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Long-term survival in renal transplant recipients with graft function

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Background. Death with graft function (DWGF) is a common cause of graft loss. The risks and determinants of DWGF have not been studied in a recent cohort of renal transplant recipients. We performed a population-based survival analysis of U.S. patients with end-stage renal disease (ESRD) transplanted between 1988 and 1997.

Methods. Registry data were used to evaluate long-term patient survival and cause-specific risks of DWGF in 86,502 adult (≥18 years) renal transplant recipients.

Results. Out of 18,482 deaths, 38% ($N = 7040$) were deaths with graft function. This accounts for 42.5% of all graft loss. Patient survival with graft function was 97, 91, and 86% at 1, 5, and 10 years, respectively. The risk of DWGF decreased by 67% (RR = 0.33, $P < 0.001$) between 1988 and 1997. The adjusted rate of DWGF was 4.6, 0.8, 2.2, and 1.4 deaths per 1000 person-years for cardiovascular disease, stroke, infections, and malignancy, respectively. The suicide rate was 15.7 versus 9.0 deaths per 100,000 person-years in the general population ($P < 0.001$). In multivariate analysis, the following factors were independently and significantly predictive of DWGF: white recipient, age at transplantation, ESRD caused by hypertension or diabetes mellitus, length of pretransplant dialysis, delayed graft function, acute rejection, panel reactive antibody >30%, African American donor race, age >45 years, and donor death caused by cerebrovascular disease.

Conclusions. Patients with graft function have a high long-term survival. Although DWGF is a major cause of graft loss, the risk has declined substantially since 1990. Cardiovascular disease was the predominant reported cause of DWGF. Other causes vary by post-transplant time period. Attention to atherosclerotic risk factors may be the most important challenge to further improve the longevity of patients with successful renal transplants.

It is well established that renal transplantation confers a robust survival advantage over dialysis treatment for patients with end-stage renal disease (ESRD) [1–4]. However, the survival of transplant recipients is significantly lower than age-matched controls in the general population [5, 6]. The relatively higher mortality in renal transplant recipients is, in part, due to comorbid medical illness, pretransplant dialysis treatment, and factors uniquely related to transplantation, including immunosuppression and other drug effects [7–9]. Studies comparing patient survival on dialysis versus renal transplantation often use the intention-to-treat analysis, which, by including recipients with graft failure in the transplanted cohort, does not permit an assessment of the mortality risk in patients with functioning allografts. Furthermore, the transplant operation, graft loss, return to dialysis, and repeat transplantation are associated with variable time-dependent mortality risks that may not be fully accounted for when overall post-transplant patient survival is studied.

Death with graft function (DWGF) has been reported to occur in 9 to 30% of patients [6, 10–12], thus accounting for a substantial fraction of graft loss. In most series, consisting mainly of renal transplantations performed in the 1970s to mid-1980s, infection is often reported as the leading cause of death [13–18]. Risks and causes of mortality may have changed because of the more recent advances in immunosuppressive protocols, improved surgical techniques, and the availability of newer drugs for the medical treatment of risk factors such as hypertension and hyperlipidemia. Moreover, the transplant population now includes a greater proportion of older and sicker patients [19, 20]. These developments warrant a new assessment of the risks and determinants of mortality in the renal transplant population.

The goal of our investigation was to describe the rate of DWGF and the trends in the risks and causes of mortality at different post-transplant intervals in a recent cohort of U.S. renal transplant recipients. We evaluated cause-specific mortality rates (in different subgroups) and the correlations of patient and transplant-related factors with DWGF in adult renal transplant recipients.

Key words: graft loss, end-stage renal disease, kidney transplant, post-transplant mortality risks, and renal transplant survival.

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METHODS

This study used transplant registration and follow-up data collected by the UNOS Scientific Renal Transplant Registry in combination with ESRD patient data in the United States Renal Data System (USRDS). After excluding recipients of multiorgan transplants and those younger than 18 years of age at transplantation, all patients undergoing renal transplantation between January 1, 1988, and June 30, 1997, were studied. The final study sample consisted of 86,502 patients.

