Chapter 18: Causes of Death on Renal Replacement Therapy

Summary

- This chapter corrects the errors found after publication of the 2002 Report in the chapter analysing causes of death. When comparing UK survival with the USA, UK dialysis patients had inadvertently been compared with the US cohort of the combined dialysis and transplant population (thus wrongly showing better outcomes in the USA).

- Death rates, as expected, increased with increasing age. There were significant differences between rates of death in the incident and prevalent cohorts for the age bands 45–64 and 65+ ($p < 0.05$). Gender had no effect on outcome.

- Cardiac disease was the most common cause of death in the renal population. This was independent of age (<65 or ≥65 years) although it appeared proportionately more common in the ≥65-year age group in the prevalent cohort ($p > 0.05$). In the prevalent cohort 1997-2001, cardiac disease accounted for significantly more deaths in transplant patients than those on dialysis (36.6% versus 30.7%, $p < 0.001$). Proportionately more patients with established renal failure (ERF) died from heart disease compared with the general population (32.5% versus 24%); renal patients were 1.4 times more likely to die from a cardiac cause.

- Infection related deaths were much more common in patients with ERF than the general population (16.8% versus 11.5%) representing a 1.5-fold (46%) increase. It was the second commonest cause of death in incident patients in the first 90 days (20%) and appeared more common in the ≥65 year olds although this did not reach statistical significance. In the one year after 90 days, 16% of deaths were infection related and there was no difference between the age groups. In the prevalent cohort, infection related deaths were similar in dialysis and transplant patients (17.6% versus 18.5%) and age appeared to have little effect.

- Incident and prevalent patients had similar causes of death in similar proportions. The length of time a patient has spent on renal replacement therapy (RRT) had no effect on the overall cause of death; 41% of patients on RRT for 3–5 years died from cardiac disease compared with 32% who had been on treatment for <3 years. With increasing time on RRT, however, proportionately fewer people withdrew from treatment as a cause of death (18%, 15%, 12% at 1 year after 90 days, <3 years and 3–5 years).

- Treatment withdrawal was an important cause of death. In the prevalent cohort, significantly more of the older patients withdrew from treatment ($p < 0.05$). In the smaller number of incident patients, a similar trend was observed, which did not attain statistical significance.

- At all ages, patients on RRT have a much higher relative risk of death compared with the general population. This is most pronounced in the young; 25–29 year olds with ERF were 42 times more likely to die from any cause in a given year compared with someone of the same age in the general population. The disparity diminished with longevity; there is only a 4-fold increase in risk of death in 80–84 year olds on RRT. The general population had lower proportions of death from

cardiac disease, but higher from malignancy.

- Underlying primary renal diagnosis affected death rates irrespective of age. Cystic/polycystic patients have the lowest rate of death, patients with malignancy the highest in both incident and prevalent cohorts. Using glomerulonephritis as a reference, all other primary diagnostic groups had significantly worse outcomes.

- If patients had cardiac disease on initiating RRT, 56% of the cohort died from a cardiac cause.

- Diabetics had significantly more cardiac deaths in the first 90 days compared with non-diabetics. Proportions were higher in the 1-year after 90-day incident and prevalent cohorts but this did not reach statistical significance. Rates of death were interestingly lower in the diabetics in the first 90 days compared with non-diabetics (319.4 versus 464.6/1000 patient years exposed). This may in part be due to the younger age at start of RRT of diabetics (68 versus 72 years) and their possible earlier start of treatment. However, the reverse was true in the 1 year after 90-day period when diabetics again had a younger age at start of treatment (64 and 71 years respectively), and in the prevalent cohort.

- The UK distribution of causes of death was similar when compared with other international Renal Registries. When assessing rates of death however, UK RRT patients had significantly lower death rates in all age groups than those in the USA. The comparisons were not adjusted for ethnicity. In the USA, the ethnic minorities on RRT are known to have better survival.

Introduction

Using UK Renal Registry data, 11,607 deaths were reported since the Registry was started in 1997, 6237 (54%) having a recorded cause coded from the European Dialysis and Transplant Association (EDTA) diagnostic list for causes of death (Appendix F). Whilst many other international renal registries have examined cause of death in prevalent patients, analysis of this in incident patients has only previously been reported in the USA.

Some centres have high data returns to the Registry regarding cause of death, whilst others return no information. Provision of this information is not mandatory. The percentage completeness by centre of the returns for causes of death has remained constant over the years, indicating that there has been no change at the centre level in the practice of completion of this item.

Methods

Adult patients aged 18 years and over, from England or Wales, were included in the analyses on cause of death. The data for all prevalent patients on RRT since the inception of the UK Renal Registry to 2001 with a recorded cause of death were analysed initially by treatment modality (dialysis or transplant) (Appendix F). An initial analysis was limited to centres with a high rate of return for cause of death. When compared with an analysis of all the cause of death data on the database, the percentages in corresponding EDTA categories remained unchanged so the latter data were included subsequently.

Incident and prevalent patients were analysed as separate cohorts in order to establish causes of death in different time periods. The incident cohort included all patients starting RRT since individual renal units joined the Registry, and causes of death at day 90 and 1 year after 90 days were analysed. Many international renal registries do not include the

first 90 days of RRT in their analysis whereas in the UK day 0 is recorded as the start of treatment. Analysing separately the time periods of 90 days, and 1 year after 90 days enables accurate comparisons with other countries. Transplanted patients were excluded from the analysis in the incident cohort because of the small number transplanted in this group (fewer than 100 per year) and their very low death rate. The prevalent cohort of patients was defined as those alive on 31 December 2000. The '2001' cohort was defined as those on RRT on or before 30 September 2000 and alive on 31 December 2001. Analysis of these patients provided larger numbers for analysis and comparisons of causes of death with the general population of England and Wales to be made.

