

# Chapter VI

## Causes of Death

The analyses of cause-specific mortality presented in this chapter may serve as a source of new hypotheses to explain the high mortality rate of the ESRD population. Such hypotheses and further in-depth epidemiologic and clinical research efforts would facilitate reduction of deaths or cause-specific death rates. 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 ESRD Death Notification Form serves as the primary source of information on causes of death among the ESRD population. A revised form has been in use since 1990, which includes 59 cause of death categories (including categories for “other known” and “unknown” cause). This differs from the prior form which listed 22 causes of death. In addition, on the previous form “withdrawal from dialysis” was listed as one of the 22 causes, whereas the new form inquires whether “withdrawal from dialysis” occurred prior to death, as a question separate from “cause of death”. Thus for each death, the patient’s physician reports both the cause of death and whether the patient withdrew from dialysis prior to death. The current USRDS reports on data for deaths in 1991-1993 .

The USRDS files include a “missing” cause of death category for those patients who, by means of the Social Security Death Benefits files and hospital discharge records, are known to have died but for whom no Death Notification Form was received. Analyses of these sources reveals that the Death Notification Form is missing or incomplete in about 11 percent of total reported deaths. For completeness, the death rates for patients with missing cause are also shown as a category in all tables. For the purpose of this report, the 59 causes on the HCFA Death Notification Form plus the “missing” category, were

collapsed into 14 cause of death categories as shown in Table VI-1. More detailed information is provided in the Reference Tables, section D for the death categories are collapsed to 22 causes. The majority of this chapter presents statistics for adult ESRD patients (age 20 and over). A brief description of causes of death for pediatric patients is also presented.

Death rates were analyzed by primary cause of death among patients who were prevalent at the beginning of, or incident (defined as 90 days following start of ESRD) during, the years 1991, 1992 and 1993. 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 January 1 (if prevalent) or inception (if incident) to date of death. On this basis, statistics for patient years at risk were calculated. A patient prevalent at the beginning of both 1991 and 1992 contributed data to both years. In all analyses, patients were censored at loss to followup or end of the calendar year, and in analyses of dialysis groups, patients were censored at transplantation. Patient followup was characterized by age (20-44, 45-64, 65+), race (followup, White), sex, and modality (PD, never transplanted; HD, never transplanted; unknown dialysis, never transplanted; functioning transplant; PD, failed transplant; HD, failed transplant; unknown dialysis, failed transplant) at the beginning of each cohort year for prevalent patients or at 90 days of ESRD for incident patients, better reflecting the effect of modality, which may change in a given patient from one year to the next. The total number of patient deaths by cause and years at risk for both years were aggregated to enhance the stability of the estimated death rates.

Cause-specific death rates for various patient subgroups presented in this chapter were statistically adjusted for demographic covariates (age, race, sex, diabetes and as indicated, for modality) using direct

**Collapsed Categories from Causes of Death on Death Notification Form (HCFA-2746)\***

**Acute Myocardial Infarction (Acute MI)**

**Cardiac Arrest, cause unknown**

**Cardiac, other**

- Atherosclerotic heart disease
- Cardiac arrhythmia
- Cardiomyopathy
- Pericarditis, including cardiac tamponade
- Pulmonary edema, due to exogenous fluid
- Valvular heart disease

**Cerebrovascular (CVD)**

- Cerebrovascular accident
- Ischemic brain damage

**Septicemia**

- Septicemia, due to vascular access
- Septicemia, due to peritonitis
- Septicemia, due to PVD/gangrene
- Septicemia, other

**Other Infection**

- Pulmonary infection, bacterial
- Pulmonary infection, fungal
- Pulmonary infection, other
- Viral infection, CMV
- Viral infection, other
- Tuberculosis
- Fungal peritonitis
- Infection, other
- Hepatitis B
- Other viral hepatitis

**AIDS**

**Malignancy**

- Malignant disease, Hx of immunosupp. Rx
- Malignant disease, other

**Hemorrhage**

- GI hemorrhage
- Hemorrhage from transplant site
- Hemorrhage from vascular access
- Hemorrhage from dialysis circuit
- Hemorrhage from ruptured vascular access
- Hemorrhage from surgery
- Other hemorrhage

**Cachexia**

**Hyperkalemia**

**Other**

- Pulmonary embolus
- Mesenteric infarction/Ischemic bowel
- Liver-drug toxicity
- Cirrhosis
- Polycystic liver disease
- Liver failure, cause unknown
- Pancreatitis
- Perforation of peptic ulcer
- Perforation of bowel
- Bone marrow depression
- Dementia
- Seizures
- Diabetic coma, hypo/hyperglycemia
- Chronic obstructive pulmonary disease
- Complications of surgery
- Air embolism
- Accident related to treatment
- Accident unrelated to treatment
- Suicide
- Drug overdose-street drugs
- Drug overdose
- Other identified cause