Patients were considered to have died with graft function if: (*a*) death was not preceded by return to dialysis (or refusal to return when indicated) or transplant nephrectomy, (*b*) no graft failure date or cause of graft failure was reported for the index renal transplant, or (*c*) serum creatinine at the last transplant follow-up visit was less than 4.0 mg/dL. Patients were withdrawn from the study (censored) at the first report of graft failure, transplant nephrectomy, resumption of maintenance dialysis, retransplantation, or the end of study on June 30, 1998.

The cause of death data were obtained from two sources: the transplant recipient follow-up form and the ESRD death notification form. Both forms were completed with data from a combination of sources including medical records and death certificates. Inconsistencies between the two forms were resolved in favor of the ESRD death notification form, except when the cause of death was missing or unknown in the latter. For the purpose of analysis, the codes for cause of death were collapsed into eight categories: cardiovascular deaths, stroke, infection/sepsis, malignant neoplasm, gastrointestinal tract disorder, accident/suicide, miscellaneous others, and unknown.

Patient survival with graft function was estimated with the Kaplan-Meier product limit method. Adjusted survival probabilities and cause-specific mortality risks were computed as days to death using the Cox proportional hazard regression. Patients were censored (removed) from the cause-specific survival analysis at the date of death if they died from other causes, therefore being at risk of dying of the cause of interest until that time. Chi-square and *t*-test were used for univariate analysis. Control variables studied in the multivariate patient survival analysis included recipient age, race, and gender; primary cause of ESRD; pretransplant duration of dialysis and pretransplant blood transfusion; cytomegalovirus (CMV) status; most recent panel reactive antibody (PRA) level; year of transplantation; history of prior renal transplantation; delayed graft function (that is, need for one or more dialysis treatments in the first posttransplant week); acute rejection up to six months posttransplant; source of donor organ (living vs. cadaveric donor); donor age, gender, race, and cause of death.

Table 1. Baseline characteristics of renal transplant recipients according to vital status

Characteristic	Died with graft function (N = 7040)	Alive with graft function (N = 58,172)	P value
Recipient factors			
Age *years*	49.6 ± 12.1	42.8 ± 12.4	<0.001
Gender			
male:female	64.3:35.7	59.5:40.5	<0.001
Race			
White	74.8	74.1	0.184
African American	20.4	19.1	0.014
Other	4.8	6.8	<0.001
Primary cause of ESRD			
Glomerulonephritis	17.9	25.5	<0.001
Hypertension	17.5	15.4	<0.001
Diabetes mellitus	35.6	23.2	<0.001
Cystic kidney disease	5.8	5.9	0.672
Other	7.7	11.4	<0.001
Prior renal transplant	10.6	10.8	0.589
Donor factors			
Living:cadaveric	14.9:85.1	28.5:71.5	<0.001
Gender			
male:female	59.0:41.0	57.5:42.5	0.015
Age *years*	33.5 ± 15.8	33.2 ± 15.0	0.144
Race			
White	87.4	87.5	0.981
African American	10.6	9.8	0.168
Other	2.0	2.7	<0.001
Mean serum creatinine			
mg/dL	1.9 ± 0.8	1.7 ± 0.7	<0.001

Abbreviations are: *N*, number of patients; ESRD, end-stage renal disease. Data are % or mean ± 1 SD.

In order to capture any variability in the outcomes across transplant centers ("center effect") [21–24], we constructed an indicator of the success rate for each center based on the center's one-year graft survival of first cadaveric renal transplants performed in 1995, which was then adjusted for the yearly number of transplants per center and the average age of the recipients. A total of 228 centers was divided into three groups according to the calculated indicator variable (adjusted one-year cadaveric graft survival) in the following way: group I, <85%; group II, 85 to 90%; and group III, >90%. This classification scheme included 97, 86, and 45 transplant centers in groups I, II, and III, respectively.

