

# **Chapter VII**

## **Causes of Death**

**I**n view of the relatively high mortality among ESRD patients, a clear understanding of the causes of death is needed to support efforts directed at improving survival for these patients. This chapter describes death rates for specific causes of death per year at risk among various subgroups of prevalent dialysis and transplant patients.

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### **Analytical Methods**

The HCFA Death Notification Form is the primary source of information on causes of deaths. For overall death rates, additional information is retrieved by the USRDS from other sources including Social Security Death Benefits files and hospital discharges. Analysis of these sources reveals that the Death Notification Form is missing or incomplete in 14.3 percent of deaths. Physicians report deaths and causes of death for all ESRD patients according to a list of 22 causes of death on the Death Notification Form including categories for "other known cause" and "unknown cause." The latter two categories were listed as 7.8 percent and 6.2 percent, respectively, of reported ESRD deaths for all patients. Future reports will contain more detailed death information since a new Death Notification Form with 60 causes of death has been

developed and was fielded in the Fall of 1990. For the present USRDS report, the causes of death from the new form have been collapsed into the categories of the old form. More detail is provided below regarding withdrawal as cause of death according to the new form which inquired for each death whether withdrawal from dialysis had occurred.

Mortality rates by primary cause of death were analyzed among patients prevalent at the beginning of the years 1989, 1990, and 1991. Patients were followed through each year and the days at risk were calculated for each patient by year, so that patients dying during a year contribute only the days from the beginning of the year to date of death. On this basis, figures for patient years at risk were calculated. Patients surviving through the end of one year also contributed to the next year's analysis. The analysis of death rates by causes of death for all ESRD patients is shown in Table VII-1 by sex, race, and age groups. The 15 listed causes of death are derived from the 22 causes on the HCFA Death Notification Form by placing the smallest cells ( these include pulmonary embolism, air embolism, vascular access hemorrhage, viral hepatitis, pancreatitis, suicide, and treatment-related and treatment-unrelated accidents) into the

“other causes” category. Each of these small cells account for a death rate of less than 1.0 per 1,000 patient years. More detailed information is provided in the Reference Tables, Section D. For

completeness, the rates for missing data on cause are also shown as a category. Causes of death for pediatric patients are described in Chapter IX.

**Cause Specific Death Rates (per 1,000 Patient Years)  
for All ESRD Patients by Age, Race and Sex, 1989-91**

Cause of Death	Average	Male	Female	Black	White	20-44	45-64	65+
Cardiac, Acute M.I.	19.1	20.2	17.7	16.1	20.6	4.9	19.3	38.1
Cardiac, Pericarditis	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.2
Cardiac, Other	45.1	45.1	45.1	42.3	46.8	13.2	39.0	96.9
Cerebrovascular	8.4	7.1	10.0	9.8	7.9	3.1	7.3	17.1
Embolism, Pulmonary	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.0
Hemorrhage, G.I.	2.6	2.5	2.6	2.5	2.6	< 1.0	2.1	5.7
Hemorrhage, Other	1.0	< 1.0	1.1	1.0	1.0	< 1.0	1.0	1.9
Infection, Septicemia	14.8	12.9	16.9	16.6	14.0	5.7	14.1	28.0
Infection, Pulmonary	4.5	5.0	3.9	3.7	4.8	1.6	3.2	10.2
Infection, Other	2.1	2.2	2.0	2.9	1.8	2.1	2.0	2.5
Hyperkalemia	1.8	1.8	1.7	1.7	1.8	1.8	1.4	2.3
Malignancy	4.6	5.3	3.8	4.8	4.7	< 1.0	4.4	10.0
Withdrawal From Dialysis	19.5	17.3	22.2	11.1	23.8	4.0	12.7	50.0
Unknown Cause	11.0	11.0	11.1	13.4	10.0	5.6	10.2	19.8
Other	13.7	13.3	14.2	13.5	13.9	6.3	12.2	25.8
Missing Data	25.3	25.0	25.5	21.7	27.0	10.6	24.5	46.3
Total Death Rate	176.4	173.1	180.3	164.2	184.0	63.2	156.5	358.9
Total Patient Years at Risk	450,151	243,409	206,741	135,190	294,003	147,696	169,700	120,498

Medicare patients only. Source: Reference Table D.27.

