Donor Selection and Management of the High-Risk Donor

Jonathan M. Chen, MD
and Niloo M. Edwards, MD

CONTENTS

INTRODUCTION
IDENTIFYING THE CARDIAC DONOR
DONOR ASSESSMENT
DONOR SELECTION: STANDARD CARDIAC PARAMETERS
DONOR SELECTION: OTHER STANDARD PARAMETERS
STRATEGIES TO BROADEN DONOR AVAILABILITY
CONCLUSION
REFERENCES

INTRODUCTION

In light of increasing organ demand in a stable supply setting, prompt and efficacious potential cardiac donor management is of paramount importance. Since the early description of the “ideal” donor by Griepp and associates in 1971 (1), the criteria by which donors are accepted—and the characteristics that determine a “high-risk” donor—have changed substantially (see Tables 1 and 2). Indeed, the growing acceptance of donor organs that meet so-called “extended” criteria for transplantation has further emphasized the importance of aggressive donor management by experienced individuals whose interventions can transform otherwise unusable donors into ones of low or intermediate risk.
Table 1
Griepp’s Historical Criteria Describing the Ideal Cardiac Donor (1)

**Historical donor criteria**
- Age < 30 yr
- No significant medical problems
- No substance abuse
- Ischemic time < 2 h
- No evidence of infection

Table 2
Examples of Some Extended Donor Criteria

**Extended donor criteria**
- Age 60+ yr
- Significant echocardiographic abnormalities
- Ischemic time 7 h
- Donor/Recipient size mismatch up to 70%
- (+) Blood/Urine/Sputum cultures
- (+) Hepatitis B and/or hepatitis C
- Significant pressor/inotrope requirements
- Donor substance abuse
- Longstanding diabetes mellitus

This chapter’s purpose is to review the basic practical donor management principles and to address other strategies for extending basic donor criteria to include so-called “high-risk” donors. The donor management algorithm used at Columbia–Presbyterian is reviewed as are the current recommendations of the American College of Cardiology, the United Network for Organ Sharing, and a recent consensus panel on donor use.

Ultimately, however, it must be remembered that the donor “risk” question represents a larger intellectual balance of both donor and recipient risk characteristics. Thus, the number of and extent to which donor criteria are waived (“extended”) in a given circumstance often more closely represents the acuity of the recipient’s condition than the actual donor utility (or risk).

**IDENTIFYING THE CARDIAC DONOR**

Naturally, the ideal cardiac donor is of an “appropriate” age and has suffered a catastrophic enough cerebral event to be declared brain dead, but has otherwise exhibited stable hemodynamics (and excellent cardiac
function) during their hospitalization. One pursues donors whose clinical progress is notable for an absence of “major” exclusion criteria: (a) significant penetrating cardiac trauma, (b) known cardiac disease, (c) prolonged cardiac arrest (greater than 15 min) with associated chest compressions or intracardiac injections, (d) a human immunodeficiency virus (HIV)-positive history, or (e) the presence of a major extracranial malignancy. Later, this chapter discusses other “minor” criteria, as they represent areas of contention and help to define the high-risk donor.

Although generally not the purview of the cardiac surgeon or transplant team, consent for organ donation should be requested by a professional trained in its acquisition. Multiple studies have demonstrated that the consent rate for organ donation at the request of an organ procurement organization (OPO) member is favored over a physician’s request (2). Therefore, we strongly encourage the early involvement of such OPO-designated individuals in the transplant process.

Appropriate multiorgan donor assessment and management requires a careful balance of the solid organ transplant teams’ competing clinical agendas. For example, whereas aggressive fluid infusion may favor the cardiac or renal procurement teams, it may be detrimental to those procuring lungs. Conversely, the addition of inotropes to maintain blood pressure in lieu of volume resuscitation may favor pulmonary procurement but may deplete myocardial adenosine adenosine-triphosphate (ATP) stores. Ultimately, adherence to a therapeutic algorithm that maximizes donor hemodynamic stability and end-organ perfusion generally favors all various solid organ procurement teams involved and is a goal that is easily tenable with some diplomacy.