Statistical analysis performed with SAS software version 6.12 (SAS Institute, Inc., Cary, NC, USA). All tests of statistical significance are two-tailed. A result was considered to be statistically significant if the α was ≤ 0.05.

RESULTS

The study subjects (N = 86,502) accumulated 345,591 person-years of observation. Table 1 shows the baseline characteristics of study subjects who were alive and those who died with graft function. Of the 21% (N = 18,482) who died during follow-up, 7040 (38.1%) occurred in patients with graft function. The median time from trans-

Table 2. Cause of death with graft function (DWGF) among renal transplant recipients, 1988–1997

Cause of death	DWGF (N = 7040) N (%)
Cardiovascular	2538 (36.1)
Stroke	438 (6.2)
Infection/sepsis	1240 (17.6)
Malignancy	648 (9.2)
Gastrointestinal tract disorder	145 (2.1)
Accident/suicide	129 (1.8)
Other	683 (9.7)
Unknown	1180 (16.8)
Missing	39 (0.6)

plantation to death with function was 23 months (the mean was 30 ± 28 months). The most recent mean serum creatinine prior to death was 1.9 ± 0.8 mg/dL and was less than 2.0 mg/dL in 60% of patients, reflecting good renal allograft function.

The causes of DWGF are summarized in Table 2. Cardiovascular disease (CVD) was the leading cause of DWGF (36.1%, N = 2538). Half of these cardiovascular deaths occurred following acute myocardial infarction (N = 1274). Infection/sepsis and malignancy were the second and third leading causes of death, respectively. Miscellaneous causes, including pulmonary embolism, chronic obstructive pulmonary disease, hemorrhage from ruptured vascular aneurysm or other sites, dementia, and diabetic coma, accounted for 9.7% of DWGF. The cause of DWGF was unknown in 16.8% and missing (that is, not reported) in 0.6% of deaths.

Overall, DWGF accounted for 42.5% of all graft loss, with the proportion increasing from 27.2% during the first-month post-transplant to 47.3% between post-transplant months 2 and 12, and then decreasing to 43.2% during months 13 through 60, and 39.9% between post-transplant months 61 and 120. Almost half (47.1%) of the DWGF occurring within 30 days after transplantation was due to CVD, primarily acute myocardial infarction. Ischemic heart disease remained as the leading cause in each of the post-transplant intervals under study. Infection was the second leading cause of DWGF, reaching the highest level of 28.2% during the 2- to 12-month interval; however, the frequency of infectious deaths was markedly lower (less than 15% of deaths) during all other intervals. There were 62 deaths from suicide and 71 deaths from accidents. Only two of the accidental deaths were reported as transplant related. The rate of suicide was 15.7 deaths per 100,000 person-years compared with 9 deaths per 100,000 patient-years in the United States general population (P = 0.0001) [25]. The risk of suicide was highest between 13 and 60 months post-transplant. The median time from transplantation to suicide was 16 months versus 23 months for all DWGF ($P < 0.001$). The victims of suicide were younger with mean age at transplantation of 39 ± 12 years compared with 49 ± 12 years in other DWGF ($P < 0.001$). The post-transplant malignancy accounted for 4.4% of DWGF in the first year. Thereafter, 12.1 to 13.1% of DWGF were due to malignancy.

To assess whether patient subgroups with different causes of ESRD have variable predisposition to death from specific causes, we analyzed adjusted cause-specific mortality rates by cause of ESRD. The mortality rate was overall significantly higher than average for patients with diabetic ESRD (23.7 vs. 15.1 deaths per 1000 person-years, $P < 0.001$) and lower than average for patients with cystic kidney disease (9.9 vs. 15.1 deaths per 1000 person-years, P = 0.007). The excess mortality rates in the diabetic ESRD group were due primarily to more than a twofold higher than average risk of death from CVD (11.0 vs. 5.0 deaths per 1000 person-years, $P <$ 0.001) and stroke (2.3 vs. 0.9 deaths per 1000 person-years, $P < 0.001$). Post-transplant lymphoproliferative disease (PTLD) accounted for 13.4% (N = 87) of deaths caused by malignancy.