**Table VII-1**

**Cause Specific Death Rates**

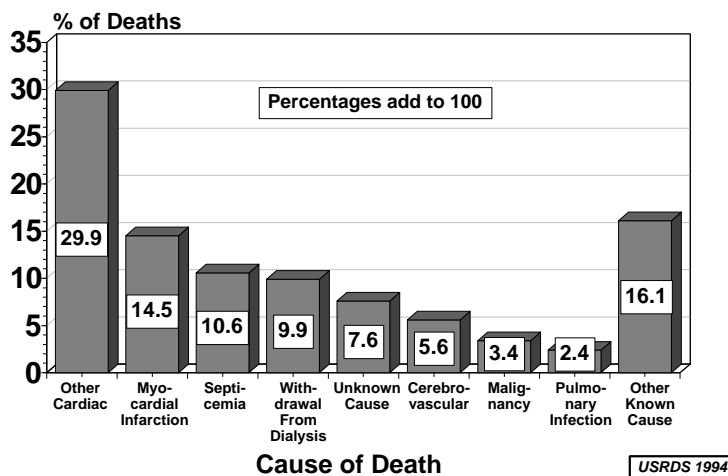
Cause specific death rates among prevalent ESRD patients are shown in Table VII-1 for 1989-1991. Myocardial infarction and “other cardiac causes” are the most common causes of reported ESRD patient deaths, with death rates of 19.1 and 45.1 per 1,000 patient years respectively. These rates increase drastically in older age groups, reaching,

respectively, 38.1 and 96.9 per 1,000 patient years for age 65 and older patients. Males have a higher rate of death due to myocardial infarction than do females (20.2 versus 17.7 per 1000 patient years). Whites have higher rates than blacks for each of the cardiac categories. Cardiac death rates for Native Americans are similar to those of blacks and rates for Asian Americans are relatively low compared to all other race groups (see Reference Tables).

The mortality rate due to septicemia is slightly higher than that due to acute myocardial infarction in 20-44 year old patients but is clearly lower in older patients. Withdrawal from dialysis is the third most common reported cause of death and accounts for 11.1 percent of deaths in ESRD patients (19.5/1000 patient years). In the patient age group of 65+, withdrawal from dialysis ranks second after cardiac causes with a death rate of 50/1000 patient years (or 13.9 percent of deaths). Withdrawal from dialysis is over twice as commonly reported for white patients than for black patients, as previously noted in a Michigan Kidney Registry study (Port, Wolfe 1992). Malignancy is not a frequently reported cause of death, reaching 4.4 and 10.0 per 1,000 patient years for ages 45-64 and 65+

respectively, yet the incidence rate of certain neoplasms has been reported to be several times higher in dialysis (Kantor; Port, Ragheb 1989) and transplant patients (Penn) than the expected rate for a matched general population. The rates for other known causes of death are also identified in Table VII-1. If one assumes that virtually all cardiac deaths are due to atherosclerotic disease, then the combination of acute myocardial infarction, other cardiac, and cerebrovascular accident gives an estimate of the contribution of atherosclerotic cardiovascular disease to all deaths in ESRD patients. This sum accounts for a death rate of 72.6 per 1,000 patient years and 41.2 percent of all ESRD deaths.

**Distribution of Causes of Death for ESRD Patients, Ages 45-64, 1989-91**



**Figure VII-1**

*Distribution of causes of death for ESRD patients, ages 45-64 years, 1989-91. Patients in Puerto Rico and the U.S. Territories are included. Medicare patients only. Source: Reference Table D.50.*

It is also of interest to analyze the distribution of causes of death. Figure VII-1 shows the causes of death as percent of deaths among all ESRD patients aged 45 to 64 years. Cardiac causes combined account for 55 percent of deaths followed by septicemia and withdrawal from dialysis, each at near 10 percent of deaths. Percentages can be calculated for various subgroups listed in the tables of this chapter by dividing the cause-specific death rate by the overall reported death rate (i.e. death rate for total minus missing).