DONOR ASSESSMENT

Formulating an accurate initial donor assessment at first referral relies on clinical practice fundamentals. Often, this task is complicated by the limited capabilities of the center where the donor resides (e.g., a small community hospital), including a lack of invasive monitoring (Swan–Ganz catheterization, serial arterial blood gas analysis) or the fact that multiple inotropes or vasopressors are not available. Under these circumstances, we have found it important to return to basic patient management principles.

**What are the Vital Signs?**

A blood pressure should be obtained every 2 h, as should a transduced central venous pressure (CVP) or, preferably, pulmonary artery (PA) catheter readings. Fluid “ins and outs” must be recorded hourly and
accurately, and a temperature should be recorded every 4 h (temperature should be maintained above 96°F).

What Is the Blood Pressure?

All attempts should be made to maintain the systolic blood pressure above 100 mmHg. Hypotension may be treated with various colloid or crystalloid solutions (as indicated by electrolyte abnormalities) or by packed red blood cell infusion should the hematocrit fall below 30 mg/dL. Most fluids should be given through fluid warmers. Should hypotension persist despite euvoelema (CVP 10–15 mmHg), low-dose inotropic or vasopressor support may be indicated.

Are There Vasopressor Requirements?

Most centers titrate dopamine or dobutamine at 5–10 µg/kg/min to maintain the systolic blood pressure above 100 mmHg. If these requirements increase despite euvoelema, the authors have found low-dose arginine vasopressin (AVP) (0.01–0.05 U/min) to be effective in supplementing the vasopressor effect (to be discussed later). Neosynephrine, epinephrine, and norepinephrine may be used in low doses to counteract the vasodilation that follows brain death, but they must be titrated carefully so as not to compromise arterial inflow to the abdominal vis-cera. Acid/base status impacts substantially on inotrope and vasopressor efficacy, thus significant acidemia or alkalemia must be corrected.

What Is the Urine Output and How Is It Trending?

The goal is to maintain urine output greater than 2 cc/kg/h. A common pathophysiologic brain death response is diabetes insipidus, which may be reflected by (1) serum sodium greater than 150 mEq/L, (2) serum osmolarity greater than 310 osm/L, or (3) urine output greater than 7 cc/kg/h. Under these circumstances, CVP monitoring is essential, and treatment by urine output replacement cc for cc with crystalloid (D5 1/3 or D5 1/4 NS) as well as with intravenous desmopressin (DDAVP) (0.05–0.10 U/min) is indicated to maintain euvoelema and electrolyte balance.

Is the Donor Adequately Oxygenating and What Is the Acid–Base Status?

Arterial blood gas analysis is the gold standard and should be available universally. Often, however, small hospitals do not provide continuous arterial access to donors, and serial analysis may require re-emphasis of its importance with the donor intensive care unit (ICU) team. Standard ventilator management to rectify abnormalities in arte-
Chen and Edwards

Rial partial pressures of oxygen (\( \text{PaO}_2 \)) and carbon dioxide (\( \text{PaCO}_2 \)) must be employed, and arterial pH must be maintained within normal limits to ensure adequate end-organ function and allow efficacious vasopressor and inotrope use.

**DONOR SELECTION:**
**STANDARD CARDIAC PARAMETERS**

All donors should have a 12-lead electrocardiogram (EKG). Nonspecific ST changes associated with brain death are common; however, major abnormalities generally require inquiry, especially if present in concert with other cardiac risk factors. Although the significance of elevated cardiac enzymes (e.g., creatinine phosphokinase-MB fractions, troponin T) in the donor referral setting has been investigated, there has been no clear consensus regarding their use. At present, we and others use serum enzyme markers as indicators that more detailed evaluation is required, should the magnitude of their elevation not correlate with other clinical findings. For example, as Grant has suggested, an otherwise acceptable donor with significantly elevated troponin T levels may warrant further echocardiographic analysis to demonstrate the absence of progressive cardiac deterioration (4). Similarly, a donor requiring significant catecholamine support but with a normal troponin T warrants further evaluation as a potentially useable source (5).