To compare rates of death between incident (90 days and 1 year after 90 days) and prevalent patients a rate per 1000 patient years exposed was calculated. This is not entirely accurate in the 90-day incident cohort as we are looking at only approximately a three-month snapshot within a one-year period. However, examining death rates by patient days exposed is not something other registries quote as they exclude the first 90 day period from their analyses. Confidence intervals were calculated around the 90-day period and then converted to that of 1000 patient year equivalents.

Subgroup analysis for both incident and prevalent patients was performed examining the relationship of age, primary diagnosis and gender to the cause of death. For the incident cohort, an analysis of the interaction between co-morbidity at the start of RRT and cause of death was also undertaken together with effect of time on RRT. The ethnicity data were too incomplete to be included. The primary diagnoses for cause of renal failure categorised by EDTA coding were grouped into 10 categories (Appendix F, Table F.3.4).

The EDTA codes of death were grouped into the following categories (Table 18.30):

1. Cardiac disease
2. Cerebrovascular disease
3. Infection
4. Malignancy
5. Treatment withdrawal (ERF treatment stopped)
6. Others
7. Uncertain or not determined

Comparisons of the prevalent data were made with the general population of England & Wales and also with data from other international Renal Registries. The two-tailed Student 't' test was used for testing the significance of proportional differences, and proportional hazard ratios, for comparisons between primary renal diagnoses.

Incident patients

The incident cohort of 6732 patients was analysed for cause of death within the first 90 days and for the period 1 year after 90 days. Two patients were excluded because of inconsistencies in the data. These subsets (early deaths) were defined to allow a meaningful comparison with the USA and other international registries, where data on RRT are not collected for the first 90 days. Causes of death were also analysed for those who had survived at least 3 years on RRT (late deaths).

Analysis of deaths in the first 90 days

For this incident cohort there were a total of 679 deaths within the first 90 days (Table 18.1), of which 401 (59%) had a recorded cause. The single largest cause of death was cardiac disease (34.9% of those recorded). Proportionately, the causes of death were similar to those in the prevalent population (Tables 18.15 and 18.17).

Table 18.1. Cause of death by age in incident patients in the first 90 days

Cause of death	All Deaths	All % of those with data	<65 Deaths	<65 % of those with data	65+ Deaths	65+ % of those with data
Cardiac disease	140	34.9	41	41.8	99	32.7
Cerebrovascular disease	29	7.2	7	7.1	22	7.3
ERF treatment stopped	50	12.5	5	5.1	45	14.9
Infection	80	20.0	11	11.2	69	22.8
Malignancy	34	8.5	12	12.2	22	7.3
Others	27	6.7	10	10.2	17	5.6
Uncertain or not determined	41	10.2	12	12.2	29	9.6
Total with cause of death	401		98		303	
No cause of death sent	278		62		216	

When analysed by age group, there was little difference in the rate of recording a cause of death for those patients aged less than 65 years and those aged 65 and over. Cardiac death remained the most common cause in both age groups, although proportionally more of the younger patients died of cardiac causes (41.8% versus 32.7%; p = 0.52) and more of the older patients died of infection-related illnesses (22.8% versus 11.2%; p = 0.09) and treatment withdrawal (14.9% versus 5.1%; p = 0.08). Although the differences in proportions were large, significant differences on statistical testing were not found. This may be a consequence of small numbers.

The average death rate for all incident patients within the first 90 days was 437 per 1000 patient years exposed (pt yrs exp) (Table 18.2, Figure 18.1).

When the effect of primary diagnosis was analysed, patients with cystic/polycystic disease had the best outcome, with a rate of death of 78.7/1000 pt yrs exp (Table 18.3) and malignancy the poorest (1309.1/1000 pt yrs exp, p < 0.001). When using glomerulonephritis (GN) as a reference point and adjustment made for the effect of age (Table 18.4), cystic/polycystic patients had a non-significantly lower risk of death, and interstitial disease and pyelonephritic patients similar rates. All other primary diseases had a significantly higher risk of death. These findings were similar to those in the subsequent analysis of the prevalent cohort (Table 18.19) except the lower risk of death in cystic/ polycystic prevalent patients reached statistical significance and interstitial disease had a significantly higher risk (Hazard Ratio 1.97, p = 0.001). Women had a non-significant lower rate of death overall (422 versus 447; Table 18.5).

It is important to note the relevance of accuracy in the enrolment of patients for potentially long-term RRT in this 90-day incident cohort. Evidence suggests variation in the criteria applied in different units, and some cases are bound to be subject to interpretation. Uncertainties of classification will inevitably bias the outcome data and are unlikely to be fully resolved in current Registry practice.

Table 18.2. Death rate, by age, in incident patients in the first 90 days

Age group	Exposure Days	Exposure years	Deaths	Rate per 90 day period	Rate per 1000 exposed years
15–19	3865	10.6	0	0	0
20–24	10627	29.1	1	0.01	34.4
25–29	13808	37.8	0	0	0
30–34	21247	58.2	4	0.02	68.8
35–39	26583	72.8	7	0.02	96.2
40–44	27337	74.8	7	0.02	93.5
45–49	37168	101.8	16	0.04	157.2
50–54	46534	127.4	24	0.05	188.4
55–59	53353	146.1	46	0.08	314.9
60–64	63773	174.6	55	0.08	315.0
65–69	75095	205.6	122	0.15	593.4
70–74	83650	229.0	157	0.17	685.5
75–79	68490	187.5	134	0.18	714.6
80–84	26953	73.8	76	0.25	1029.9
85–89	8084	22.1	27	0.30	1219.9
90+	883	2.4	3	0.31	1240.9
Total	567450	1553.6	679	0.12	437.1

Age group	Exposure days	Exposure years	Deaths	Rate per 90 day period	Rate per 1000 exposed years
20–44	99602	272.7	19	0.02	69.7
45–64	200828	549.8	141	0.06	256.4
65+	263155	720.5	519	0.18	720.4