The unadjusted overall patient survival with graft function was 97, 91, and 86% at 1, 5, and 10 years, respectively. The 10-year survival with graft function in patients with ESRD caused by glomerulonephritis was 88%, other causes 87%, cystic kidney disease 85%, hypertension 81%, and diabetes mellitus 76%. Overall, patients with ESRD caused by cystic kidney disease had a lower than average rate of DWGF (14.4 vs. 21.0 deaths per 1000 person-years, P = 0.001) but a significantly higher rate of DWGF from malignancy (1.9 vs. 1.4 deaths per 1000 person-years; P = 0.05) and stroke (1.5 vs. 0.9 deaths per 1000 person-years, P = 0.001).

Multivariate Cox proportional hazard regression was used to identify factors predisposing to DWGF. Table 3 shows the adjusted risk ratio (RR) and the corresponding significance level of patient- and transplant-related factors associated with DWGF during the first 120 months after transplantation. As would be expected, the age at transplantation exerted the strongest effect on the probability of being alive with graft function. Compared with age 18 to 29 years, recipients older than 65 years at transplantation were seven times more likely to die with function (RR = 7.02, $P < 0.001$). The risk of DWGF and recipient age also followed a highly significant direct relationship for the intermediate age groups (years) 30 to 44 (RR = 1.76), 45 to 54 (RR = 3.08), and 55 to 64 (RR = 4.64). Using glomerulonephritis as a reference group (RR = 1.00), patients with ESRD caused by cystic kidney disease were at a lower risk of DWGF (RR = 0.81, $P < 0.001$), but diabetes mellitus (RR = 1.93, $P <$ 0.001) and hypertension (RR = 1.12, P = 0.003) were associated with a greater risk of DWGF.

After controlling for other factors, the risk of DWGF was lower in both African American and other race

Table 3. Factors associated with death with graft function in renal transplant recipients

Variable (reference)	Relative risk[a]	95% Confidence interval	*P* value
Age at transplantation (18–29 years)			
30–44 years	1.76	1.54–1.95	<0.001
45–54 years	3.08	2.77–3.42	<0.001
55–64 years	4.64	4.18–5.17	<0.001
≥65 years	7.02	6.21–7.94	<0.001
Male recipient (female)	1.16	1.11–1.22	<0.001
Recipient race (white)	1.00		
African American	0.92	0.86–0.98	0.009
Other	0.76	0.68–0.85	<0.001
Primary cause of ESRD (glomerulonephritis)			
Diabetes mellitus	1.93	1.82–2.05	<0.001
Hypertension	1.12	1.04–1.20	0.003
Cystic kidney disease	0.81	0.73–0.90	<0.001
Other	0.94	0.85–1.03	0.175
Repeat transplant (primary transplant)	1.06	0.97–1.15	0.201
Transplant era (1988–1992)			
1993–1997	0.69	0.65–0.73	<0.001
Pretransplant transfusion (none)	1.10	1.06–1.17	<0.001
Prior dialysis (preemptive transplant)			
1–6 months	1.00	0.89–1.11	0.945
7–12 months	1.14	1.03–1.25	0.009
13–24 months	1.20	1.10–1.31	<0.001
>24 months	1.41	1.29–1.54	<0.001
Cadaveric donor (living donor)	1.19	0.89–1.30	0.376
Delayed graft function (no)	1.28	1.21–1.36	<0.001
Early acute rejection (no)	1.12	1.06–1.18	<0.001
Pretransplant PRA (0%)			
−1–10%	1.02	0.96–1.09	0.449
11–30%	1.00	0.90–1.10	0.944
>30%	1.18	1.08–1.30	<0.001
Donor race (white)			
African American	1.11	1.02–1.20	0.014
Other	0.91	0.76–1.08	0.275
Donor age (19–29 years)			
0–6 years	1.05	0.90–1.22	0.522
7–11 years	1.10	0.96–1.27	0.175
12–18 years	1.02	0.94–1.10	0.617
30–44 years	1.02	0.95–1.09	0.634
45–64 years	1.09	1.02–1.18	0.016
Male donor (female)	0.97	0.92–1.02	0.169
Donor cause of death (head trauma)			
Cerebrovascular disease	1.09	1.02–1.17	0.017
Transplant center (group III)			
Group I	1.26	1.17–1.35	<0.001
Group II	1.22	1.13–1.30	<0.001

