transplant through the web, television, or other forum and then volunteers to donate a kidney would be considered as an anonymous donor who is directing the donation to a particular person.

Undirected Anonymous Donor. An undirected anonymous donor is a live donor who offers to donate a kidney to the waiting list. The kidney is transplanted into the person who is at the top of the list and who would have received the next appropriate DD kidney. This form of donation has the effect of shortening the waiting time for everybody on the list by one date (from the related or unrelated categories) enters into a scheme in which the donor is exchanged with another donor–recipient candidate pair so as to achieve donor–recipient biologic compatibility of the ABO blood group system and/or negative cross-match reactivity.

Multiple Paired Exchanged Donor. This is paired exchange donation as described in the preceding section and involves more than two donor–recipient candidate pairs. Multiple paired exchanges involving paired exchange registries in different states has been recently described (22).

Conclusions

The range of organ donors for kidney transplantation has expanded rapidly. There are now several categories of donors with varied and wide-ranging implications for the clinical outcomes of kidney transplantation. Potential kidney transplant recipients and their providers need to be well informed about the choices of available DDs and living donors. Both allograft and recipient survivals are shortened when ECD kidneys are used for transplantation. Even though ECD kidney transplantation is superior to dialysis therapy, the inferior outcomes relative to SCD kidneys should be weighed when patients consider accepting ECD organs. Survival with a DCD kidney seems to be similar to DBD kidneys, but the excess risk of delayed graft function and its consequences need to be appreciated by the patient and other decision makers. Nephrologists and dialysis team providers are central to the long-term care of kidney transplant candidates and should be fully engaged in the process by which their patients are offered DD kidneys.

Disclosures

None.
References