**Causes of Death by Modality**

**All Dialysis**

Death rates by cause of death were analyzed separately for prevalent dialysis patients for the same years (1989, 1990, and 1991). Dialysis patients with a prior renal transplant were included unless the transplant failed during the year of study. Patients transplanted during the year of observation were censored (removed from the analysis) on the day of transplantation. Results of this analysis are shown in Table VII-2. Death rates are higher for dialysis patients than for

**Cause Specific Death Rates (per 1,000 Patient Years)  
for All Dialysis Patients by Age, Race and Sex, 1989-91**

Cause of Death	Average	Male	Female	Black	White	20-44	45-64	65+
Cardiac, Acute M.I.	25.8	28.6	23.0	18.6	30.7	8.2	24.5	39.1
Cardiac, Pericarditis	1.0	1.2	< 1.0	1.0	1.1	< 1.0	1.0	1.2
Cardiac, Other	62.4	65.5	59.2	49.2	71.3	24.3	51.4	100.0
Cerebrovascular	11.3	9.9	12.8	11.2	11.6	5.3	9.3	17.6
Embolism, Pulmonary	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.0
Hemorrhage, G.I.	3.5	3.7	3.4	2.8	4.0	1.1	2.8	5.9
Hemorrhage, Other	1.3	1.2	1.4	1.1	1.4	< 1.0	1.1	2.0
Infection, Septicemia	19.8	17.9	21.8	19.0	20.4	9.9	17.6	28.7
Infection, Pulmonary	5.9	6.7	5.0	4.2	6.9	2.5	3.7	10.5
Infection, Other	2.7	3.0	2.4	3.3	2.4	3.9	2.2	2.6
Hyperkalemia	2.5	2.7	2.3	2.0	2.8	3.5	1.9	2.4
Malignancy	6.0	7.2	4.7	5.4	6.6	1.2	5.1	10.1
Withdrawal From Dialysis	27.2	25.2	29.3	13.0	36.6	7.2	16.8	51.7
Unknown Cause	14.9	15.3	14.3	15.3	14.7	9.8	13.0	20.3
Other	18.1	18.3	17.9	15.2	20.2	10.5	15.1	26.5
Missing Data	30.8	30.7	30.8	22.9	35.7	14.3	26.4	46.4
Total Death Rate	235.9	240.2	231.3	186.5	269.3	105.6	194.5	368.0
Total Patient Years at Risk	317,157	162,534	154,623	114,020	187,739	72,265	124,135	116,446

Medicare patients only. Source: Reference Table D.18

**Table VII-2**

all ESRD patients because of the lower death rates particularly after the early post operative period among patients with functioning transplant (who are included in the all ESRD category). Cardiac and acute myocardial infarction deaths predominate and account for 37.4 percent of deaths, with death rates of 62.4 and 25.8 per 1,000 patient years respectively. Overall, patterns for dialysis patients are similar to those described above for all ESRD except that rates are comparatively higher, particularly for the younger age groups. Withdrawal from dialysis appears to

have increased over earlier USRDS reports, which has been reported recently for ages 50 - 69 years (Nelson).

### Hemodialysis

To further describe the role of peritoneal dialysis versus hemodialysis and that of diabetes (which is associated with high death rates) the group of prevalent dialysis patients was further subdivided by dialytic modality and diabetes status. The methodology was the same as described above. Switches among dialytic modalities during the 365

### Cause Specific Death Rates (per 1,000 Patient Years) for All Hemodialysis Patients (Never Transplanted) by Age, Race and Diabetic Status, 1989-91