[a] Adjusted for all factors listed in this table

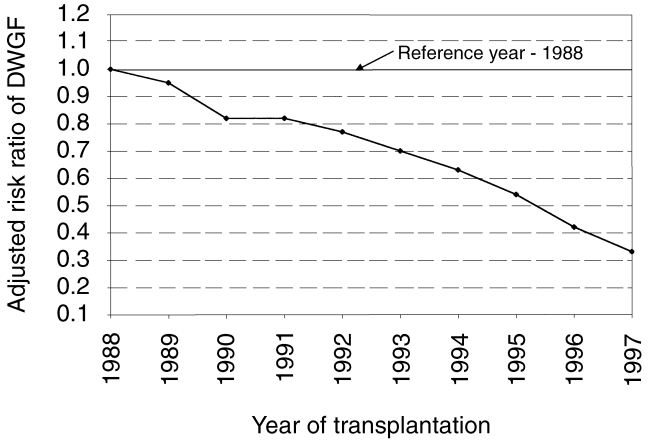

Fig. 1. Trends in the risk of death with graft function: 1988–1997 (*N* = 86,502).

group recipients compared with whites (RR = 0.92, $P = 0.009$ for African Americans, and RR = 0.76, $P < 0.001$ for others). Other recipient factors associated with DWGF were male gender (RR = 1.16, $P < 0.001$), blood transfusion (RR = 1.10, $P < 0.001$), and presensitization with most recent PRA level greater than 30% (RR = 1.18, $P < 0.001$). DWGF was less likely to occur if transplantation was preceded by no or less than six months of dialysis therapy. Compared with preemptive renal transplantation, the risk of DWGF increased with the duration of pretransplant dialysis treatment from an adjusted RR of 1. 14 for 7 to 12 months of dialysis treatment to 1.41 for more than 24 months of treatment.

A number of donor factors and early transplant events were significantly associated with greater probability of DWGF. These included delayed graft function, acute rejection episode during the first six months, African American donor race, donor age above 45 years, and donor death because of cerebrovascular disease as compared with head trauma.

The risk of DWGF was substantially lower for transplants performed after 1990. When each year of transplantation was entered separately into the Cox model along with all other covariates, there was a clear trend toward improved survival for each year after 1988 (reference), which reached statistical significance after 1989 (Fig. 1). From 1990, the reduction in risk continued until the most recent year of the study (1997). The RR of DWGF in patients grafted in 1997 was 67% lower than in patients transplanted in 1988 (RR = 0.33, $P < 0.001$). In the final model reported in Table 3, transplants were divided into two eras (1988 through 1992 vs. 1993 through 1997) to show an overall 31% reduction in the risk of DWGF for patients undergoing renal transplantation between 1993 and 1997 compared with the earlier years. The reduction in the risk of DWGF between the eras was evident for all causes of death examined, being greatest for infectious deaths, which declined by 23% in the more recent time period (1993 through 1997, RR = 0.768, $P < 0.001$) compared with 1988 through 1992.

