Donor factors that affect the number of organs transplanted per donor

Background—Demographic factors and factors from donors' medical and social history influence the number of organs transplanted per donor. The goal for organ procurement organizations is 4.30 organs transplanted per standard criteria donor.
Objective—To examine the influence of factors related to donors' demographics and donors' medical and social histories on the number of organs transplanted per donor.
Methods—The medical and social histories of 772 deceased donors were reviewed to assess demographic factors (eg, age, sex), diseases (eg, heart disease, hepatitis, diabetes, hypertension), and other factors (eg, body mass index, high-risk behavior, alcohol abuse). Statistics were calculated by using MarketSight software.
Results—Between 2003 and 2007, 2409 organs were recovered and transplanted from 772 donors (number of organs per donor, mean [SD], 3.12 [1.73]) in our designated service area. Some demographic factors (eg, age, sex) were associated with significantly fewer organs transplanted per donor. Other factors from donors' medical and social histories also played a major role, with each added factor significantly decreasing the number of organs transplanted per donor. The number of organs transplanted differed significantly between donors with 0 vs 1, 1 vs 2, and 2 vs 3 or more factors related to their medical and social histories.
Conclusion—Demographic factors and other factors in donors' medical and social histories significantly reduced the number of organs transplanted per donor. An algorithm that uses all potential demographic factors and factors related to medical and social history nested within each other could be developed to predict number of organs transplanted. (*Progress in Transplantation.* 2009;19:259-266)

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The number of organs transplanted per donor (OT/D) from the nation's organ procurement organizations (OPOs) is greatly influenced by the demographic factors and factors related to the medical and social histories of the donors in each OPO's designated service area. The Health Resources and Services Administration, through "The Organ Donation Breakthrough Collaborative," established goals for OPOs in an effort to maximize the number of donors and the number of organs transplanted per donor. The United Network for Organ Sharing has divided the deceased donor pool into 3 distinct groups. Group 1, standard-criteria donation (SCD), includes all donors who do not fit into the other 2 groups. Group 2, donation after cardiac death (DCD), comprises donors who donate after cardiac death. Group 3, extended-criteria donation (ECD), is defined by the donors' age (≥60 years old or ≥50 years old with any 2 of the following 3 conditions), death caused by a cerebral vascular accident, and/or a history of hypertension, and/or a serum level of creatinine greater than 1.5 mg/dL (to convert to micromoles per liter, multiply by 88.4).[1]

The definition of ECD is used for kidney allocation but does not provide accurate expectations for extrarenal organs transplanted per donor. OPOs are placed in a tenuous position when a donor with multiple diseases is still considered a SCD. We examined the expected number of organs transplanted per donor when a single or multiple diseases and other factors are present. The Organ Donation Breakthrough Collaborative has suggested that OPOs set goals of 4.30 OT/D from SCDs, 2.75 OT/D from DCDs, and 2.50 OT/D from ECDs.[2]

Tuttle-Newhall JE et al[3] and Selck FW et al[4] reviewed donors' comorbid diseases, but they did not present the data to predict the effect of comorbid disease(s) on the number of organs transplanted per donor. Wu et al[5] addressed the effects of recipients' comorbid diseases on graft and patient survival but did not address donor factors or donors' comorbid diseases. Several

Table 1 Factors from donors' medical and social histories that were studied

Cause of death	Trauma (unnatural) vs nontrauma (natural); the terms are interchangeable
Hypertension	History of hypertension (No vs Yes), and years of hypertension
Body mass index	Weight in kilograms divided by height in meters squared, at the time of hospital admission
Diabetes	History of diabetes, (No vs Yes), and years of diabetes mellitus (diabetes), as determined by assessing the use of oral medication or insulin injection
Heart surgery	History of cardiac surgery, including • coronary artery bypass graft • valve replacement surgery • other heart surgeries
High-risk behavior	High-risk behavior (No vs Yes), as defined by the Centers for Disease Control and Prevention
Hepatitis	History of exposure to hepatitis virus as indicated by positive results of serologic tests for hepatitis B core or hepatitis C antibodies
Marijuana use	History of smoking marijuana (No vs Yes); the donor was deemed a marijuana user even if the use was in the past
Alcohol abuse	History of alcohol abuse (No vs Yes) and years of abuse (criteria for alcohol abuse were alcohol use more than 3 or 4 times a week or binge drinking); having a glass of wine every night or drinking a beer daily or on weekends was not considered alcohol abuse
Drug abuse	History of drug abuse (drugs other than marijuana, such as cocaine, methamphetamine)
Smoking	History of smoking; the smoking index was a calculation of the number of pack(s) per day multiplied by the years of smoking

published articles have addressed the effects of donor obesity, ECD (older donors with hypertension), and high-risk or marginal donors on recipients' outcomes.[6-8]