**Unknown**

**Missing (Cause of death not recorded or no Death Notification Form)**

\* Revised, in use since September 1990

**Table VI-1**

standardization. Adjustments for age were by 5 year age categories. Patients less than age 20 were excluded. Stratified unadjusted death rates for a variety of subgroups are presented in the Reference Tables, Section D. Adjusted and unadjusted death rates due to different causes of death (columns) can be added within a given patient subgroup. The same applies to tables for unadjusted death rates.

Although death rates tend to be more informative, it is also of interest to analyze the distribution of causes of death among patients who died. This also allows comparisons with other studies and data from other registries which present the percent distribution of cause of death. Percentages can be calculated for various subgroups from death rates in the reference

tables and from the "total" columns of Tables VI-2 to VI-5 by dividing the cause-specific death rate by the overall reported death rate (i.e. using death rate for the total minus the missing as the denominator). Similarly, for patient subgroups listed in the same tables, dividing an adjusted death rate (minus that for missing) by the overall reported death rate would result in the percent of deaths by subgroup.

**Cause Specific Death Rates**

Table VI-2 shows death rates among all prevalent and incident *ESRD* patients (dialysis and transplant) by cause of death for sex, race, age (20-64 years and greater than 65 years) and cause of *ESRD* (diabetes versus all others) subgroups, adjusted for all other

**Adjusted<sup>1</sup> Cause Specific Death Rates for All ESRD Patients  
By Sex, Race, Age (20-64,65+), and Diabetic Status, 1991-1993**

Cause of Death <sup>2</sup>	Deaths per 1000 Dialysis Patient Years <sup>3</sup>								
	Total	Male	Female	Black	White	Age 20-64	Age 65+	Diab	Non-Diab
Acute MI	18.5	20.6	16.2	14.1	20.8	13.2	26.6	26.6	14.9
Cardiac Arrest	31.0	31.9	30.1	27.9	32.9	20.9	46.0	44.9	25.2
Other Cardiac	28.8	31.3	26.2	20.4	33.1	17.0	46.6	36.9	25.4
CVD	10.2	9.0	11.4	10.1	10.4	7.0	15.4	14.6	8.3
Septicemia	18.1	16.8	19.6	18.5	18.4	13.5	26.3	25.7	14.7
Other Infection	5.9	6.5	5.3	4.9	6.4	3.7	9.2	7.0	5.5
AIDS	1.3	1.9	0.6	2.4	0.3	1.9	0.2	0.3	1.6
Malignancy	6.7	7.9	5.5	6.4	7.1	4.3	12.1	4.4	7.8
Hemorrhage	3.4	3.5	3.4	3.1	3.6	2.4	4.9	3.0	3.7
Hyperkalemia	3.6	3.5	3.7	2.2	4.5	2.8	4.5	5.1	3.0
Cachexia	1.9	1.6	2.3	1.6	2.2	0.9	3.3	2.0	1.8
Other	23.3	22.6	24.1	18.0	26.4	15.7	35.1	28.5	21.3
Unknown	11.9	12.5	11.5	12.0	12.0	8.6	17.4	16.6	10.0
Missing	21.2	23.1	19.3	17.3	23.5	13.5	37.2	27.3	19.0
<b>TOTAL</b>	<b>185.9</b>	<b>192.6</b>	<b>179.1</b>	<b>159.0</b>	<b>201.4</b>	<b>125.2</b>	<b>284.8</b>	<b>242.8</b>	<b>162.1</b>

Medicare patients over age 20. Source: Special Analysis

<sup>1</sup> Adjusted for sex, race, age (5-year categories) and diabetic status

<sup>2</sup> Categories collapsed from Death Notification Form (HCFA-2746) as per Table VI-1

<sup>3</sup> Death Rates add vertically to the total.

**Table VI-2**

covariates. Cardiac arrest of unknown cause, acute myocardial infarction and all other cardiac causes, with adjusted death rates of 31, 18.5 and 28.8 deaths per 1000 patient years, respectively, make cardiac causes combined the most commonly reported cause of ESRD patient deaths.

The high prevalence of cardiac disorders in ESRD patients has been noted previously and has been shown to be associated with an elevated risk of mortality (USRDS 1992; Churchill 1992; Foley 1995). As expected, these rates increase in older age groups, reaching respectively, 46, 26.6 and 46.6 deaths per 1000 patient years for patients age 65 and older. Death rates due to these cardiac causes are

substantially higher among diabetics than among nondiabetics. They are also higher among White than Black and among male than female ESRD patients.