Finally, we found differences in the risk of DWGF among transplant centers in a pattern consistent with the well-documented center-dependent variability in graft survival [21–24]. In center groups I, II, and III (classified

according to one-year cadaveric graft survival of <85%, 85 to 90%, and >90%, respectively), the risk of DWGF increased inversely with graft survival. Using center group III as the reference group, the RR of DWGF in center groups I and II was 1.26 and 1.22, respectively ($P < 0.001$ each). Center size did influence the risk of DWGF. Center group I with the lowest patient and graft survival had a higher proportion of African American recipients (27.3%) compared with 19.3 and 19.5% in center groups II and III, respectively ($P = 0.001$).

DISCUSSION

The results of this observational study show a marked and significant improvement over time in the survival of renal transplant recipients with functioning grafts. The 10-year patient survival with function increased from 55 to 60% in the late 1970s [14, 16, 26–29] to 86% in this series. Importantly, the post-transplant mortality rate continued to decline despite a substantial increase in the number of high-risk ESRD patients undergoing renal transplantation [19, 20].

The study also highlights the importance of DWGF relative to other competing risks of graft loss. Almost half (43%) of all graft loss was due to death with function, and the effect of DWGF on graft loss was gradually more pronounced with longer time since transplantation. This finding supports the strong case previously made by others [11, 12] that graft survival analyses should consider death with function for better interpretation. This is particularly important as graft survival statistics are increasingly being used to evaluate programs and formulate policy [30].

The hazard of mortality from CVD was most pronounced in diabetics in whom the adjusted CVD death rate was twofold higher than any other group. Primary acute ischemic heart disease accounted for most of the cardiovascular deaths and was predominant during all post-transplant intervals. This is in agreement with several reports [11, 16, 17, 29], including a series reported by Lindholm et al in which ischemic heart disease was the overwhelming cause of death, accounting for 53% of deaths with graft function [6]. However, many more studies, consisting mainly of earlier series, have reported infection as the leading cause of death in a mix of transplant recipients with and without graft function [13–15, 18, 26–28, 31–33]. The discrepancy in the leading cause of death among studies can be explained by several differences, including the transplant era (1970s to early 1980s vs. more recent years), patient selection, post-transplant interval under study, nosological definition of terms, and the source of mortality statistics. In contrast to others [16, 29, 32], we estimated survival from the date of transplantation to avoid bias of survivorship effects in prevalent cohorts, and studies using a similar approach have uniformly reported CVD as the most important cause of mortality [6, 11, 12].

The suicide rate in this study was higher than that reported in the U.S. general population. A high rate of suicide has been reported in transplant patients, but mostly in the setting of graft failure occurring early after transplantation [18]. ESRD is associated with devastating psychological trauma and high potential for situational depression [34–37]. The relatively high rate of suicide observed in patients who have been freed from the tedium of chronic dialysis treatment (for which higher suicide rates have been reported) illustrates the ongoing psychological burden attendant to ESRD as a chronic disease [20, 38]. In the present study, suicide was more likely in younger recipients, and unlike in the general population, there was no racial or gender predisposition.

Although 35% of suicides occurred in the first 12 months post-transplant, the median time from transplantation to suicide was 16 months. This indicates that mood disturbance associated with high-dose corticosteroid therapy in the immediate post-transplant period was unlikely to be the major proximate cause of suicide. Even after successful transplantation, emotional crisis may be precipitated by abrupt termination of social support provided by the in-center dialysis programs or the inability to realize the anticipated dramatic change in life necessary to sustain an independent mode of living [39]. The potential for suicide may also be heightened by treatment of concurrent medical conditions, for example, as a depressive side-effect of antihypertensive medications [40].