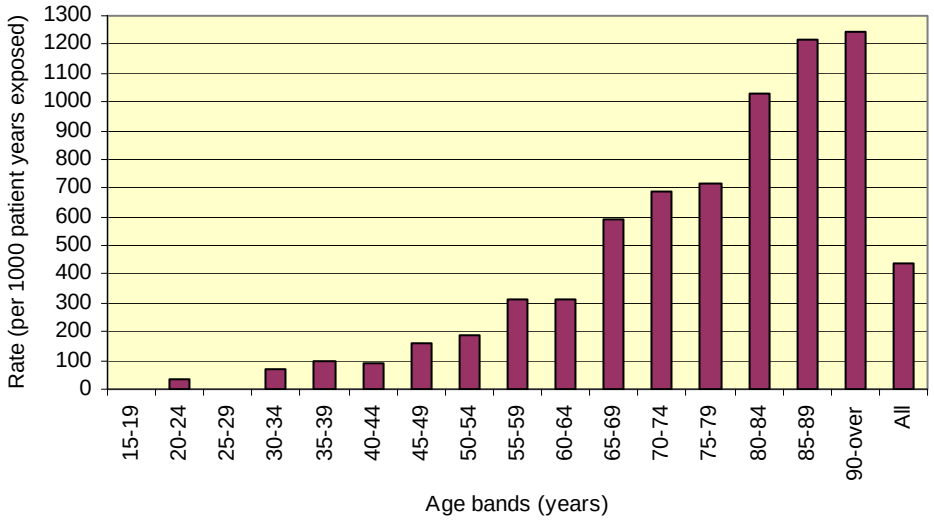

Figure 18.1. Death rate in incident patients in the first 90 days

Table 18.3. Death rate, by primary diagnosis, in incident patients in the first 90 days

Primary diagnosis	Exposure days	Exposure years	Deaths	Rate per 90 day period	Rate per 1000 exposed years
Amyloid	8362	22.9	21	0.226	917.3
Cystic/polycystic	37132	101.7	8	0.019	78.7
Diabetes	98261	269.0	82	0.075	304.8
Glomerulonephritis	58577	160.4	27	0.041	168.4
Interstitial	8836	24.2	4	0.041	165.3
Malignancy	11439	31.3	41	0.323	1309.1
Pyelonephritis	47478	130.0	34	0.064	261.6
Renal vascular disease	61178	167.5	100	0.147	597.0
Other	110176	301.6	198	0.162	656.4
Uncertain	126011	345.0	164	0.117	475.4
Total	567450	1553.6	679	0.108	437.1

Table 18.4. Risk of death by primary diagnosis compared with GN, age adjusted, in the first 90 days

Primary diagnosis	Ref with GN	Lower 95% CI	Upper 95%CI	p value
Amyloid	4.16	2.35	7.37	<0.001
Cystic/polycystic	0.48	0.22	1.05	0.067
Diabetes	1.67	1.08	2.58	0.021
Interstitial	0.81	0.28	2.32	0.699
Malignancy	4.85	2.98	7.90	<0.001
Pyelonephritis	1.24	0.75	2.05	0.413
Renal vascular disease	2.18	1.42	3.34	<0.001
Other	2.73	1.83	4.10	<0.001
Uncertain	1.81	1.20	2.73	0.005

Ref with GN, Hazard Ratio referenced against glomerulonephritis adjusted for age.

Table 18.5. Death rate, by gender, in incident patients in the first 90 days

	Exposure years	Deaths	Rate per 1000 exposed yrs
Male	951.7	425	446.6
Female	601.9	254	422.0
Total	1553.6	679	437.1

Analysis of deaths in the first year after 90 days

There were 899 deaths in the 1-year after 90 days analysis (Table 18.6), with a recorded cause in 483 (54%) patients. The overall rate of death was 185/1000 pt yrs exp (Table 18.7), contrasting with 437/1000 pt yrs exp within the first 90 days (Table 18.2); these figures increased with increasing patient age (Figure 18.2).

Table 18.6 shows that cardiac disease, 29% of cohort deaths, remained the most common cause of death, but proportionately fewer deaths in those aged less than 65 years were cardiac than in the 90 day cohort (29% versus 42%). Similar to the 90-day analysis, treatment withdrawal was more common in those aged over 65 years (21.1% versus 13.3%, p = 0.24), although, as a group, withdrawal was more common in the 1 year after 90 days group (18.4% versus 12.5% respectively). Infection-related deaths were similar in both age groups (17.6% versus 15.1%): this contrasts with the first 90-day period, in which infections accounted for a lower proportion of deaths in patients aged less than 65 years (11% versus 23%).

In the analysis of the effect of primary diagnosis, malignancy again appeared to carry the highest rate of death, and cystic/polycystic the lowest (Table 18.8). Results were similar to those for incident patient deaths at 90 days (Table 18.3) but the rates were lower at 1 year after 90 days in all groups except interstitial disease. This may in part be due to having to calculate rates per 1000 patient years from a 90 day censored period in the earlier incident cohort. In the case of interstitial disease, the fact that there were only four deaths in the 90-day cohort may have given an artificially low death rate. Ratios using glomerulonephritis as a reference were similar in both time periods except interstitial disease and malignancy ratios were lower in the first 90 days (0.81 v 2.33; and 4.85 v 6.27 respectively). The reverse was true of amyloidosis with a lower ratio at 1 year after 90 days (4.16 v 2.86). Although not significant, men had a lower rate of death than women (178 versus 195/1000 pt yrs exp; Table 18.10).

Comparing the first 90, and 1 year after 90 days, rates of death were higher in the first 90 days than 1 year after 90 days, especially from age band 40–44 years upwards. Using USA age banding, rates of death at 90 days were two and a half times that at 1 year after 90 days in those aged 65 and above (720 versus 292/1000 pt yrs exp). Overall, the rate of death was lower in the 1 year after 90 days (185/1000 pt yrs exp), compared with the first 90 days (437/1000 pt yrs exp) (Figure 18.3).