Cause of Death	Diabetic					Non-Diabetic				
	Average	Black*	White*	20-44	45-64	Average	Black*	White*	20-44	45-64
Cardiac, Acute M.I.	38.7	27.8	46.8	22.7	37.7	22.1	16.1	26.5	4.1	17.4
Cardiac, Pericarditis	1.2	<1.0	1.4	1.1	1.2	1.0	1.0	1.0	<1.0	<1.0
Cardiac, Other	83.3	62.6	98.0	56.5	70.0	57.5	45.7	66.4	17.2	40.5
Cerebrovascular	15.8	15.4	16.4	11.0	13.2	10.0	10.1	10.0	4.2	7.4
Embolism, Pulmonary	1.0	1.0	1.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hemorrhage, G.I.	3.8	3.4	4.2	2.2	2.9	3.8	3.0	4.4	<1.0	2.9
Hemorrhage, Other	<1.0	<1.0	<1.0	<1.0	<1.0	1.6	1.3	1.9	<1.0	1.4
Infection, Septicemia	26.3	25.1	27.7	17.5	21.8	16.8	16.4	17.1	7.5	13.7
Infection, Pulmonary	5.7	4.4	6.4	3.8	3.9	6.6	4.3	8.1	2.2	3.9
Infection, Other	2.5	2.1	2.7	3.5	2.5	2.3	3.0	1.7	3.5	1.8
Hyperkalemia	3.4	2.0	4.5	8.0	2.7	2.6	2.2	2.9	3.5	2.0
Malignancy	3.2	4.0	2.9	<1.0	2.8	8.1	6.8	9.1	1.5	7.0
Dialysis Withdrawal	36.0	18.5	48.6	18.4	25.8	25.9	11.7	36.0	4.1	12.3
Unknown Cause	20.6	19.4	21.6	21.5	17.8	13.2	14.2	12.7	8.0	10.5
Other	19.1	15.6	22.0	18.5	15.2	17.9	15.1	19.9	8.6	13.8
Missing Data	37.8	26.9	46.0	24.2	32.9	27.7	20.5	33.1	10.4	19.5
Total Death Rate	301.2	231.4	353.1	212.7	253.9	219.9	173.7	253.8	79.3	157.6
Total Pt. Yrs. at Risk	68,238	25,821	38,124	9,957	32,500	173,889	67,069	100,587	39,584	59,966

Medicare patients only. Source: Reference Tables D.22 and D.23. \* All ages.

Table VII-3

days of follow-up were not considered. These results are presented in Table VII-3 for hemodialysis patients by two groups: those with diabetes as primary cause of ESRD, and those with all other causes of ESRD combined. The age groups 20-44 and 45-64 years are shown in this table (data for age groups beyond this range are shown with further detail in the Reference Tables, Section D). The sample size for the age and race groups ranged from 9,957 to 100,587 patient years for the three one-year follow-up periods. The diabetic group has higher death rates for most causes, on average by a factor of 1.3 to 2.7. Of note are the greater than three-fold differences for diabetics aged 20-44 years compared to non-diabetics of the same age group, for causes such as acute myocardial infarction, other cardiac causes, and withdrawal from dialysis. Similar death rates for diabetic and non-diabetic patients were observed among 45-65 year old patients for gastrointestinal and other hemorrhages, and for pulmonary infection. White patients in these age ranges have higher death rates than blacks, particularly for cardiac causes, withdrawal from dialysis, pulmonary infection and, among diabetic patients, for hyperkalemia.

### **CAPD/CCPD**

The same treatment specific analyses were repeated for prevalent CAPD and CCPD patients combined. The results, shown in Table VII-4, may be compared among subgroups of this table and with the findings for hemodialysis patients reported in Table VII-3. Diabetic as compared to non-diabetic patients treated with CAPD/CCPD at the beginning of each year had overall

higher death rates with particular excess (greater than three fold) for those due to myocardial infarction, other cardiac causes, cerebrovascular disease, hyperkalemia, and withdrawal from dialysis. This excess is greater among the 20-44 than the 45-64 year age group. These observations are similar to those described above for hemodialysis patients.

A comparison of the CAPD groups relative to the hemodialysis groups (Tables VII-3 and VII-4) reveals for patients aged 45-64 years, higher death rates (by more than 5/1000 patient years) due to myocardial infarction, other cardiac causes, septicemia, and withdrawal from dialysis for among both diabetic and non-diabetic patients. These differences by dialytic modality are smaller for the 20-44 age group. These observations agree well with the comparative mortality risk analyses among incident CAPD and hemodialysis patients (Held).

### **Transplant**

For patients who received a transplant during the years 1986, 1987, and 1988, the death rates by causes of death were analyzed with the same methodologies described above. However, analyses in this report focused on either the early or the subsequent post transplant experience. Thus follow-up was restricted to either the first year after transplantation or from the first anniversary date to the end of the third year post transplantation.