In line with other studies [6, 9, 10], the most important determinants of death with function were recipient age and ESRD caused by diabetes mellitus. The direct relationship between recipient age and mortality risk in all age groups under study is in agreement with a previous report [10]. The excess risk of death in diabetics can be explained, primarily, by significantly higher mortality rates from both CVD and stroke. ESRD from cystic kidney disease conferred an overall lower risk of death, but the slightly higher risk specifically for stroke and malignancy-related deaths in this subgroup may be related to the association between polycystic kidney disease and cerebral aneurysm and renal cancer. As recently shown by Cosio et al, we also found prior history and duration of pretransplant dialysis treatment (>6 months) to be associated with an increased risk of death with function [9]. This finding suggests longer exposure to the immunosuppressive effect of both renal failure and dialysis and greater likelihood of malnutrition, both of which may adversely affect post-transplant survival [9].

In line with other studies [6, 10, 16], increased mortality was associated with established risk factors for graft survival such as presensitization, delayed graft function, acute rejection, advanced donor age, and donor death caused by cerebrovascular disease. In some cases, this

concordance of risk factors for mortality and graft survival suggests a direct mechanistic relationship. For example, atherosclerotic disease with iliofemoral involvement is prevalent in the renal transplant population [41] and may predispose to DWGF followed by successful graft recovery and subsequent premature cardiovascular death. Alternatively, risk factors such as plasma renin activity (PRA) levels may carry over to DWGF as an epiphenomenon of the mix of patients selected for transplantation. In the latter respect, the presence of a "center effect" in patient survival suggests differences in the mix of transplant candidates and management of post-transplant complications between centers. Although the cause of center variability has not been fully elucidated, clinical differences not measurable in registry data have been implicated [21].

Serum creatinine (S_{Cr}) at the last follow-up was used to define patients dying with graft function. However, S_{Cr} was recorded only semiannually during the first year and annually thereafter. Thus, whether patients in the study actually died with graft function as opposed to death because of impairment of graft function is open to question. A reasonable level of assurance was obtained by our exclusion of patients with advanced renal allograft dysfunction. In addition, graft function in patients who died (mean S_{Cr} 1.9 $\pm$ 0.8 mg/dL) compares favorably with transplant recipients who were alive without dialysis treatment (1.7 $\pm$ 0.7 mg/dL).

A potential source of bias was the multiple reporting of the cause of death data, which originated from the ESRD death notification form, medical records, and death certificate. Reporting of data to these diverse sources was designed to address the specific and legitimate but often incompatible needs of the respective agencies. There is generally poor agreement between the registry and death certificates in cause of death reported for ESRD patients, but agreement was much better for transplant recipients [42]. Source differences in the cause of death information may partly explain the disparity between this study and others with respect to the ranking of causes of death. The proportion with unknown cause of death is typical for mortality statistics in general, and only a small fraction (0.6%) of patients was missing the cause of death. Differential misclassification of the cause of death was also a potential source of bias [43]. Notwithstanding this potential limitation, our findings are in agreement with individual transplant center reports, which likely have more complete and uniform reporting of causes of death than registry data [6, 9, 11, 12, 16, 18].

This study is generalizable to the U.S. renal transplant population because it used population-based data. Nevertheless, the absence of more detailed clinical information such as blood pressure levels, lipids and homocysteine levels, and other important atherosclerotic risk factors limits the interpretations of the results, particularly given the dominance of cardiovascular deaths in the study cohort.

In summary, the survival of patients with functioning renal transplants is high and has markedly improved in recent years. CVD, primarily acute myocardial infarction, supersedes infection as the leading cause of death at all times during the first 10 years following renal transplantation. Cause-specific mortality varies substantially depending on the post-transplant interval under study. Mental health support should be an integral part of post-transplant care because emotional dehiscence may become a lethal complication despite successful renal transplantation, particularly in younger recipients. Recipient age and ESRD caused by diabetes mellitus were the overriding determinants of DWGF. Preemptive and living-donor renal transplantation independently favor improved longevity. Attention to cardiovascular risk factors, particularly in diabetics, offers the greatest potential to improve the chances of living longer with graft function.

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