Generally, transthoracic echocardiography (TTE) is available at all designated donor hospitals, although, if necessary, portable TTE devices brought by the consulting donor team may be used for local donors for whom TTE has been absent or equivocal. Although not essential, TTE allows for the elimination of donors with intracardiac abnormalities (e.g., valvular pathology or septal defects). Clearly, a completely “normal” TTE indicates unequivocal physiologic candidacy, and, conversely, a significantly “abnormal” exam (e.g., valvular stenosis or insufficiency, substantial focal wall motion abnormalities) precludes use. However, interpreting the significance of other “intermediate” TTE abnormalities—especially mild hypokinesis—on posttransplant outcome remains difficult.

Gilbert and colleagues demonstrated TTE’s use in 74 potential donor organs; of these, 21 would have been discarded had they not been cleared echocardiographically (6). Seiler et al. described complete wall motion abnormality resolution in all transplant recipients whose donors demonstrated mild to severe wall motion abnormalities. (7).

Investigators at the University of Virginia re-emphasized this finding by evaluating posttransplant “recovery” in patients whose donors dem-
onstrated reduced left ventricular ejection fraction (LVEF) (39 ± 11%) on TTE by serial posttransplant TTE analysis. Their findings over the perioperative period revealed gradual improvement from 49 ± 8% (1 d) to 55 ± 3% (30 d) (8).

Although generally not as available, often transesophageal echocardiography (TEE) clarifies contentious findings on TTE. Body habitus, trauma dressings, and operator inexperience may render TTE windows suboptimal, or at least technically difficult, where TEE may resolve such confusion. Stoddard et al. demonstrated excellent correlation (16/17) between TTE and TEE in their small cohort; however, the findings of TEE eliminated five more donors than TTE (9).

Perhaps more important to donor selection than echocardiographic analysis may be the difficulty of relying on an outside echocardiogram interpretation by a referring cardiologist who is inexperienced in the common echocardiographic findings of neurologic dysfunction and brain death and who has a presumed incentive to overestimate minor echocardiographic findings (a tendency to “overcall” for fear of subsequent lawsuit or blame for posttransplant dysfunction). Lewandowski and investigators at the University of Michigan compared donor echocardiogram interpretations screened by cardiologists at referring donor hospitals to those of “experts” trained in donor heart selection. In 67 patients, they found poor correlation between two groups: minor abnormalities were 18% sensitive and 75% specific (53% agreement), major abnormalities were 33% sensitive and 94% specific (77% agreement), and the designation “unusable” was 33% sensitive and 96% specific (81% agreement); the recommendation (by the referring cardiologist) to reject a donor based on the echocardiogram was considered inappropriate (by the experts) in two patients (10).

Generally, coronary angiography with left ventriculography is required for male donors greater than 45 yr and female donors greater than 55 yr based on the likelihood of coronary atherosclerosis’ in these age groups. In addition, catheterization is often requested when there is a significant history of longstanding hypertension, cigarette smoking, insulin-dependent diabetes, cocaine use, or focal electrocardiographic or echocardiographic abnormalities. However, coronary angiography is frequently unavailable at small referring donor hospitals, and, in these cases, depending on the recipient’s acuity and the other concomitant donor risk factors, direct coronary palpation for atheromatous plaques by an experienced donor team may represent the best alternative assay of coronary disease. In addition, mild hypokinesis evident on echocardiogram can be analyzed more closely in the operating room by needle-pressure assessment of the PA or left atrium, as indicated.
DONOR SELECTION:
OTHER STANDARD PARAMETERS

*Size*

Donor size is matched to recipient size on weight basis, where a discrepancy greater than 20% is generally considered significant. This crude size parameter seeks to estimate donor–recipient compatibility so that the heart is of sufficient size to support the recipient circulation, but is not so large as to preclude sternal closure or promote tamponade. Because of frequent massive recipient cardiac dilatation in the long-standing heart failure setting, it is rare for even a substantially larger donor heart not to fit in the recipient’s pericardium and thus allow for chest closure (this is generally more of a pediatric recipient concern). An unusually tall recipient can infrequently require that the donor team procure more superior vena caval tissue (often up to and including the innominate vein) to allow enough length to span the intercaval vertical distance. In an effort to potentially alleviate posttransplant right ventricle (RV) failure risks, some centers purposely seek considerably larger donors for patients whose preoperative pulmonary hemodynamic profiles suggest pulmonary hypertension. However, this strategy is theoretical. The converse (using a significantly undersized heart for a recipient with high preoperative pulmonary hemodynamic indices) is not recommended, as the donor RV may not be equipped to tolerate the increased afterload posttransplant.