Patients whose transplant failed during the first year remained in the transplant group for the first year study

of causes of death. For patients who had a functioning transplant at the first anniversary, follow-up continued in the transplant group even after transplant failure until death or end of the third post transplant year. As example, Figure VII-2, shows the percent distribution of causes of death after the first year post transplant for patients 45 to 64 years old. Acute myocardial infarction and other cardiac causes predominate as causes of death followed by sepsis. This pattern is not dissimilar from that shown in Figure VII-1 for all ESRD patients.

Analysis of cause specific death rates for the same period of follow-up and age group, shown in Table VII-5, reveals however, markedly lower rates for this group than for similar dialysis patients. This is true for each cause of death comparison with corresponding rates in dialysis patients. Table VII-5 also shows that cardiac and cerebrovascular death rates are greater in blacks than whites among non-diabetic patients. By contrast, among diabetic patients these differences by race are in the opposite direction. For death rates due to septicemia, blacks are at much greater

**Cause Specific Death Rates (per 1,000 Patient Years) for CAPD/CCPD Patients (Never Transplanted) by Age, Race and Diabetic Status, 1989-91**

Cause of Death	Diabetic					Non-Diabetic				
	Average	Black*	White*	20-44	45-64	Average	Black*	White*	20-44	45-64
Cardiac, Acute M.I.	43.9	32.1	46.9	23.1	48.2	21.9	12.5	25.3	4.8	21.9
Cardiac, Pericarditis	1.5	<1.0	1.7	2.1	1.0	1.0	1.5	<1.0	1.2	<1.0
Cardiac, Other	92.6	73.3	97.6	51.5	83.1	51.6	35.5	57.6	13.5	46.7
Cerebrovascular	18.5	17.5	19.3	9.8	18.3	8.8	7.2	9.6	2.0	6.5
Embolism, Pulmonary	1.7	<1.0	1.9	<1.0	2.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hemorrhage, G.I.	3.3	1.4	4.0	1.5	2.9	2.7	1.9	3.0	<1.0	2.9
Hemorrhage, Other	<1.0	<1.0	1.0	<1.0	1.2	1.1	1.0	1.0	<1.0	<1.0
Infection, Septicemia	35.2	36.9	35.4	21.9	33.8	19.2	17.1	20.2	9.0	19.1
Infection, Pulmonary	4.4	4.2	4.4	2.1	2.9	4.7	2.9	5.3	2.3	3.3
Infection, Other	4.1	3.7	4.3	3.0	3.5	4.8	7.6	4.0	5.7	2.8
Hyperkalemia	1.6	1.4	1.6	1.8	1.4	<1.0	1.0	<1.0	<1.0	<1.0
Malignancy	1.8	<1.0	2.0	<1.0	2.0	4.6	2.9	5.4	<1.0	4.5
Dialysis Withdrawal	39.6	20.8	45.2	20.0	34.7	23.4	9.8	28.5	4.7	14.7
Unknown Cause	21.6	18.4	22.4	12.9	23.2	11.7	11.3	12.0	4.8	9.8
Other	24.2	17.9	24.1	12.9	23.2	19.9	17.4	21.0	11.1	19.8
Missing Data	38.8	27.9	42.8	17.6	39.9	22.1	17.0	24.1	7.9	19.2
Total Death Rate	334.8	259.7	357.6	183.4	322.3	200.4	148.4	220.9	71.8	175.3
Total Pt. Yrs. at Risk	10,453	2,113	7,893	3,238	4,808	26,964	6,519	19,598	7,802	9,788

Medicare patients only. Source: Reference Tables D.25 and D.26. \* All ages.

**Table VII-4**



risk than whites. For each of these causes death rates are clearly higher for the 45 - 64 compared to the 20 - 44 year age groups.

The markedly lower cause specific death rates among transplant recipients compared to dialysis groups of Tables VII-2 to VII-4 is likely due, in part, to selection of healthier patients to transplantation (Port 1992; Gaylin; USRDS 1992). This would explain the finding that the risk of death due to septicemia and neoplasm is also lower among transplant recipients during year

2 and 3 even though the risks associated with immunosuppressive medications has been well established. More detail by cause of death for males and females and for other age groups is provided in the Reference Tables.