Factors From Donors' Medical and Social Histories

Eleven factors from donors' medical and social histories were evaluated and analyzed (Table 1). The effects of demographic factors and factors from donors' medical and social histories on the number of organs transplanted per donor are the subject of this study. These factors may also affect organ function and ultimately influence long-term organ survival.

During this study period, one thoracic transplant program and one abdominal transplant program hired aggressive directors who more than doubled the number of local transplants performed, which significantly simplified organ placement within the designated service area. This study data set belongs to an OPO whose designated service area encompasses 3 1/2 states in 3 time zones. Therefore, many organ transports to recipient centers had longer cold ischemia times, which affect organ placement.

Materials and Methods

The OPO reviewed the medical records of 777 donors from 2003 to 2007 to evaluate the effect of donors' demographics and factors related to donors' medical and social histories on the number of organs transplanted per donor. Five donors (designated donors) were excluded from the study because their medical and social histories were unavailable. The remaining 772 donors were used for this study. All donors were categorized into 1 of 4 groups: all donors, SCD, DCD, and ECD. The relationship between donors' demographics (age, sex, race) and the number of organs transplanted per donor was evaluated.

Donors' social and medical histories were provided by the next of kin. In many cases, the individuals giving these histories may have been unaware of certain specifics of behavior (eg, the extent of alcohol abuse). Other families may present a more positive or negative donor history depending on family relationships. Therefore, some of the data sets evaluated may not have been entirely accurate. When the next of kin had no knowledge of one of the donor factors, a question mark was entered into the database. These donors were not used in the evaluation for that specific factor; therefore, the totals of subjects studied may not add up to 772 donors.

Parameters that were not significant were consolidated into fewer groups. For example, the number of organs transplanted per donor did not differ significantly between donors with a body mass index (BMI) of 18.5 or less and donors with a BMI of 18.6 to 24.9 or 25.0 to 29.9. These 3 groups were combined into 1 group with BMIs less than 30. The result was that only 2 groups (BMI <30 and BMI ≥30) were compared for that factor.

Each parameter was evaluated for significance and listed according to the number of organs transplanted per donor (eg, trauma donors had 3.63 OT/D

whereas nontrauma donors had 2.60 OT/D, indicating a difference between the groups of 1.03 OT/D).

Statistics

Statistical analysis was done by using MarketSight software (Cambridge, Massachusetts). MarketSight automatically selects and applies the appropriate statistical tests (analysis of variance, *t* test, χ^2, Z test) for group mean and standard deviation for each data set. A 95% confidence level was used to analyze data. Analysis of several groups resulted in unequal variances. In these cases, a Kruskal-Wallis test was performed to determine significance. These results are identified by an asterisk after the *P* value in the tables. A *P* value less than .05 was considered significant.

Results

Donor Type and Number of Organs Transplanted per Donor

A total of 772 donors was reviewed and analyzed; 547 donors (71%) were SCDs, 107 (14%) were DCDs, and 118 (15%) were ECDs. The number of organs transplanted per donor differed significantly among the 3 donor types (Table 2). A total of 2409 organs were transplanted from 772 donors. The mean (SD) number of organs transplanted per donor from 772 donors was 3.12 (1.73). The number of organs transplanted per donor among SCD donors was significantly higher than the number among DCD donors or ECD donors ($P < .001$), and the number among DCD donors was higher than the number among ECD donors ($P = .006$; Table 2).

Demographic Factors

Donor's Age. Donor's age played a significant role in predicting the number of organs transplanted per donor. With the exception of donors less than 11 years old, the number of organs transplanted per donor decreases significantly with each decade of age. For many donors less than 11 years old, there is a size issue (donor and recipient matching). In the young, matching lung size is more difficult and pancreases are not usually transplanted. Furthermore, infant kidneys are rarely transplanted. For donors between the ages of 31 and 50 years (31-40 vs 41-50 years), the number of organs transplanted per donor did not differ significantly. Therefore those donors were combined into 1 age group (31-50 years). Donors between 51 and 65 years old were grouped together for the same reason. Table 3 has age groups with the mean number of organs transplanted per donor, along with each standard deviation and *P* value. Figure 1 shows the age distribution within the age groups, illustrating the importance of age in relation to the number of organs transplanted per donor. Except for donors 10 years old or less, the older the donor, the fewer organs transplanted.