Despite the emphasis placed on size compatibility and functional potential, several investigators have revealed weight to be a poor heart size or function surrogate. In 1989, Hosenpud demonstrated that small hearts rely on increased heart rate and elevated filling pressures to achieve adequate cardiac output, but also showed that there is no correlation between donor weight and cardiac output or stroke volume (11). In contrast, investigators at Temple University demonstrated a gradual increase in LV mass among undersized hearts when compared with controls over a 10-wk posttransplant period (12). Also, Chan et al. evaluated the echocardiograms of 235 normal adults and demonstrated no difference in LV dimensions between 40–90 kg women or 50–99 kg men; they found major incompatibilities only at extremes of height, weight, and body surface area (13).

Weight, at present, remains one of few size parameters widely available for estimating heart size or function. Nonetheless, the transplant clinician must realize the above limitations in its consideration.
Donor age was one of the first criteria extended in an effort to expand the donor pool. Indeed, since the Stanford Group identified the ideal donor as less than 30 yr, several investigators have reported successful heart use from donors as much as twice that age (14–22). The traditional concern with older donors has been coronary atherosclerosis; however, in its absence (usually confirmed by coronary angiography), what prevents the graft from potentially functioning for another 30 yr? In other words, what is the likelihood that other competing risks posttransplant will not substantially outweigh the risk resulting from donor age alone—how can one estimate the “biological age” of the graft itself?

Table 3 collates a few major publications that have evaluated the effect of age on posttransplant survival, and, from this, it is clear that age alone does not specifically impact survival. Recently, we have accepted donors of increasing age with good result, but we generally suggest that donors greater than 50 yr be considered only if demonstrated to be free of coronary atherosclerosis by either angiography or direct palpation. Again, the impetus to accept increasingly older donor organs may often reflect the recipient’s acuity or general condition (e.g., accepting a 65-yr-old donor for a 65-yr-old Status I recipient, not for a 25-yr-old Status II recipient), thus it represents risk balancing between donor and recipient.

**Table 3**

**Studies Examining the Effect of Increasing Donor Age on Posttransplant Outcome**

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>n</th>
<th>Age range</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schuler</td>
<td>1989</td>
<td>74</td>
<td>36–54 yr</td>
<td>No difference in survival</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No difference in 1.4-yr angiogram</td>
</tr>
<tr>
<td>Mulvagh</td>
<td>1989</td>
<td>47</td>
<td>35–59 yr</td>
<td>No difference in survival</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No difference in graft function</td>
</tr>
<tr>
<td>Alexander</td>
<td>1991</td>
<td>165</td>
<td>45–55 yr</td>
<td>No difference in survival</td>
</tr>
<tr>
<td>Menkis</td>
<td>1991</td>
<td>19</td>
<td>40–59 yr</td>
<td>No difference in survival</td>
</tr>
<tr>
<td>Luciani</td>
<td>1992</td>
<td>18</td>
<td>40–55 yr</td>
<td>No difference in survival</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Higher infection rate in older group</td>
</tr>
<tr>
<td>Ott</td>
<td>1994</td>
<td>22</td>
<td>40–66 yr</td>
<td>No difference in survival</td>
</tr>
<tr>
<td>Ibrahim</td>
<td>1995</td>
<td>40</td>
<td>40–62 yr</td>
<td>No difference in survival</td>
</tr>
<tr>
<td>Tenderich</td>
<td>1998</td>
<td>19</td>
<td>57–78 yr</td>
<td>No difference in survival</td>
</tr>
<tr>
<td>Chen</td>
<td>2000</td>
<td>305</td>
<td>27–64 yr</td>
<td>No difference in 30-d mortality</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>For &gt; 60 yr</td>
</tr>
</tbody>
</table>
Ischemic Time

Although the traditional benchmark for acceptable cold ischemic time was 120 min, this, too, has been extended so that the current benchmark is approx 240 min. Certainly, innumerable reports have documented successful ischemic times of up to 9 h, especially in the pediatric population; however, the impact of progressively long ischemic times may not be reflected easily in perioperative mortality statistics. It has been suggested that impaired (i.e., not catastrophic) preservation’s “minor” effects are most often reflected by more protean manifestations (prolonged postoperative inotrope dependence, prolonged ICU stay, etc.) rather than acute graft failure. Ironically, longer ischemic times may result in more consistent, colder donor organ preservation, as shorter times necessitate wider fluctuations in temperature over a shorter time period; the significance of these differences on postoperative function is unknown.