Table 18.6. Cause of death, by age, in incident patients at 1 year + 90 days

Cause of death	All deaths	All % of those with data	<65 deaths	<65 % of those with data	65+ deaths	65+ % of those with data
Cardiac disease	139	28.8	47	28.5	92	28.9
Cerebrovascular disease	42	8.7	15	9.1	27	8.5
ERF treatment stopped	89	18.4	22	13.3	67	21.1
Infection	77	15.9	29	17.6	48	15.1
Malignancy	49	10.1	14	8.5	35	11.0
Others	34	7.0	12	7.3	22	6.9
Uncertain or not determined	53	11.0	26	15.8	27	8.5
Total with cause of death	483		165		318	
No cause of death sent	416		123		293	

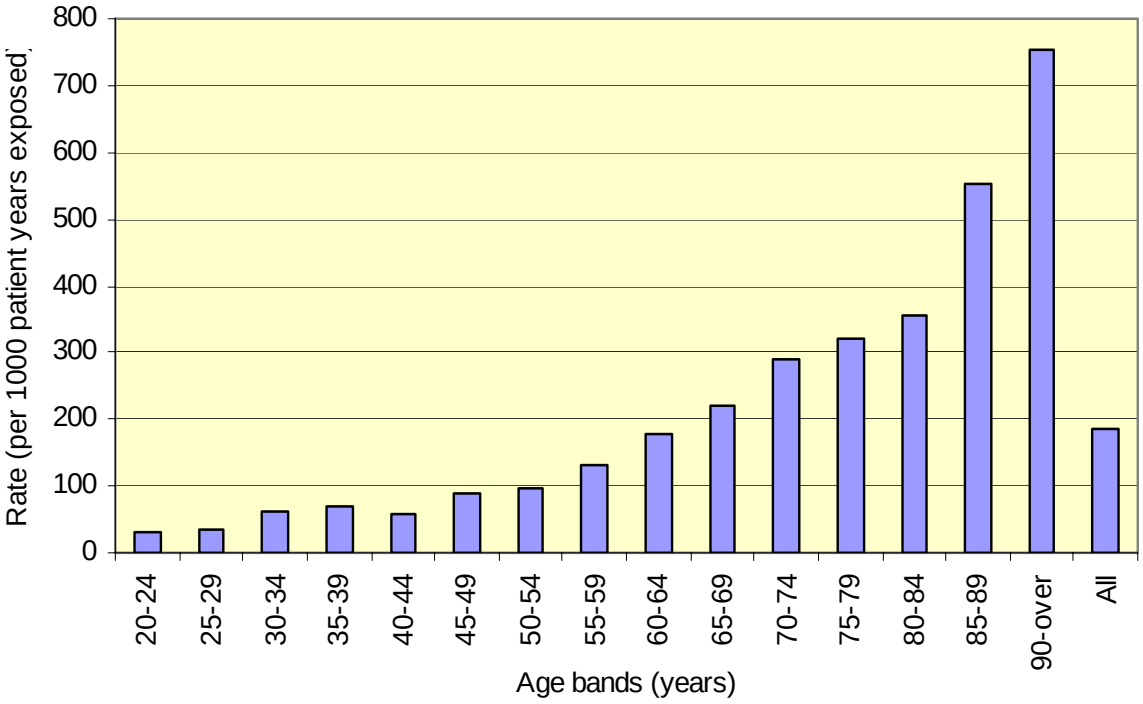

Figure 18.2. Death rate in incident patients in the 1 year after 90 days

Table 18.7. Death rate, by age, in incident patients at 1 year + 90 days

Age group	Exposure years	Deaths	Rate per 1000 exposed years
15–19	36.0	0	0
20–24	99.1	3	30.3
25–29	138.3	5	36.1
30–34	191.9	12	62.5
35–39	244.5	17	69.5
40–44	257.2	15	58.3
45–49	336.3	30	89.2
50–54	431.6	42	97.3
55–59	480.3	64	133.2
60–64	560.5	100	178.4
65–69	630.6	140	222.0
70–74	678.9	198	291.6
75–79	535.1	172	321.5
80–84	196.3	70	356.6
85–89	49.0	27	551.6
90+	5.3	4	753.5
Total	4870.7	899	184.6

Age group	Exposure years	Deaths	Rate per 1000 exposed years
20–44	931.0	52	55.9
45–64	1808.7	236	130.5
65+	2095.1	611	291.6

Table 18.8. Death rate, by primary diagnosis, in incident patients at 1 year + 90 days

Primary Diagnosis	Exposure years	Deaths	Rate per 1000 exposed years
Amyloid	65.4	19	290.4
Cystic/polycystic	341.8	18	52.7
Diabetes	875.4	179	204.5
Glomerulonephritis	537.3	43	80.0
Interstitial	73.7	17	230.7
Malignancy	70.7	55	777.6
Pyelonephritis	431.5	56	129.8
Renal vascular disease	515.4	109	211.5
Other	864.3	200	231.4
Uncertain	1095.1	203	185.4
Total	4870.7	899	184.6

Table 18.9. Risk of death by primary diagnosis compared with GN, age adjusted, 1 year + 90 days

Primary diagnosis	Ref with GN	Lower 95% CI	Upper 95% CI	P value
Amyloid	2.86	1.67	4.92	<0.001
Cystic/polycystic	0.63	0.36	1.11	0.109
Diabetes	2.33	1.67	3.25	<0.001
Interstitial	2.33	1.33	4.09	0.003
Malignancy	6.27	4.20	9.35	<0.001
Pyelonephritis	1.33	0.90	1.99	0.158
Renal vascular disease	1.68	1.18	2.40	0.004
Other	2.13	1.53	2.97	<0.001
Uncertain	1.57	1.13	2.19	0.008