The revised Death Notification Form has provided detailed information on deaths attributed to cardiac causes. Table VI-3 shows the percent distribution of specific cardiac causes among all deaths classified as cardiac and among all deaths. It shows that the largest proportion (39.5 percent) of cardiac deaths are attributed to "cardiac arrest, cause unknown. Acute myocardial infarction, cardiac arrhythmia, atherosclerotic heart disease and cardiomyopathy account for 23 percent, 13 percent, 9 percent and 9 percent of cardiac deaths respectively.

**Adjusted<sup>1</sup> Death Rates and Percent Distribution of Specific Cardiac Causes, Among All Cardiac Causes for All ESRD Patients, 1991-93**

Cause of Death	Total DR	% of Cardiac	% of Total
Cardiac arrest, cause unknown	31.0	39.5	16.6
Acute myocardial infarction	18.5	23.7	10.0
Cardiac arrhythmia	10.8	13.8	5.8
Cardiomyopathy	7.5	9.6	4.1
Atherosclerotic heart disease	7.4	9.5	4.0
Valvular heart disease	1.1	1.5	0.6
Pericarditis	0.4	0.5	0.2
Pulmonary edema	1.6	2.0	0.8
<b>Total Cardiac Causes</b>	<b>78.3</b>	<b>100.0</b>	<b>42.1</b>
<b>Overall Total</b>	<b>185.9</b>		

<sup>1</sup> Adjusted for age (5 yr categories), race, sex, and diabetic status  
Medicare patients over age 20. Source: Special Analysis

**Table VI-3**

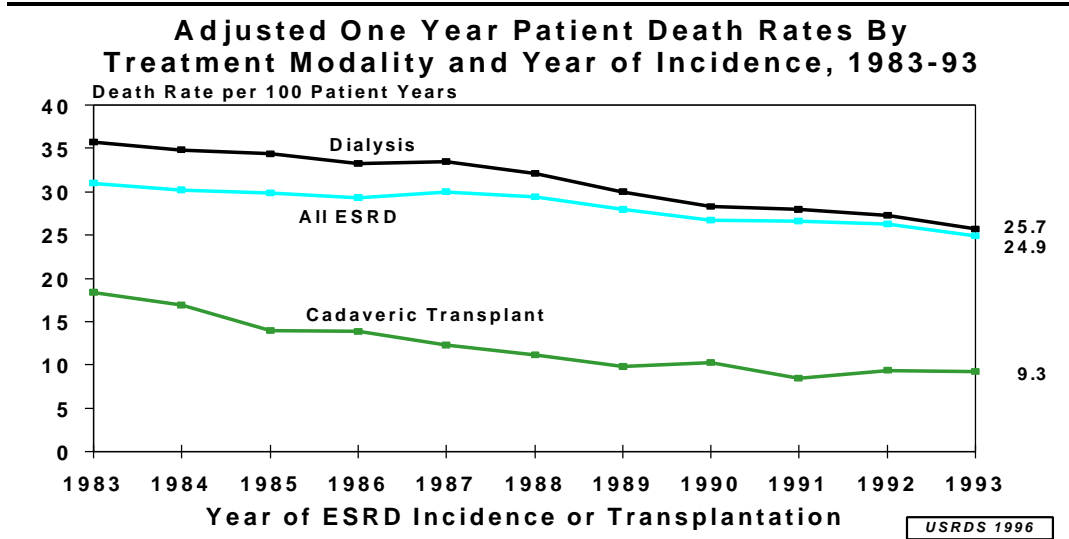


Figure VI-1

The categories are collapsed from the Death Notification Form as per Table VI-1. Infection includes Septicemia, Other infection, and AIDS. Other known cause includes Hemorrhage, Cachexia, Hyperkalemia, and Other. Missing cause of death is excluded. Patients in Puerto Rico and the U.S. Territories are included. Medicare patients only. Source: Reference Table D.4.

Pulmonary edema, valvular disease, and pericarditis are relatively uncommon reported cardiac causes of death.

The overall death rate due to cerebrovascular disease was 10.2 deaths per 1000 patient years (Table VI-2). The death rates due to this cause increased substantially by age, were almost twice as high among diabetics than nondiabetics, were higher among females than males and were similar by race.

If one assumes that virtually all cardiac deaths are due to atherosclerotic disease, then the combination of acute myocardial infarction, cardiac arrest, 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 88.5 per 1000 patient years overall (47.6 percent of all deaths) and a death rate as high as 134.6 per 1000 years among the over 65 age group (47 percent of all deaths in this age category).