Donor's Sex. The sex of the donor was a factor in the number of organs transplanted per donor. Men (n = 480) had 3.27 (1.76) OT/D, whereas women (n = 292) had 2.87 (1.66) OT/D ($P = .002$; difference of 0.4 OT/D). To explain this observation, the data were sorted to determine if more women than men

Table 2 Comparison of number of organs transplanted by donor type (SCD, DCD, ECD) for 772 donors

Comparison	No. of organs transplanted per donor, mean (SD)			*P*[a]
	SCD (n = 547)	DCD (n = 107)	ECD (n = 118)	
SCD vs DCD	3.57 (1.70)	2.23 (1.02)		<.001*
DCD vs ECD		2.23 (1.02)	1.86 (1.43)	.006
SCD vs ECD	3.57 (1.70)		1.86 (1.43)	<.001*

Abbreviations: DCD, donation after cardiac death; ECD, extended-criteria donation; SCD, standard-criteria donation.
[a] *P* value is based on Kruskal-Wallis test because variances were unequal.

Table 3 Age as a factor in the number of organs transplanted per donor (OT/D; all donors, N = 772)

Age, y	OT/D, mean (SD)	*P*[a]
0-10	2.37 (1.20)	
		<.001*
11-20	4.48 (1.72)	
		.02*
21-30	4.00 (1.57)	
		<.001*
31-50	3.05 (1.46)	
		<.001*
51-65	2.18 (1.36)	
		<.001*
>65	1.08 (1.08)	

[a] *P* value is based on Kruskal-Wallis test because variances were unequal.

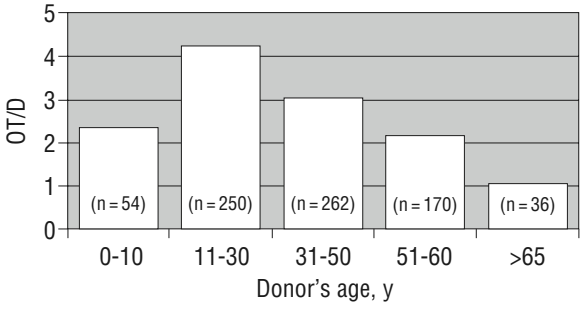

Figure 1 Mean number of organs transplanted per donor (OT/D) by donor's age (N = 772).

Table 4 Difference in number of organs transplanted per donor for all donors

				Index				
Factor	Differences	No	Yes	<10	≥10	<30	≥30	*P*
Heart surgery (No vs Yes)	1.79	3.17 (1.72) n = 746	1.38 (1.12) n = 13					<.001
Hepatitis (No vs Yes)	1.41	3.17 (1.73) n = 746	1.76 (1.20) n = 25					<.001
Diabetes (No vs Yes)	1.37	3.20 (1.73) n = 732	1.83 (1.34) n = 36					<.001
Hypertension (No vs Yes)	1.33	3.47 (1.69) n = 551	2.14 (1.50) n = 188					<.001
Cause of death (Trauma [No vs Yes])	1.03	2.60 (1.63) n = 389	3.63 (1.68) n = 188					<.001
Smoking index (<10 vs ≥10)	0.87			3.39 (1.76) n = 519	2.52 (1.45) n = 175			<.001
Body mass index (<30 vs ≥30)	0.76					3.29 (1.76) n = 579	2.53 (1.51) n = 174	<.001
Alcohol abuse (No vs Yes)	0.28	3.21 (1.74) n = 569	2.93 (1.69) n = 190					.048

died of nontraumatic injuries (eg, cerebral vascular accidents, strokes), thereby having a greater number of comorbid conditions that would have reduced the number of organs available for transplant. The data were divided by sex and factors related to the donor's medical and social histories (mean [SD], 0.93 [1.08] factors in 480 men vs 0.98 [1.01] factors in 292 women; difference not significant). Analysis was performed on donors over the age of 50 years and also over the age of 55 years. None of the groups showed a significant difference in donors' number of factors by sex to explain the difference in number of organs transplanted per donor. Additionally, the number of organs transplanted per donor was compared between men and women at least 55 years old who had a natural cause of death (mean [SD], 1.75 [1.31] OT/D in 53 men vs 1.74 [1.26] in 57 women; difference not significant). The reason for the significance of sex in the number of organs transplanted per donor is not fully explained by this data.