Table 18.10. Death rate, by gender, in incident patients at 1 year + 90 days

	Exposure years	Deaths	Rate per 1000 exposed years
Male	2996.0	534	178.2
Female	1874.7	365	194.7
Total	4870.7	899	184.6

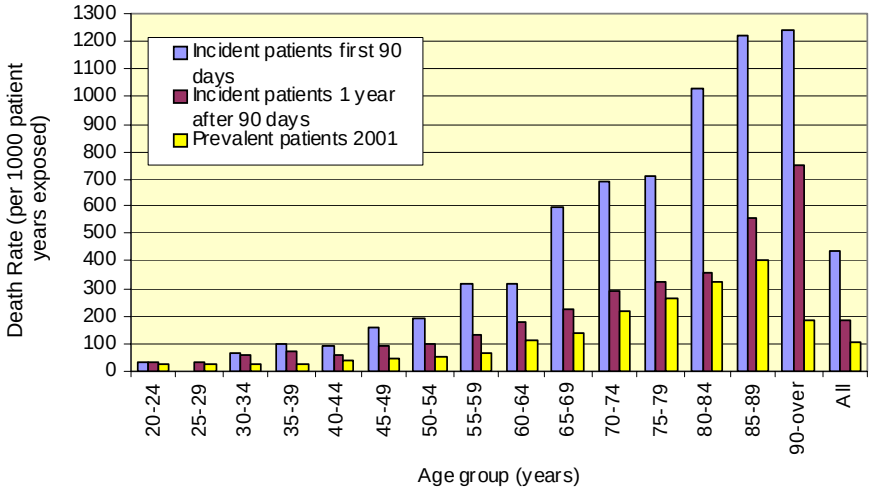

Figure 18.3. Death rates in incident and prevalent patients with ERF

Table 18.11 analysed cause of death by time on RRT (less than 3 years and 3–5 years) with age under 65 or 65 and over. Cardiac death was again the most common cause across age groups and independent of time on RRT. Withdrawal of treatment as a proportion of deaths fell with increasing time on RRT (18%, 15%, 12% at 1 year after 90 days, less than 3 years and 3–5 years respectively; Figure 18.4). Infection was an important cause of death in both age groups though less so in the over 65s who had been on dialysis for three or more years. This may in part be due to the small numbers within the group as a whole.

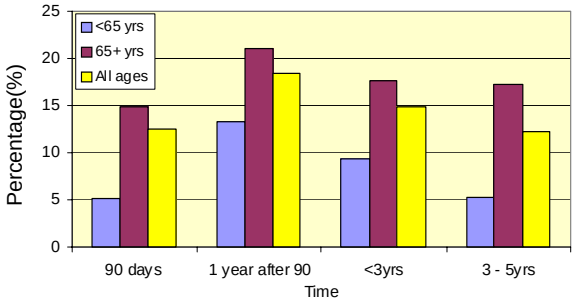

Figure 18.4. Treatment withdrawal over time in incident patients

When comparing incident and prevalent patients, causes of death were similar (Tables 18.1, 18.6, 18.15 and 18.17),

Table 18.11. Cause of death, by time, on RRT at 3 years

	All ages	<65		65+	
Cause of death	**3–5 yrs on RRT**	**3–5 yrs on RRT**	**<3 yrs on RRT**	**3–5 yrs on RRT**	**<3 yrs on RRT**
Cardiac disease	37 (41.1%)	16 (42.1%)	148 (34.4%)	21 (40.4%)	271 (30.2%)
Cerebrovascular disease	7 (7.8%)	5 (13.2%)	38 (8.8%)	2 (3.8%)	70 (7.8%)
ERF treatment stopped	11 (12.2%)	2 (5.3%)	40 (9.3%)	9 (17.3%)	158 (17.6%)
Infection	15 (16.7%)	10 (26.3%)	74 (17.2%)	5 (9.6%)	162 (18.0%)
Malignancy	6 (6.7%)	3 (7.9%)	37 (8.6%)	3 (5.8%)	82 (9.1%)
Others	7 (7.8%)	1 (2.6%)	41 (9.5%)	6 (11.5%)	66 (7.3%)
Uncertain/not determined	7 (7.8%)	1 (2.6%)	52 (12.1%)	6 (11.5%)	89 (9.9%)
Total	90	38	430	52	898
No cause of death sent	64	21	305	43	775

although age had an effect especially in relation to treatment withdrawal. Proportionately, there were higher rates of treatment withdrawal and infection in prevalent patients aged less than 65 when compared with incident patients who died in the first 90 days.

Effect of co-morbidity

The influence of co-morbidity on death was assessed in the incident population of RRT patients. The number of patients with both co-morbidity at the start of RRT and cause of death recorded were too small to analyse the effect of these factors on death at 90 days and 1 year after 90 days. The analysis includes all incident patients with complete records who died within 3 years of starting RRT. There were 468 deaths in the patient group with completed co-morbidity. Of these, 277 patients (59%) had a cause of death recorded, a similar level of completion to both the incident and prevalent groups.

Comparison of cardiac and peripheral vascular co-morbidity

Because of the limited data, co-morbidity was grouped into:

1. Cardiac disease
2. Generalised (mainly peripheral) vascular disease
3. Either of these groups
4. Patients recorded as having no co-morbidity present.

In Table 18.12, of those patients recorded as having cardiac disease at the time of starting RRT (*n* = 167), only 100 (59.8%) also had a recorded a cause of death and of these, 56% (*n* = 56) died from a cardiac cause. In comparison, of patients recorded as having no cardiac disease (*n* = 301; 177 also with a recorded cause of death), only 18.1% (*n* = 32) died from cardiac causes. In this group, the causes of death were more widely distributed with treatment withdrawal being the commonest cause. The presence of generalised vascular disease at the start of RRT (Table 18.13) had less impact on the rate of cardiac death, only slightly increasing the risks (35.7% v 29.6%).