The overall death rate due to septicemia was 18.1 per 1000 patient years and due to other infections (excluding AIDS) was 5.9. Combined, these infectious causes had a higher death rate than acute myocardial infarction among the overall populations and for all race, sex and age subgroups shown. ESRD patients are known to have a high incidence of infection due to defects in cellular immunity, neutrophil function and complement activation (Khan

1993; Vanholder 1993). Additionally, dialysis patients have an elevated risk of infection due to the vascular access or peritoneal catheter. Although death rates due to septicemia were higher for females than males, the death rate due to other infections was higher among males. Adjusted death rates due to septicemia were similar among Blacks and Whites, whereas death rates due to other infections were higher among Whites. Death rates due to both infectious etiologies were higher among patients age 65 and older compared to younger categories and among diabetics compared to nondiabetics. AIDS was an uncommon reported cause of death for the ESRD population (< 1 percent of deaths overall). Adjusted death rates due to AIDS were over 3 times higher for males than females, over 8 times higher among Blacks than Whites and approximately 10 times higher among patients 20-64 compared to those over 65, which seems to reflect the risk of acquiring AIDS. Death rates due to AIDS were much lower among diabetics than nondiabetics, probably due to competing risks.

Death rates due to malignancy (6.7 deaths per 1000 patient years) indicate that malignancy is not a common cause of death. Previous studies have suggested an increased risk of certain malignancies in the dialysis (Port, 1989a; Kantor 1987; Inamoto 1991) and transplant (Penn 1988) population as compared to the general population. Although this may be due to the effect of uremia or a side-effect of

**Adjusted<sup>1</sup> Cause Specific Death Rates for Never Transplanted  
Dialysis Patients<sup>2</sup> By Treatment Modality, Age, Sex, Race  
and Diabetic status, 1991-93**

Cause of Death <sup>3</sup>	Deaths Per 1000 Patient Years <sup>4</sup>										
	Total	HD	PD	Male	Female	Black	White	20-64	65+	Diab	Nondiab
Acute MI	25.5	24.8	31.5	28.3	22.6	18.9	29.1	17.8	34.8	35.1	20.8
Cardiac Arrest	43.3	43.4	45.3	44.7	42.0	38.2	46.3	28.8	61.2	60.5	35.5
Other Cardiac	40.5	39.2	51.5	43.8	37.0	27.7	47.0	23.6	60.3	50.2	36.0
CVD	14.0	13.6	18.2	12.3	15.7	13.4	14.4	9.3	19.9	18.9	11.6
Septicemia	24.7	23.4	36.8	22.7	26.8	24.8	25.1	18.2	33.4	34.3	19.9
Other Infection	7.6	7.5	8.3	8.4	6.9	6.1	8.4	4.3	11.6	8.8	7.1
AIDS	1.8	1.6	3.1	2.6	0.8	3.1	0.4	2.6	0.1	0.3	2.2
Malignancy	9.0	9.3	6.8	10.8	7.4	8.4	9.7	5.6	13.6	5.5	10.7
Hemorrhage	4.7	4.8	4.4	4.8	4.7	4.2	5.0	3.2	6.6	4.0	5.1
Hyperkalemia	5.1	5.3	3.6	4.9	5.1	3.0	6.3	3.8	6.3	6.9	4.2
Cachexia	2.7	2.6	4.4	2.3	3.2	2.2	3.1	1.3	4.5	2.8	2.6
Other	31.7	31.1	39.0	30.7	32.8	23.6	36.4	20.8	44.3	37.0	29.3
Unknown	16.3	16.1	18.7	17.0	15.8	16.1	16.5	11.6	22.2	21.4	13.8
Missing	26.6	27.0	26.9	29.0	24.4	20.2	30.1	15.7	39.5	32.5	24.1
TOTAL	253.5	249.6	298.5	262.1	245.2	209.9	277.8	166.6	358.2	318.1	222.8

Medicare patients over age 20. Source: Special Analysis

<sup>1</sup> Adjusted for sex, race, age (5-year categories), modality and diabetic status

<sup>2</sup> Excludes patients with a history of prior transplant and on "unknown dialysis".

<sup>3</sup> Categories collapsed from Death Notification Form (HCFA-2746) as per Table VI-1

<sup>4</sup> Death Rates add vertically to the total.

**Table VI-4**

renal replacement therapy, the recent USRDS Case Mix studies found a diagnosis of malignancy in 9 percent of patients at initiation of therapy (USRDS 1992), suggesting that acceptance of patients with malignancy is relatively common. Death rates due to this cause are almost 3 times higher among ages 65+ compared to ages 20-64 and almost 2 times higher among nondiabetics than diabetics. The latter may again reflect the issue of competing risks among diabetics i.e. the high probability of dying of other causes.