Donor's Race. Race was analyzed as a possible influence on number of organs transplanted per donor. According to statistical analysis, race as an independent variable, was not statistically significant. This result may be due to the low number of nonwhites in the sampling group. The data were further divided into white vs nonwhite groups. The 664 whites had a mean (SD) of 3.15 (1.74) OT/D, compared with 2.93 (1.71) OT/D for 107 nonwhites. This difference was not statistically significant. Therefore, race was not a determinate in this study.

Factors From Social and Medical Histories

Table 4 lists (in descending order) the differences in the number of organs transplanted per donor between the donors with and without each factors from the medical and social histories. The factor that had the greatest influence on number of organs transplanted per donor was heart surgery (1.79), followed by hepatitis, diabetes, hypertension, cause of death, smoking index, BMI, and alcohol abuse.

Two factors from the medical and social histories did not show a significant relationship to the number of organs transplanted per donor: donors considered high risk (as defined by the Centers for Disease Control and Prevention) and donors with a history of drug abuse (ie, abuse of legal prescription medications or illegal drugs). Therefore, those groups were excluded from this study. With a larger number of donors, however, the significance (*P* value) may change in these groups.

Heart Surgery. A history of heart surgery had the largest influence on number of organs transplanted per donor, but only 13 donors had a history of heart surgery. Histories of heart surgery(s) included coronary artery bypass graft, valve replacement, and/or associated conditions. The mean (SD) for number of organs transplanted per donor was 3.17 (1.72) for 746 donors without a history versus 1.38 (1.12) for 13 donors with a history of heart surgery, a difference of 1.79 OT/D ($P < .001$). However, because of the low number of donors with a history of heart surgery, this factor should be studied further in a larger group of donors.

Hepatitis. The relationship between positive results of serologic tests for hepatitis and the number of organs transplanted per donor was evaluated. One would expect to see a lower number of organs transplanted per donor when the donor has a positive serological marker

Table 5 No. of organs transplanted per donor, mean (SD): cause of death vs hypertension

Cause of death	No hypertension	Hypertension	*P*
Trauma	3.79 (1.65)	2.54 (1.50)	<.001
Nontrauma	2.99 (1.58	2.03 (1.51)	<.001
P	<.001	.07	

Abbreviation: NS, not significant.

for core antibodies to hepatitis B, hepatitis C, or both. Other positive results of serologic tests were not included in the study because the number of positives was too small to analyze. Status relative to cytomegalovirus was not analyzed. The 746 donors without hepatitis had a mean (SD) of 3.17 (1.73) OT/D whereas the 25 donors positive for the core antibody to hepatitis B, hepatitis C, or both had a mean (SD) of 1.76 (1.20) OT/D ($P < .001$). The mean difference between donors without versus with hepatitis was 1.41 OT/D.

Diabetes. The difference between diabetic donors and nondiabetic donors was 1.37 OT/D. Patients with diabetes can have significant vascular disease that can affect transplantability of all organs. In this study, only 36 donors had diabetes, compared with 732 donors who did not have diabetes. The mean (SD) was 3.20 (1.73) OT/D in the nondiabetic group and 1.83 (1.34) OT/D in the diabetic group ($P < .001$).

Hypertension. Donors with a history of hypertension have significantly more cardiovascular and renal complications that can affect organ transplantability than do donors with no history of hypertension. The 551 donors without hypertension had a mean (SD) of 3.47 (1.69) OT/D vs 2.14 (1.50) for the 188 donors with hypertension ($P < .001$; Table 4). Therefore, donors with a history of hypertension have 1.33 OT/D fewer than donors without hypertension.

Cause of Death. Patients hospitalized because of unnatural (trauma) causes were compared with patients admitted for natural causes of death. The 389 patients admitted because of trauma had a mean (SD) of 3.63 (1.68) OT/D as compared with the 383 patients who died of natural causes, who had 2.60 (1.63) OT/D ($P < .001$). Donors with nontraumatic causes of death had 1.03 fewer organs transplanted than did trauma patients.