In those patients without cardiac or circulatory disease on starting RRT (Table 18.14), treatment withdrawal was the most common cause of death (23.2%), although causes were generally evenly distributed across all the categories. It is interesting to note that the presence of underlying cardiac or generalised vascular disease did not appear to affect the proportion of cerebrovascular deaths.

Table 18.12. Cardiac co-morbidity and cause of death

	No cardiac disease	No %	Yes cardiac disease	Yes %	Total Number	Total %
Cardiac disease	32	18.1	56	56.0	88	31.8
Cerebrovascular disease	11	6.2	7	7.0	18	6.5
ERF treatment stopped	47	26.6	9	9.0	56	20.2
Infection	33	18.6	10	10.0	43	15.5
Malignancy	17	9.6	5	5.0	22	7.9
Others	26	14.7	6	6.0	32	11.6
Uncertain or not determined	11	6.2	7	7.0	18	6.5
Total	177		100		277	
Cause of death not sent	124		67		191	

Table 18.13. Generalised vascular co-morbidity and cause of death

	No vascular disease	No %	Yes vascular disease	Yes %	Total number	Total %
Cardiac disease	53	29.6	35	35.7	88	31.8
Cerebrovascular disease	11	6.1	7	7.1	18	6.5
ERF treatment stopped	33	18.4	23	23.5	56	20.2
Infection	33	18.4	10	10.2	43	15.5
Malignancy	18	10.1	4	4.1	22	7.9
Others	21	11.7	11	11.2	32	11.6
Uncertain or not determined	10	5.6	8	8.2	18	6.5
Total	179		98		277	
Cause of death not sent	121		70		191	

Table 18.14. Cardiac or peripheral vascular co-morbidity and cause of death

	None	None %	Either	Either %	Total number	Total %
Cardiac disease	21	16.8	67	44.1	88	31.8
Cerebrovascular disease	8	6.4	10	6.6	18	6.5
ERF treatment stopped	29	23.2	27	17.8	56	20.2
Infection	27	21.6	16	10.5	43	15.5
Malignancy	15	12.0	7	4.6	22	7.9
Others	17	13.6	15	9.9	32	11.6
Uncertain or not determined	8	6.4	10	6.6	18	6.5
Total	125		152		277	
Cause of death not sent	89		102		191	

Prevalent Patients

Prevalent Patients 1997–2001

The 6237 deaths with a recorded cause on the database since the inception of the UK Renal Registry were analysed. By EDTA code for cause of death, the most common cause of death in the dialysis population was myocardial ischaemia or infarction (*n* = 872, 17.7%; Appendix F), closely followed by 'uncertain' or 'not identified' (*n* = 758, 15.4%). In the transplant population, these were again the two most common causes, accounting for 22.2% and 10.5% of deaths respectively (Table F.4.3 Appendix). The EDTA codes were regrouped as outlined in the methods, and cardiac disease remained the most common cause of death in both the transplant and dialysis populations (37% and 31% respectively; Table 18.15), irrespective of age (Table 18.16). Using the two-tailed Student 't' test, the proportion of cardiac deaths appeared significantly greater in the transplant population; this may have been due to the lower proportion of transplant patients who withdrew from treatment or who had an uncertain/undetermined cause of death. Statistically, there were significant differences between the dialysis and transplant groups for each category except cerebrovascular disease and infection.

Table 18.15. Cause of death by treatment modality

	Dialysis No.	Dialysis %	Transplant No.	Transplant %	Total No.	Total %	p value
Cardiac disease	1511	30.7	480	36.6	1991	31.9	<0.001
Cerebrovascular disease	398	8.1	87	6.6	485	7.8	0.089
ERF treatment stopped	616	12.5	43	3.3	659	10.6	<0.001
Infection	865	17.6	243	18.5	1108	17.8	0.424
Malignancy	324	6.6	149	11.4	473	7.6	<0.001
Others	456	9.3	178	13.6	634	10.2	<0.001
Uncertain or not determined	757	15.4	130	9.9	887	14.2	<0.001
Total	4927		1310		6237		

Table 18.16. Cause of death by modality and age

	Trans <55		Trans 55+		Total trans		Dialysis <65		Dialysis =65		Total dialysis	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Cardiac disease	220	37.2	260	36.2	480	36.6	588	33.3	923	29.2	1511	30.7
Cerebrovascular disease	41	6.9	46	6.4	87	6.6	159	9.0	239	7.6	398	8.1
ERF treatment stopped	19	3.2	24	3.3	43	3.3	116	6.6	500	15.8	616	12.5
Infection	116	19.6	127	17.7	243	18.5	318	18.0	547	17.3	865	17.6
Malignancy	50	8.4	99	13.8	149	11.4	123	7.0	201	6.4	324	6.6
Others	90	15.2	88	12.3	178	13.6	190	10.8	266	8.4	456	9.3
Uncertain or not determined	56	9.5	74	10.3	130	9.9	273	15.4	484	15.3	757	15.4
Total	592		718		1310		1767		3160		4927	

Prevalent patients in 2001 and comparison with the general population

There were a total of 1271 deaths in this cohort of 12855 patients, 572 (45%) of which had a recorded cause. In total, 63% of deaths occurred in those patients aged over 65 years. Cardiac death was the most common cause (32.5%) irrespective of age group under or over 65 years (Table 18.17). Treatment withdrawal was significantly ($p < 0.05$) more common in those aged over 65 than those under 65 (17.1% versus 7.7% respectively).