Inotropic/Vasopressor Support

Early donor inclusion criteria often included an inotrope limitation of 10 µg/kg/min dopamine or dobutamine infusions. We currently have no exclusion criteria, and it is not uncommon for us to accept organs from donors receiving “wide open” inotrope and vasopressor infusions. Here, potentially more than anywhere else in donor management, use of experienced on-site clinicians (generally transplant coordinators) is critical. Attention to regulation of acid/base status, serum electrolyte abnormalities (especially calcium), hypothermia, oxygenation, and euvolemia often reduces or eliminates such requirements.

Natural brain death progression involves an initial surge of catecholamine release, followed by its converse, and an additional series of neurohumoral deficiencies, most of which result in hypotension. In the early 1990s, we were encouraged by the dramatic effects of intravenous triiodothyroidine (T3; 2–4 µg bolus, 2–4 µg/h infusion) as an adjunct to help reduce vasopressor and inotrope requirements; these practical efforts were based largely on by Novitsky’s preliminary primate and human work demonstrating a relative thyroid hormone deficiency in the brain death setting, the rectification of which led to improved hemodynamics in this and later studies (23,24). This enthusiasm waned somewhat in the late 1990s, owing to the medication’s cost (and often limited availability at donor hospitals) as well as its inconsistent effect.

More recently, it was demonstrated that a substantial number of hemodynamically unstable donors display a relative deficiency in the naturally occurring hormone vasopressin (3). The deficiency in this hormone is known to account for the diabetes insipidus phenomenon...
during brain death, where the treatment is a DDAVP infusion. DDAVP
is a vasopressin analog with an almost exclusive effect on the vaso-
pressin V$_2$ (renal) receptors. This central deficiency in vasopressin also
accounts for a peripheral deficiency of hormone available to stimulate
the vasopressin V$_1$ (vasoconstrictor) receptor; however, this fact was
underappreciated.

Infusions of low (physiologic)-dose, commercially available AVP
(which has both V$_1$ and V$_2$ effects) has helped salvage countless donors
from hemodynamic instability (Figs. 1 and 2) (3). From this, we have
postulated that in the setting of brain death a central vasopressin defi-
ciency may lead to dramatic vasodilation unresponsive to catecholamine
pressor infusion; correcting this deficiency allows for hemodynamic
stability and better vasomotor tone (3).
The suggestion to add a low-dose vasopressin infusion often meets with resistance, particularly from the renal procurement teams. However, we contend that it is better physiologically to require dramatically fewer vasopressors with a small amount of AVP than to continue giving increasing doses of pressors, with their other attendant detrimental effects (e.g., lactic acidosis, end-organ hypoperfusion, etc).

**ABO Compatibility/Positive Cross-Match**

Although there appear to be no appreciable sequelae to transplanting across Rhesus blood groups, transplantation within ABO blood groups remains axiomatic. On occasion, we have transplanted across ABO-compatible blood groups with poor results, even with adjunctive plasmapheresis and additional immunosuppression. Patients awaiting transplantation on our waiting list routinely undergo standard panel reactive antibody (PRA) testing at regular intervals to confirm that their reactivity is less than 20%. For those above this level, a prospective lymphocytotic cross-match is mandatory prior to transplantation, essentially limiting the potential donor pool to local donors only. Occasionally, we have transplanted across a positive cross-match (and on more occasions transplanted inadvertently across a retrospectively positive cross-match) with reasonable results. In this setting (and for those awaiting transplantation whose PRA is high), a combination therapy of cyclophosphamide, intravenous immunoglobulin, and/or plasmapheresis has been useful in lowering apparent immune reactivity (see also Chapter 8) (25). The overall results in these settings, however, remain marginal.