Hypertension Versus Cause of Death. Many nontrauma donors have had a cerebral vascular accident. In most cases, these patients have a history of hypertension. This observation raises the question, Is the reduction in number of organs transplanted per donor in these cases the result of the cause of death or the hypertension? The number of organs transplanted per donor did not differ significantly between trauma and nontrauma donors when hypertension was present ($P = .07$). Therefore, it seems that hypertension is the influencing parameter (Table 5). However, the number of organs transplanted per donor differs significantly (0.80 OT/D) between trauma and nontrauma donors, when no hypertension is present ($P < .001$).

Table 6 No. of organs transplanted per donor, mean (SD), by smoking index

Smoking index	n	No. of organs transplanted per donor, mean (SD)	Difference[a]
0	693	3.35 (1.73)	0.48
>0	325	2.87 (1.70)	
≤5	437	3.39 (1.76)	0.72
>5	258	2.67 (1.58)	
≤10	485	3.39 (1.76)	0.87
>10	210	2.52 (1.42)	
≤15	519	3.33 (1.77)	0.80
>15	176	2.53 (1.45)	
≤20	547	3.30 (1.77)	0.81
>20	148	2.49 (1.42)	
≤30	606	3.25 (1.74)	0.97
>30	89	2.28 (1.43)	
≤40	646	3.20 (1.73)	1.12
>40	49	2.08 (1.38)	

[a] All differences were significant at $P < .001$ by Kruskal-Wallis test.

Smoking Index. The number of cigarette packs per day times the number of years of smoking yields the smoking index. Groups were selected by using a smoking index in 5-year increments to determine a statistical point that provided the largest differences between groups. The differences were collected and compared with all other groups. The groups were (0 vs >0, ≤5 vs >5, ≤10 vs >10, ≤15 vs >15, ≤20 vs >20, ≤30 vs >30, and ≤40 vs >40; Table 6). At all times, the more a donor smoked, the fewer organs were transplanted. The trends line in Figure 2 shows a constant decline in number of organs transplanted per donor as the smoking index increases ($y = -0.2232x + 3.8141$). For every increase of 10 in the smoking index, there is a loss of 0.22 OT/D.

Body Mass Index. BMI was calculated as the weight in kilograms times the height in meters squared. Persons with a BMI less than 18.5 are considered underweight, 18.5 to 24.9 is normal weight, 25.0 to 29.9 is overweight, and 30 or greater is obese.

Donors were divided into groups on the basis of BMI (underweight, normal, overweight, and obese).

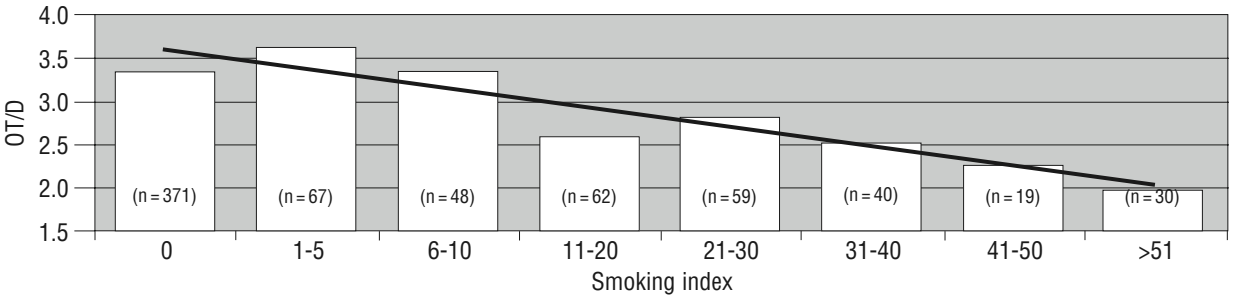

Figure 2 Mean number of organs transplanted per donor (OT/D) by smoking index.

The total does not add up to 772 because 76 families did not know if the donor smoked.

Each group was compared with all the other groups (Table 7). The largest difference was between the normal weight group and the obese group (difference of 0.84 OT/D). The only statistically significant difference was between the nonobese and the obese. The mean (SD) was 3.29 (1.76) OT/D for the 579 nonobese donors and 2.53 (1.51) for the 174 obese donors ($P < .001$; see Table 4). The difference was a loss of 0.76 OT/D in the obese donors as compared with the nonobese donors.