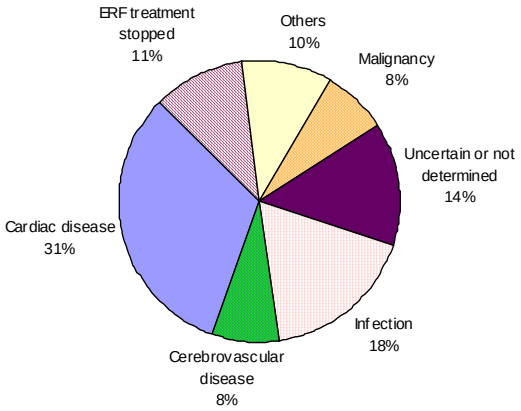

Figure 18.5. Cause of death in prevalent patients 1997-2001

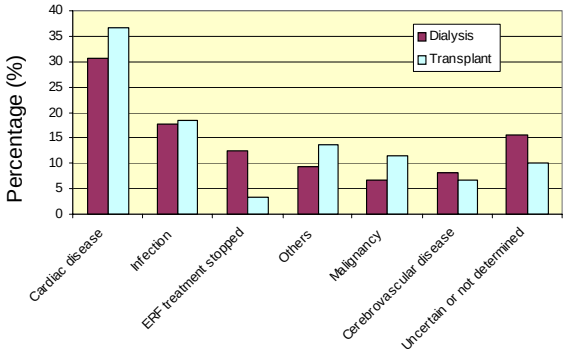

Figure 18.6. Cause of death in prevalent patients by modality

Table 18.17. Cause of death in prevalent patients, by age

Cause of death	All No. of deaths	All % of those with data	<65 deaths	<65 % of those with data	65+ deaths	65+ % of those with data
Cardiac disease	186	32.5	80	36.2	106	30.2
Cerebrovascular disease	40	7.0	19	8.6	21	6.0
ERF treatment stopped	77	13.5	17	7.7	60	17.1
Infection	96	16.8	36	16.3	60	17.1
Malignancy	46	8.0	23	10.4	23	6.6
Others	66	11.5	28	12.7	38	10.8
Uncertain or not determined	61	10.7	18	8.1	43	12.3
Total with cause of death	572		221		351	
No cause of death sent	699		249		450	

Table 18.18. Rate of death, by gender and primary diagnosis, in prevalent patients

EDTA group	Exposure years	Deaths	Rate per 1000 pt years exposed
Amyloid	81.9	13	158.7
Cystic/polycystic	1217.9	73	59.9
Diabetes	1277.0	236	184.8
Glomerulonephritis	1956.2	124	63.4
Interstitial	158.7	28	176.5
Malignancy	51.9	26	500.6
Pyelonephritis	1742.6	123	70.6
Renal vascular disease	1103.8	154	139.5
Other	1783.6	182	102.0
Uncertain	2809.8	312	111.0
Total	12183.4	1271	104.3
Male	7605.9	784	103.1
Female	4885.3	487	99.7

The rates of death by primary diagnosis (Table 18.18) and age (Table 18.20) were calculated; not unexpectedly, death rate increased with increasing age, the highest rate of death being seen in those with underlying malignancy (501/1000 pt yrs exp). The three lowest rates were seen in those with cystic/polycystic disease (60/1000 pt yrs exp), glomerulonephritis (63/1000 pt yrs exp) and pyelonephritis (71/1000 pt yrs exp). A comparison of primary diagnoses with glomerulonephritis (GN) as the reference (Table 18.19) showed that all other primary diseases had a significantly different rate of death except pyelonephritis and 'uncertain'. Cystic/polycystic disease had a better, and pyelonephritis and 'uncertain' a similar, outcome related to GN, whereas other conditions had a significantly poorer one. Gender differences were not significant, with rates of death 103/1000 pt yrs exp in males compared with 100 in females (Table 18.18).

Table 18.19. Risk of death by primary diagnosis compared with GN, age adjusted, in prevalent patients

EDTA group	Ref with GN	Lower 95% CI	Upper 95% CI	p value
Amyloid	1.97	1.11	3.48	0.021
Cystic/polycystic	0.72	0.54	0.96	0.024
Diabetes	2.36	1.90	2.94	<0.001
Interstitial	1.97	1.31	2.97	0.001
Malignancy	3.75	2.45	5.74	<0.001
Pyelonephritis	0.99	0.77	1.27	0.941
Renal vascular disease	1.29	1.01	1.64	0.038
Other	1.28	1.01	1.60	0.038
Uncertain	1.19	0.97	1.47	0.104

Ref with GN, Hazard Ratio referenced against glomerulonephritis adjusted for age

Table 18.20. Death rate, by age, for prevalent patients: comparison with the general population

Age	E&W Pop mid-98 (000)	E&W deaths	E&W /1000 pop	Ren Reg exposed years	Expected no. of deaths	RenReg deaths	RenReg deaths per 1000	Observed Expected Ratio
20–24	3084.2	1832	0.6	122.9	0.1	3	24.4	41.1
25–29	3883.4	2364	0.6	354.2	0.2	9	25.4	41.8
30–34	4294	3187	0.7	648.8	0.5	15	23.1	31.2
35–39	4035.4	4345	1.1	1002.3	1.1	28	27.9	26.0
40–44	3479.8	5643	1.6	1090.4	1.8	40	36.7	22.6
45–49	3403.8	8331	2.4	1142.1	2.8	53	46.4	19.0
50–54	3500.1	14132	4.0	1355.1	5.5	70	51.7	12.8
55–59	2709.4	18481	6.8	1457.9	9.9	100	68.6	10.1
60–64	2489.8	27244	10.9	1330.8	14.6	152	114.2	10.4
65–69	2314.6	40735	17.6	1233.4	21.7	172	139.5	7.9
70–74	2085.8	62384	29.9	1122.8	33.6	241	214.6	7.2
75–79	1781.3	88977	50.0	777.8	38.9	207	266.1	5.3
80–84	1089.6	88123	80.9	424.1	34.3	136	320.7	4.0
85–89	669	89474	133.7	104.8	14.0	42	400.7	3.0
90+	347.7	76482	220.0	16.1	3.5	3	185.9	0.9
Total	39167.9	531734	13.6	12183.4	165.4	1271	104.3	7.7