**Trauma**

In general, most centers have avoided donors who have withstood significant chest trauma for fear of apparent or occult cardiac contusion. Additionally, some have feared the potential infectious risk of prolonged tube thoracostomy in this setting. The authors have found that, as in routine trauma patients, the cardiac contusion diagnosis can be difficult, as the findings of generalized ST abnormalities on EKG, or pericardial fluid on echocardiogram, may be evident even in atraumatic donors. Investigators have previously demonstrated neither short cardiac resuscitation episodes nor significant hemothorax/rib fractures to impact on posttransplant graft function (26,27). Generally, we do not accept donors who have undergone open cardiac massage or intracardiac injection; however, we do consider donors with appreciable closed resuscitation efforts. In these situations, the experienced opinion of the harvest team (e.g., hemopericardium? overall function?) is essential.
Substance Abuse/Poisoning

It is rare to find a donor who has no history of previous substance use and/or abuse. Most commonly found is a history of cigarette use that, if chronic and substantial, may warrant coronary angiography. The second most common finding is a history of marijuana use, the significance of which is unclear. Often, marijuana use may represent additional intravenous drug use. This certainly raises the transmissible disease specter and warrants more detailed investigation.

Often, donors have a history of alcohol abuse, and it has been suggested that in these cases “preclinical” alcoholic cardiomyopathy could lead to a latent graft dysfunction postoperatively. Houyel has suggested that hearts from alcoholic donors demonstrate increased wall thickness and LV mass, with questionable LV filling impairment; this is thought to be independent of the duration of their alcoholism (27). Freimark’s cohort analysis (17 of 100 donors were alcoholic) demonstrated decreased survival in recipients of these organs at 1 and 2 yr (61 vs 95%) (28). Unfortunately, estimating the true magnitude of a given donor’s alcohol use (and thus the organ’s suitability) is difficult and, unless egregious, generally is not weighted heavily.

Cocaine use is known to be correlated to vasospastic coronary disease and even myocardial infarction. As with other illicit substances, the quantity and administration method (intranasal, intravenous) is generally unclear. Freimark evaluated 112 consecutive donors at UCLA and found a 16% incidence of significant cocaine use. In this cohort, there was no evidence of prior cocaine use’s impact on morbidity, mortality, or endomyocardial ischemia (by biopsy) (29).

Various poisons have accounted for brain death in potential donors. Several case series have demonstrated successful heart transplantation from donors who suffered cyanide or carbon monoxide poisoning (both traditionally absolute contraindications to use) (30,31). Because the history and impact of significant substance abuse or poisoning is incomplete, we have tended, in these circumstances, to rely heavily on the echocardiogram and the donor team’s opinion at visualization to assess global myocardial function.

Infection

Pyrexia is a common finding of the brain-dead state, and finding positive cultures is extremely common in organ donation, owing largely to prolonged ICU support prior to the donation consent acquisition. Thankfully, in the current broad-spectrum antibiotic era, the rate of bacterial infection transferred from cardiac donor to recipient is exceed-
Chen and Edwards

ingly low. Naturally, any organisms known to have been cultured from the donor should form the basis for specific recipient preoperative and postoperative antibiotic prophylaxis. Sweeney demonstrated a lack of transmission from 17 donors with significant positive cultures (32), and Jeevanandam reported 2 of 25 donors with positive cultures resulting in posttransplant infections (33).

Toxoplasmosis has been transmitted in the donor graft but may not be suspected until present on posttransplant endomyocardial biopsy. For those recipients who demonstrate prior exposure, no therapy is necessary; for those who are negative and receive an organ documented to be toxoplasma-positive or who receive an organ from a donor with unknown toxoplasma status, prophylaxis with pyramethamine and folate is initiated for the first 6 wk after transplant (see Chapter 7). HIV positivity remains an absolute contraindication to organ donation.

The use of donors with a positive hepatitis panel remains contentious. Hepatitis B surface antibody positivity, reflecting exposure, has not been a contraindication to use. We do not consider Hepatitis B core antibody positivity, reflecting recent exposure, as a contraindication to transplantation, but, generally, this is not accepted worldwide. Traditionally, hepatitis B surface antigen positivity, indicating active infection, has represented an absolute contraindication to transplantation. We and others are currently studying this cohort to evaluate whether these hearts could be used for recipients who received the proper pretransplant immunization and who will receive appropriate posttransplant therapy.