Alcohol Abuse. Alcohol abuse as a yes or no question revealed a mean difference of 0.28 OT/D (see Table 4). The 37 donors who abused alcohol for 1 to 5 years had a mean (SD) of 3.89 (1.79) OT/D, whereas the 56 donors who did not abuse alcohol had 3.21 (1.74) OT/D ($P = .02$). The 85 donors with a history of alcohol abuse for greater than 6 years had a mean (SD) of 2.78 (1.51) ($P = .001$; Table 8).

Marijuana Use. In this limited study, the donors with a history of marijuana use created a quandary. Donors with a history of marijuana use (n = 265) had a higher number of organs transplanted per donor than did 490 nonusers (mean [SD], 3.33 [1.71] vs 3.04 [1.74]; $P = .007$).

Dopamine Administered in the Donor's Intensive Care Unit or Operating Room. While evaluating many factors, we noted that the number of organs transplanted per donor differed significantly depending on whether dopamine was administered in the intensive care unit and/or the operating room. The 212 patients who received dopamine in the intensive care unit had a mean (SD) of 3.50 (1.75) OT/D, whereas the 519 patients who did not receive dopamine had 3.06 (1.69) OT/D ($P = .001$). Likewise, the 120 patients who received dopamine in the operating room had a mean (SD) of 3.54 (1.76) OT/D, whereas the 624 patients who did not receive dopamine had a mean (SD) of 3.10 (1.71) ($P = .01$). The reason for the increase in the number of organs transplanted per donor when dopamine is administered is unknown.

Influence of Number of Factors From Medical or Social History on Number of Organs Transplanted per Donor. A total of 344 donors without any of the factors from the medical and social histories provided 1293 organs, for a mean (SD) of 3.76 (1.76) OT/D. Donors were divided into 4 groups, by number of factors from the medical and social histories (0, 1, 2, and 3 or more). Most organ donors (428 of 772, 55%) had 1 or more factors. The number of organs transplanted

Table 7 Mean No. of organs transplanted per donor by body mass index[a,b]

Body mass index	<18.5 (n = 68)	18.5-24.9 (n = 281)	25-29.9 (n = 230)	≥30 (n = 174)
<18.5	*3.16*	.36	.30	<.001
18.5-24.9		*3.37*	.25	<.001
25-29.9			*3.20*	<.001
≥30				*2.53*

[a] Numbers in italics are number of organs transplanted; other numbers are *P* values.
[b] Nineteen donors were not included in the analysis because height was not documented in their charts.

Table 8 No. of organs transplanted per donor, mean (SD), by years of alcohol abuse[a,b]

Alcohol abuse, y	0 (n = 586)	1-5 (n = 37)	>5 (n = 85)
0	*3.21 (1.74)*	.02	.03
1-5		*3.89 (1.79)*	.001
>6			*2.78 (1.51)*

[a] Numbers in italics are mean (SD) for number of organs transplanted; other numbers are *P* values.
[b] Sixty-four donors were not included in the analysis because their family members did not know whether the donor abused alcohol.

Table 9 Organs transplanted per donor, mean (SD), by donor type and number of factors from medical and social histories

All donors	No. of factors				
No. of factors	0 (n = 344)	1 (n = 208)	2 (n = 151)	≥3 (n = 69)	*P*
0 vs 1	3.76 (1.76)	3.04 (1.49)			<.001
1 vs 2		3.04 (1.49)	2.36 (1.53)		<.001
2 vs ≥3			2.36 (1.53)	1.84 (1.21)	.01
Standard-criteria donors					
No. of factors	0 (n = 280)	1 (n = 148)	2 (n = 90)	≥3 (n = 69)	
0 vs 1	4.04 (1.77)	3.36 (1.44)			<.001
1 vs 2		3.36 (1.44)	2.89 (1.46)		.01
2 vs ≥3			2.89 (1.46)	2.14 (1.25)	.01
Donation after cardiac death donors					
No. of factors	0 (n = 48)	1 (n = 34)	2 (n = 151)	≥3 (n = 10)	
0 vs 1	2.5 (0.95)	2.32 (0.84)			.39
1 vs 2		2.32 (0.84)	1.47 (1.13)		.005
2 vs ≥3			1.47 (1.13)	1.80 (1.23)	.49
Extended-criteria donors					
No. of factors	0 (n = 16)	1 (n = 26)	2 (n = 46)	≥3 (n = 30)	
0 vs 1	2.62 (1.31)	2.12 (1.75)			.32
1 vs 2		2.12 (1.75)	1.63 (1.36)		.19
2 vs ≥3			1.63 (1.36)	1.57 (1.14)	.83