Figure VI-1 shows the percent distribution (rather than death rates) for the major categories of reported cause of death among *all ESRD patients* aged 45-64 years. Nineteen percent of all deaths were attributed to the category cardiac arrest, cause unknown, followed by infection (16 percent), "other cardiac causes" (16 percent), myocardial infarction (13 percent), cerebrovascular disease (6 percent) and malignancy (4 percent). The distribution is similar for patients over 65 with the exception that "other cardiac causes" are somewhat more common and infection less common as causes of death than in patients age 45-64.

### Causes of Death among Dialysis Patients

Death rates by cause of death were analyzed for prevalent and incident ESRD patients treated with hemodialysis or peritoneal dialysis who had never received a transplant. Patients with a history of prior transplant and receiving "unknown" dialysis were excluded. Patients transplanted during the year of observation were censored (removed from the analysis) on day of transplantation. Results of this analysis are shown in Table VI-4 for 1991-1993. These death rates are adjusted for age, race, sex, modality and diabetic status. Overall, patterns of cause of death for *dialysis* patients are similar to those described above for *all ESRD*. However, death rates due to all causes of death are higher for *dialysis* patients than for the general *ESRD* population because the *transplant* population, which is generally younger and healthier and which has lower death rates, is included in the total *ESRD* category. Cardiac causes of death predominate with cardiac arrest, acute MI, other cardiac causes and cerebrovascular disease accounting for 49 percent of deaths, with death rates of 43.3, 25.5, 40.5 and 14.0 per 1000 dialysis patient years, respectively.

A comparison of the all-cause mortality rates by dialysis modality adjusted for age, race, sex, and

diabetes (Table VI-4) reveals a 20 percent higher risk of death among prevalent peritoneal dialysis compared to prevalent hemodialysis patients, consistent with a prior published study which used similar USRDS prevalent patient data, for years 1987-89 (Bloembergen, 1995a). This difference has previously been shown to be attributed to an increased risk of death due to infection, acute myocardial infarction, all other cardiac causes (including cardiac arrest), cerebrovascular disease, and withdrawal from dialysis (Bloembergen, 1995b). Table VI-4 allows a similar comparison of cause of death and shows that death rates due to acute myocardial infarction, "other cardiac causes", cerebrovascular disease, septicemia, cachexia and other known causes are greater among PD than HD treated patients. This analysis indicates that although there is a substantial difference in death rates due to acute MI and "other cardiac causes", there is little difference in death rates reported in the "cardiac arrest" category among PD and HD treated patients. Cardiac arrest may be a poorly defined label and must be interpreted with caution. The death rate due to AIDS is higher among PD than HD treated patients. This may reflect greater utilization of PD among AIDS patients developing ESRD. The death rate due to malignancy is lower for peritoneal dialysis than hemodialysis, also consistent with the prior published study. This analysis also reveals that the death rate due to hyperkalemia is higher among hemodialysis patients. These differences in cause-specific mortality among PD and HD treated patients may be due to the technical differences of these dialysis modalities, differences in compliance, medical care, or dose of dialysis. As a result of a number of studies showing a relationship of dose of dialysis and mortality, dose of dialysis has increased substantially on a national level among the hemodialysis population (see chapter IV). However, only recently has a similar relationship been found among PD treated patients, and has stimulating an interest in increasing the dialysis dose in this population as well (Canada-USA). Difference in case-mix severity among these patient groups may also play a role although a previous study has shown relatively small differences in comorbidity between PD and HD treated incident patients (USRDS 1992 ADR; Held 1994).

The all-cause death rate remains higher (7 percent) among male than female dialysis patients although this difference has decreased over the past decade (Chapter V). Table VI-4 shows that this difference is mainly attributable to higher adjusted death rates due to acute myocardial infarction, malignancy, cardiac arrest, and other cardiac causes.

This is consistent with a previous study that compared cause-specific mortality between males and females (Bloembergen 1994), although the relative risks (male/female) are lower due to the decrease in the difference of all-cause mortality between males and females, over recent years. Also consistent with this study and of note is that death rates due to cerebrovascular disease are higher among females. Death rates reported to be due to septicemia were higher among females while death rates due to other infections were higher among males.