Hepatitis C donors are equally controversial, as many studies have demonstrated poor outcome for recipients of hepatitis C-positive hearts and have shown a substantial seroconversion rate among recipients (34,35). A potential solution is the use of hepatitis C-positive hearts for hepatitis C-positive recipients; however, this generally requires using an alternative list for transplantation, which is discussed later.

STRATEGIES TO BROADEN DONOR AVAILABILITY

Nonbeating Donors

Some enthusiasm has arisen from the liver and kidney procurement literature for organ use from nonbeating donors. Whereas experimental literature suggests that hearts may be harvested as long as 30 min post-mortem, this process requires preservation with blood cardioplegia prior to cardiac arrest, the logistics of which in the human condition are unclear (36,37). Indeed, the further legal implications of cardiac death vs brain death, the lack of good long-term results from animal studies, and the
need for pretreatment with heparin and/or free radical scavengers renders this an unlikely donor organ source in the immediate future.

**Consent Rates**

Whereas most efforts have been directed at expanding the donor pool by broadening donor acceptance criteria, it must be remembered that potentially the largest impact may be made by increasing consent rates. Rayburn investigated the national recovery of consented heart referrals for 1995 and collated the reasons donors were declined (see Table 4). Although difficult to estimate, clearly a proportion of these donors would surely have been used today, albeit potentially as “high risk.” Rayburn then estimated the number of hearts that would be made available by either broadening donor criteria or increasing consent rates by 10, 25, and 50%, respectively (see Table 5). As demonstrated, the effect of increasing consent rates is nearly double that of extending donor criteria (38). Furthermore, of this proportion, not all would be marginal donors, hence the increase in usable donors would likely be greater. Thus, it is imperative that transplant clinicians consistently make efforts toward community education to promote an increase in organ donation consent.
**Alternate List**

Since 1996, investigators from UCLA have promoted the alternate transplantation waiting list concept, in which candidates who would not be considered for transplantation under standard criteria on an age basis or other “minor” exclusion criteria (e.g., diabetes, hepatitis), might receive hearts that otherwise would have been discarded (39,40). According to their scheme, a standard donor heart would first be offered to the appropriate Status I recipient. If declined, it would then be offered to the next Status II recipient. If declined again, it would be offered to the appropriate alternate list recipient. Similarly, if a “marginal” heart became available, but was declined by the first Status I recipient on the list, it would be offered to an alternate list recipient. Marginal hearts would not be offered to Status II patients. The results of this format have been promising and have demonstrated few complications attributable solely to recipient comorbidities.

We have also employed an alternate list based on similar schema. The alternate list concept is particularly appealing in that it may use normal hearts that otherwise would be discarded for lack of an appropriate recipient. However, the transplant clinician must be careful of “stacking risks” for those hearts that are more high-risk, for the marginal donor and marginal recipient combination clearly creates a marginal outcome. For the authors’ alternate list, this has meant restricting the defining (alternate) criterion to one (e.g., a 67-yr-old patient, not a 67-yr-old patient with hepatitis) and resisting the tendency to list significantly high-risk recipients with multiple comorbidities.

**CONCLUSION**

Such donor–recipient mismatching as promoted by the alternate list represents the consideration central to every potential donor referral acceptance. Extending donor criteria to include “riskier” donors has largely stemmed from the acuity of the Status I list. Indeed, as medical heart failure management has improved over the past two decades, so, too, have the patients on the Status I list become potentially sicker. Thus, whether to consider the donor with minor TTE changes, chronic alcoholism, and a possible history of cocaine use derives largely from whether the designated recipient is a Status I patient dying in the ICU, a Status II patient otherwise well at home, or a patient from the blood group O alternate list. We continue to advocate aggressive marginal donor management, in particular because of a programmatic sense that many are
actually poorly managed reasonable donors. We also continue to push comorbidity limits by which we may accept patients on their waiting list. However, as Copeland suggested (41), cost effectiveness is a social imperative in these situations, and we must constantly remember that the donor use assessment always represents the critical evaluation of the donor–recipient combination, rather than individual donor characteristics alone. Ultimately, this combination accounts for posttransplant survival and, therefore, equitable scarce resource use.

REFERENCES