**Trends by cause of death**

Analyses of trends in causes of death for the middle to late 1980s have revealed interesting patterns: whereas cardiac, infectious and neoplastic causes showed statistically significant increases, the adjusted death rates due to

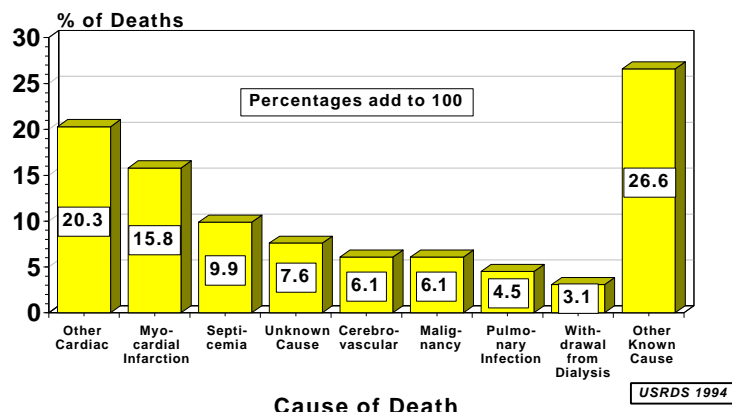
**Cause Specific Death Rates (per 1,000 Patient Years) for Patients With a Functioning Cadaveric Transplant After One Year by Age, Race and Diabetic Status, 1986-88**

Cause of Death	Diabetic					Non-Diabetic				
	Average	Black*	White*	20-44	45-64	Average	Black*	White*	20-44	45-64
Cardiac, Acute M.I.	9.4	4.3	10.6	8.1	12.0	3.5	5.1	3.0	2.0	5.8
Cardiac, Pericarditis	<1.0	1.0	<1.0	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cardiac, Other	11.9	11.8	12.3	10.5	15.8	5.5	7.2	5.0	4.5	7.5
Cerebrovascular	5.8	3.2	6.4	5.4	7.1	1.1	1.4	1.0	<1.0	1.9
Embolism, Pulmonary	<1.0	2.1	<1.0	<1.0	1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hemorrhage, G.I.	<1.0	.	<1.0	<1.0	.	<1.0	<1.0	<1.0	<1.0	<1.0
Hemorrhage, Other	<1.0	1.0	<1.0	<1.0	1.6	<1.0	<1.0	<1.0	<1.0	<1.0
Infection, Septicemia	4.7	8.6	4.1	4.2	6.0	2.8	3.8	2.6	2.1	4.0
Infection, Pulmonary	1.1	.	1.3	1.1	1.0	1.3	1.9	1.1	<1.0	2.4
Infection, Other	1.1	1.0	1.1	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	1.0
Hyperkalemia	<1.0	1.0	<1.0	1.3	.	<1.0	<1.0	<1.0	<1.0	<1.0
Malignancy	<1.0	1.0	<1.0	<1.0	1.6	1.6	1.3	1.7	<1.0	2.9
Dialysis Withdrawal	3.6	1.0	4.1	3.6	3.8	<1.0	<1.0	<1.0	<1.0	<1.0
Unknown Cause	6.4	9.7	5.6	6.5	6.0	2.4	4.1	1.8	2.4	2.6
Other	5.3	8.6	4.7	4.0	8.7	4.3	5.4	3.8	3.2	5.9
Total Death Rate	70.6	72.4	71.2	64.3	85.7	35.8	46.2	32.8	26.2	52.8
Total Pt. Yrs. at Risk	6,340	925	5,274	4,443	1,830	25,187	6,035	18,104	13,731	8,701

Medicare patients only. Source: Reference Tables D.51 and D.52. \* All ages.