The risk of death is also higher among White than Black dialysis patients. This has previously been shown to be attributed to an increased risk of death due to acute myocardial infarction, all other cardiac causes, withdrawal from dialysis and infection (Bloembergen 1994). Table VI-4 confirms that the adjusted death rates for all causes are higher among Whites than Blacks with the exception of AIDS for which death rates are markedly lower for Whites. The largest excess risk is for "other cardiac causes", acute MI, and cardiac arrest and hyperkalemia. Lower degrees of comorbidity among the Black compared to the White ESRD population, either because Blacks reaching ESRD are "healthier" or because of greater acceptance of Whites with comorbid conditions, could explain these differences in mortality by race. In addition, a higher transplantation rate among Whites would leave fewer "healthier" patients in the dialysis group as compared to Blacks. However, this explains at most a small part of the observed difference in death rate, since Table VI-2 also shows a markedly higher death rate for Whites in the all ESRD (combined dialysis and transplant) population.

Among dialysis patients, diabetics have substantially higher adjusted death rates due to acute myocardial infarction, cardiac arrest, other cardiac causes, septicemia, cerebrovascular disease, and hyperkalemia than nondiabetics.

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## Causes of Death among Transplant Recipients

Table VI-5 shows cause-specific death rates per 1000 patient years for all prevalent patients with a *functioning transplant* on Jan 1 of 1991, 1992 and 1993, adjusted for sex, race, age and diabetes status. Patients are followed through the remainder of each year independent of transplant failure that may have occurred in some patient during the year. Comparison of patients with similar age reveals markedly lower death rates for each cause of death among patients with a functioning transplant as compared to those

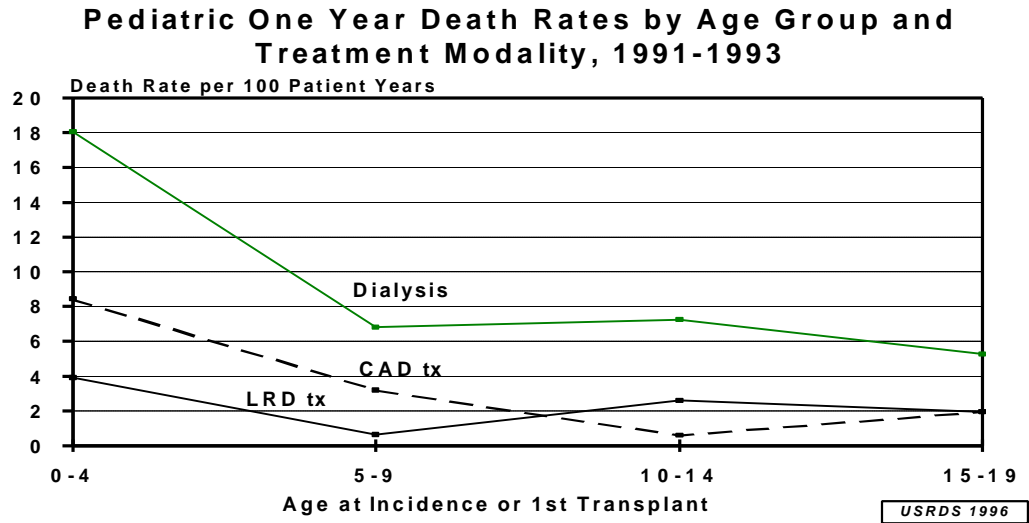


Table VI-5

among dialysis patients (see Table VI-4). This is likely due in part to selection of healthier patients to transplantation (Port 1992, Gaylin 1993; USRDS 1992). In addition to patient selection, other factors such as the greater level of renal functional replacement with transplantation may be playing a role in the better long-term outcomes with transplantation.

Cardiac causes of death (cardiac arrest, acute MI, other cardiac causes and cerebrovascular disease) are reported to account for approximately 28 percent of

all deaths in patients with a functioning transplant, in contrast to never transplanted dialysis patients, among whom cardiac causes combined account for approximately 49 percent of deaths.

Similar to the *dialysis* population, death rates due to acute myocardial infarction, other cardiac causes, and malignancy were higher among males than females among patients with a functioning transplant. Death rates due to septicemia and other infections were also higher among males than females in this