per donor differed significantly between donors without any such factors and donors with 1, 2, or 3 or more such factors. The 280 SCD donors with no such factors had a mean (SD) of 4.04 (1.77) OT/D, and the 148 SCD donors with 1 such factor had 3.36 (1.44) OT/D ($P < .001$). Donors with 1 factor have a higher number of organs transplanted per donor than do donors with 2 and 3 or more such factors in this study (Table 9). The low number of donors with 3 or more factors made statistical analysis difficult in all groups.

In the DCD donors, the data showed a significant difference in only 1 area (1 vs 2 factors from medical and social histories). DCD donors with only 1 factor had a significantly different mean (SD) number of organs transplanted per donor than did DCD donors with 2 factors: the 34 donors with 1 factor had 2.32 (1.31) OT/D, whereas the 15 donors with 2 factors had 1.47 (1.13) OT/D ($P = .005$).

In every ECD group (0 vs 1 vs 2 vs 3 factors from medical and social histories), the number of organs transplanted per donor decreased, although the ECD group lacked sufficient numbers to make a statistical statement.

Discussion

In this study, the numbers of donors with a history of heart surgery (n = 13), hepatitis (n = 26), and diabetes (n = 36) were too small for complete analysis. Other factors (blood type, donor location [Alaska, Puerto Rico]) may play a role in the number of organs transplanted per donor. Factors from the donor's medical and social histories (eg, previous cardiac surgery, history of hepatitis, history of diabetes, hypertension, cause of death, smoking index, BMI, and alcohol abuse) did show a significant relationship to the number of organs transplanted per donor.

The OPO community is experiencing pressure to provide the highest possible number of organs transplanted per donor. The cause of death, in association with other factors and comorbid diseases, limits the number of transplanted organs per donor. This study demonstrates that not every SCD donor can be expected to provide 4.30 organs. The term extended-criteria donor (ECD) was historically developed to promote kidney placement from older donors to appropriate recipients, in an effort to maximize organ transplantation. OPOs designate donor type, using the current terminology of ECD, according to the UNOS definition. A 49-year-old obese woman who dies nontraumatically and has a history of diabetes, hypertension, and chronic obstructive pulmonary disease should not be considered a standard-criteria donor. Extended-criteria kidneys rather than ECD should be considered by UNOS for kidney allocation. For OPO purposes, the

ECD term may be redefined as any deceased donor with 2 or more risk factors in the medical and social histories. Furthermore, it may be helpful to list the appropriate number of such factors at the end of each of the 3 donor types (SCD, DCD, ECD). For example, a SCD with 2 such factors would be an SCD2, a DCD with 3 such factors would be a DCD3, and so on.

This study of 772 deceased donors should provide some insight into the potential number of organs transplanted per donor from SCDs, but a larger study is needed to secure statistical significance for ECD and DCD donors. Every potential donor must be assessed individually, but with a larger number of donors, an algorithm for determining the number of organs transplanted per donor could be developed (by using computer software). This algorithm could contain groups, nested within each other, to predict the effect of every combination of demographic factors and factors from the donor's medical and social histories on the number of organs transplanted per donor. The question could then be asked, "What would be the expected number of organs transplanted from a 49-year-old, obese woman with a history of hypertension, diabetes, and chronic obstructive pulmonary disease who smoked 1 pack of cigarettes per day for 30 years?" An algorithm tool would be useful to assess donor potential and provide more consistency in selecting potential donors for the industry.

We developed an algorithm, by using these data and nesting factors to predict the number of organs transplanted per donor. After analyzing the data, it became clear that we had too few donors in this study, with the multitude of demographic factors and factors from donors' medical and social histories, to draw conclusions about the number of organs transplanted per donor. Although this study provides limited indicators, a data set of tens of thousands of donors is needed to provide a more accurate predictor of number of organs transplanted per donor.

OPOs and transplant centers should work together to maximize organ recovery and transplantation at the lowest possible cost. Evaluation and donor maintenance, with little or no potential, can strain OPO resources and result in increased standard acquisition charges for organs.

Financial Disclosures

None reported.

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