Table VII-5

**Distribution of Causes of Death After First Year Post Cadaveric Transplant, Ages 45-64, 1986-88**



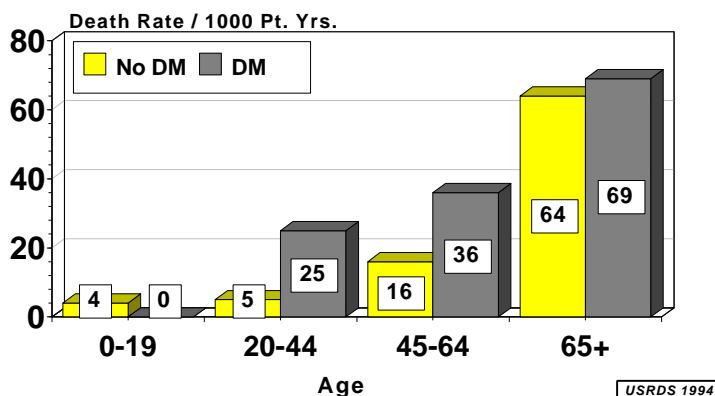
**Figure VII-2**

*Distribution of causes of death after first year post cadaveric transplant, ages 45-64, 1986-88. Patients in Puerto Rico and the U.S. Territories are included. Medicare patients only. Source: Reference Table D.50.*

cerebrovascular accidents decreased (Bloembergen). This finding is encouraging and indicates the value of research in this area. A recent study by Mailloux et al using a different cause of death classification showed infection as a leading cause of death among dialysis patients. This suggests the need for

further research regarding causes of death among ESRD patients.

**Death Rate Due to Withdrawal Among Dialysis Patients by Age and Diabetic Status, 1991**



**Figure VII-3**

*Death rate due to withdrawal among dialysis patients by age and diabetic status, 1991. Patients in Puerto Rico and the U.S. Territories are included. Medicare patients only. Source: Special analysis.*

### Reasons for Withdrawal from Dialysis, All Dialysis Patients, 1991

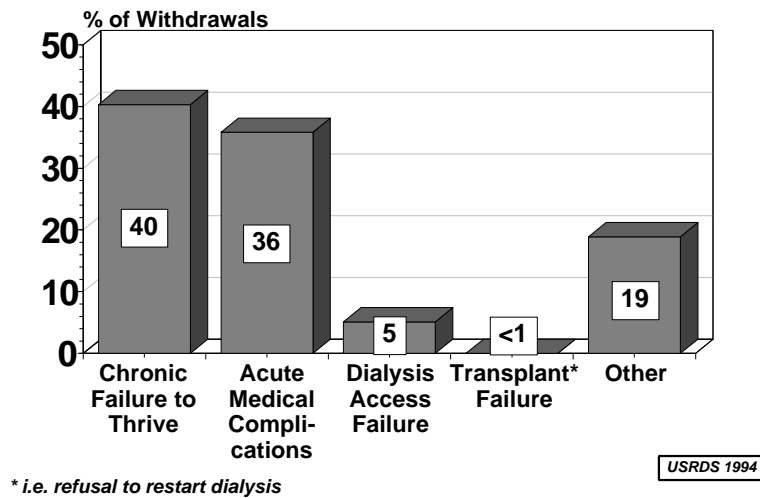


Figure VII-4

Reasons for withdrawal from dialysis, all dialysis patients, 1991. Patients in Puerto Rico and the U.S. Territories are included. Medicare patients only. Source: Special analysis.

## Withdrawal from Dialysis

Since the new ESRD Death Notification Form, introduced by HCFA in late 1990, requires information on all patients regarding prior withdrawal from dialysis, new analyses are now feasible. As shown in Figure VII-3, the death rate due to withdrawal from dialysis increased with age and was more than two fold higher in diabetics aged 20 to 64 than non-diabetics while it was similar for diabetics as for non-diabetics of older age. In this analysis, withdrawal from dialysis was analyzed as the overriding cause of death. For patients above 65 years of age, the withdrawal death rate exceeded 60 per 1000 patient years. By comparison, the previous form had listed withdrawal from dialysis as a primary cause of death in 50 patients per 1000 patient years for the same age group (Table VII-1). This indicates that withdrawal from dialysis was not always

listed as the primary cause of death when it was considered only as one of the causes of death.

According to the new Death Notification Form the reason for withdrawal from dialysis can also be assessed. The leading reason for withdrawal was chronic failure to thrive (40 percent) as shown in Figure VII-4. Acute medical complications led to withdrawal as the second most common reason (36 percent). Dialysis access failure was an uncommon cause and transplant failure with refusal to return to dialysis was extremely rare. Using this new data collection tool more detail will be explored in future studies.

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