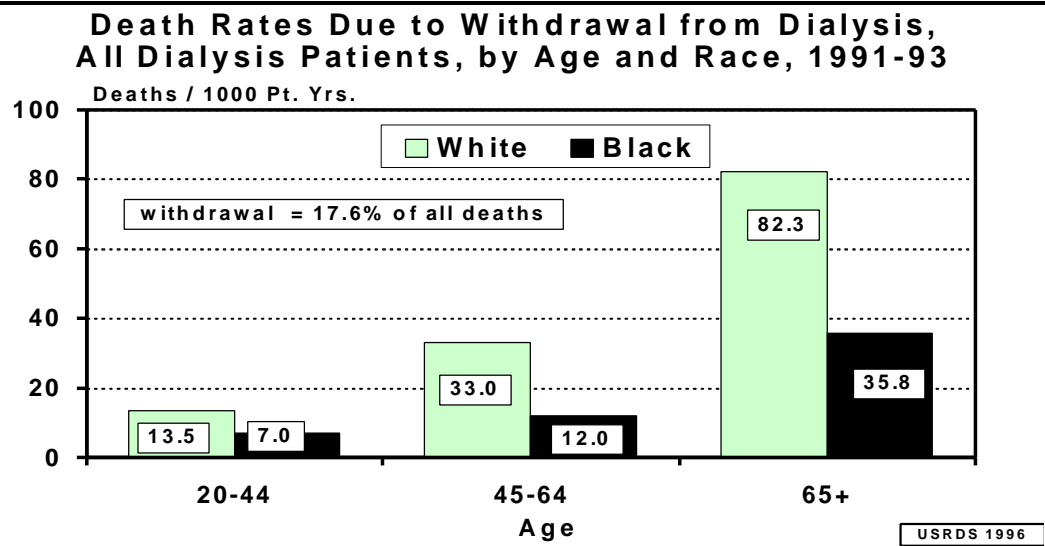


Figure VI-2

Death rate due to withdrawal among dialysis patients by age (on January 1 or at incidence) and race, 1991-93. Patients in Puerto Rico and the U.S. Territories are included. Medicare patients only. Source: Reference Table D.5.

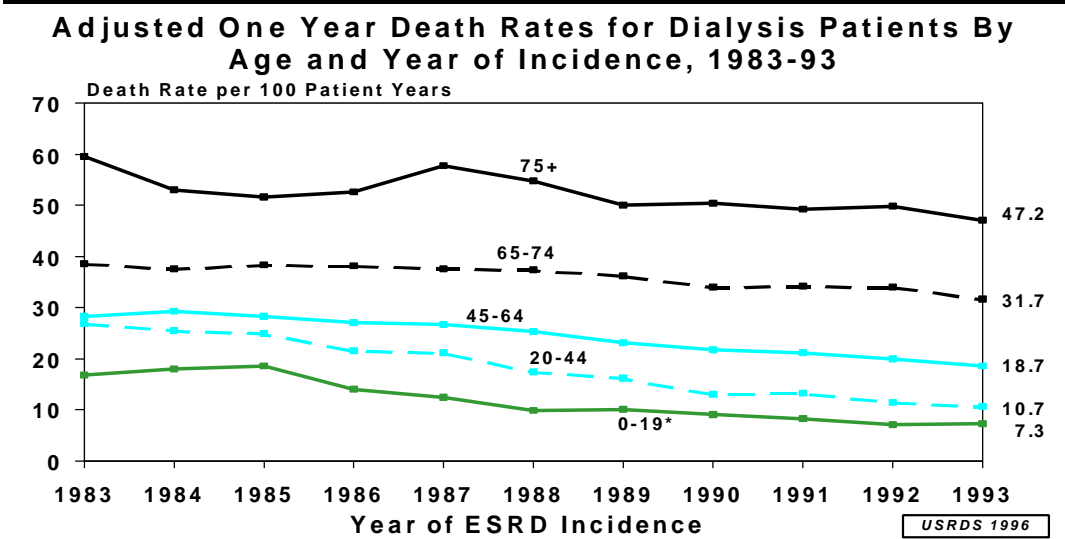


Figure VI-3

Reasons for withdrawal from dialysis, all dialysis patients, 1991-93. Patients in Puerto Rico and the U.S. Territories are included. Medicare patients only. Source: Reference Table D.5.

modality group.

Of interest is that death rates by race due to all causes except hyperkalemia and cachexia are higher among Blacks which is in direct contrast to the dialysis population where death rates due to most causes were higher among Whites. Despite these higher death rates among Black transplant recipients the benefit of cadaveric renal transplantation compared to dialysis patients on the transplant waiting list is large and similar to that observed in Whites (Ojo, 1994).

As expected, death rates for most causes were higher among the older transplant population, and death rates due to most causes were higher among diabetics.

### Withdrawal from Dialysis

In addition to data on causes of death, the new Death Notification Form provides data on whether or not the patient withdrew from dialysis prior to death. Overall, approximately 17.6 percent of patients withdraw from dialysis prior to death due to any cause. As seen in Figure VI-2 death rates for deaths preceded by (not necessarily due to) withdrawal increased with age and were approximately two fold higher in Whites compared to Blacks for all age categories over age 20. This is consistent with previous studies which have also shown that withdrawal from dialysis is over twice as commonly reported for White patients than for Black patients

(Port, 1989b; Bloembergen 1994) and that withdrawal rates increase with age (Mailloux 1993, Nelson 1994). These differences by race may be explained by a greater acceptance of White patients likely to withdraw, differences in cultural attitudes or religious beliefs toward the discontinuation of therapy, or perhaps a lesser degree of trust of Black patients and their families toward the predominantly White medical community (Leggat, 1996). Analysis of other racial groups revealed that, in terms of the percentage of deaths preceded by withdrawal from dialysis, Asian patients (12 percent) were similar to Black patients (11 percent) and Native Americans were similar to Whites (approximately 20 percent). Withdrawal from dialysis preceded death more commonly in females than males (19.4 percent versus 15.8 percent of deaths). The percentage of HD and PD patients withdrawing were similar.

Figure VI-3 shows the reported reasons for withdrawal from dialysis. The leading reason for withdrawal was chronic failure to thrive (42 percent), followed by acute medical complications (35 percent). Five percent of withdrawals were due to access failure and the remainder were due to undefined or other reasons.

Withdrawal from dialysis reflects, on the one hand, failure of renal replacement therapy, and on the other hand acceptance of patients for whom benefits from therapy may have been uncertain at initiation of ESRD therapy. As individual patient outcome is not predictable, some have advocated an approach of



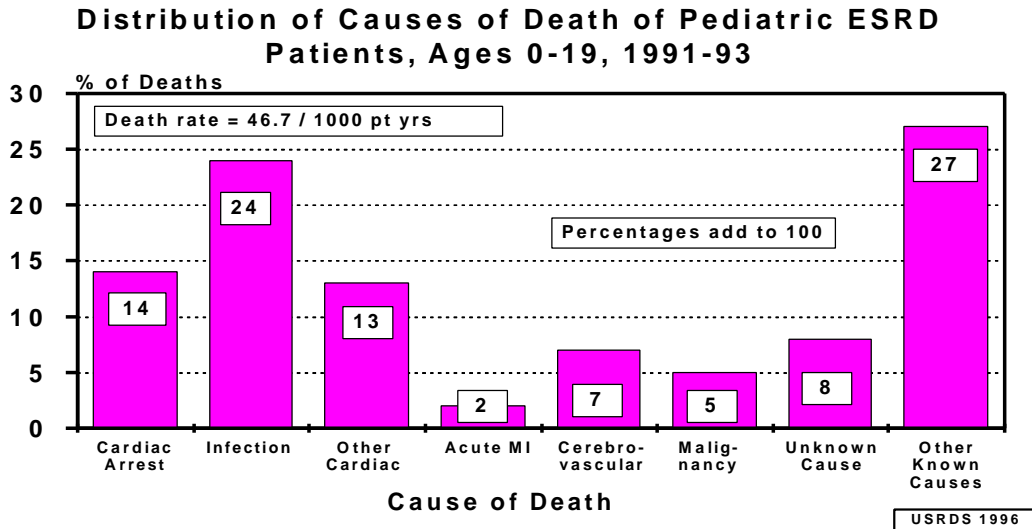


Figure VI-4

The categories are collapsed from the Death Notification Form as per Table VI-1. Infection includes Septicemia, Other infection, and AIDS. Other known cause includes Hemorrhage, Cachexia, Hyperkalemia, and Other. Missing cause of death is excluded. Patients in Puerto Rico and the U.S. Territories are included. Medicare patients only. Source: Reference Table D.

liberal acceptance policies combined with a willingness to support patients in their decision to withdraw from dialysis (Port 1994).

changes in the delivery of dialysis have been associated with decreases in mortality due to specific causes of death.

### Causes of Death among Pediatric ESRD Patients

Causes of death in pediatric patients are shown in Figure VI-4, which provides the distribution of causes of death during 1991-1993 for patients 0-19 years old. Cardiac arrest and other cardiac deaths accounted for 14 and 13 percent respectively. Acute myocardial infarction was an infrequent cause of death, accounting for less than 2 percent of deaths. Cerebrovascular accidents accounted for 7 percent of deaths. In total all cardiovascular causes (cardiac and cerebrovascular) combined accounted for 36 percent of deaths. After cardiac deaths, infection was the next most common cause of death in children accounting for 24 percent of deaths.

As for adults, data are available that secondarily label deaths according to whether or not withdrawal from dialysis occurred prior to death. These data indicate that 8 percent of pediatric deaths in 1991-93 were preceded by withdrawal from dialysis.

Further study of cause-specific mortality is necessary to enhance the understanding and reduction of preventable deaths in the ESRD population. Future longitudinal analyses may help to determine if

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