Table 18.20 uses data from the Office for National Statistics (ONS) and shows the population by age band for England & Wales, and the number of deaths per thousand in the general population. The death rates of patients on RRT were calculated. The observed number of deaths on RRT was divided by the expected number of deaths calculated for the general population to provide the relative risk (RR) of dying given underlying established renal failure (ERF), compared with another individual of the same age group without ERF in England & Wales. Results showed that although the death rate increases with increasing age, the risk of death compared with the general population without ERF is greatest in the younger age bands (Table 18.20 and Figure 18.7). The RR of dying for 20–24 year olds on RRT was 41.1 compared with 4.0 in the 80–84 year-olds.

The same procedure was repeated looking at dialysis patients alone (Figure 18.8). This showed that the risk of death in a dialysis patient from all cause mortality was very much greater compared with the general population and more so than when transplant patients were included in the analysis. The

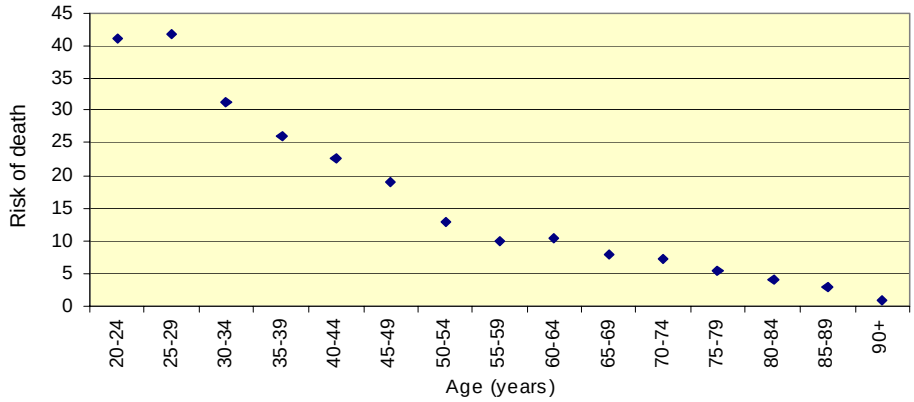

Figure 18.7. Relative risk of death in ERF patients

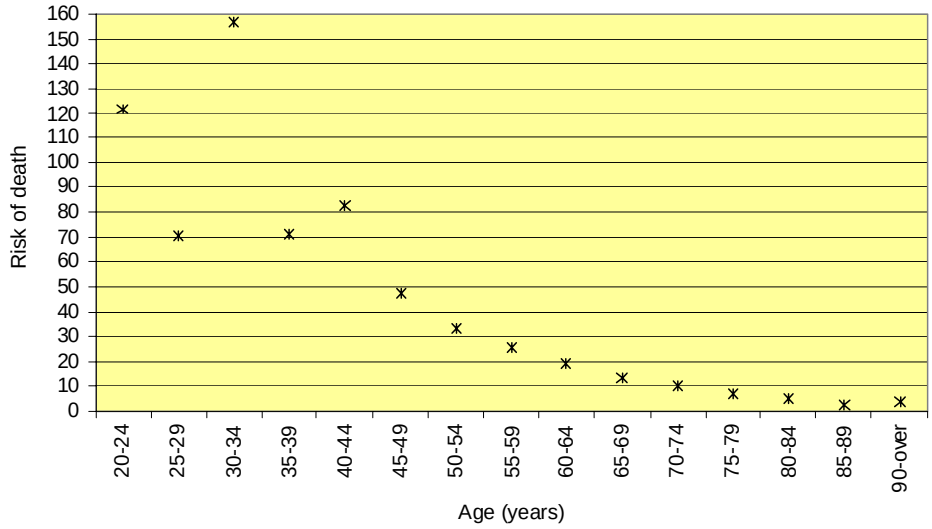

Figure 18.8. Relative risk of death in dialysis patients

risks were again highest in the young such that a 20–24 year old on dialysis had a RR of death of 121.

Causes of death in the ERF population were also compared with those in the general population of England & Wales as supplied by the ONS (Table 18.21). In the general population, the three most common causes of death were classified as 'other' (27.8%), malignancy (25.2%) and cardiac disease (24%). Very few people had a recorded cause of death of diabetes, or one of its associated complications, although this probably reflects the stringency applied to death certification. This category doesn't appear in the EDTA coding for cause of death. When compared with the ERF population, proportionately more renal patients died of a cardiac cause (32.5% versus 24%), reflecting a 35% or 1.4-fold increased risk of cardiac death in these patients (Figure 18.9). Similarly, infection was more common as a cause of death in renal patients (16.8% versus 11.5%) reflecting a 46% or 1.5-fold increase in risk. Maybe as a consequence, or as a reflection of the selection of patients taken on for RRT, the risk of malignancy in the ERF group was much lower than that of the general population (8.0% versus 25.2%, a 68% or threefold decreased risk). Of note, some differences may be related to the fact that the ONS data includes deaths in people from age 15 whereas our renal data starts from age 18.

Table 18.21. Population deaths, by sex and age

	Sex	No. 15–64	% 15–64	No. 65+	% 65+	No. Total	% Total
Cardiac disease	All	16,475	19.0	111,559	25.0	128,034	24.0
Cerebrovascular disease	All	3,968	4.6	48,491	10.9	52,459	9.8
Diabetes	All	860	1.0	4,902	1.1	5,762	1.1
Infection	All	4,187	4.8	57,215	12.8	61,402	11.5
Malignancy	All	32,745	37.7	101,495	22.7	134,240	25.2
Other	All	26,445	30.4	121,837	27.3	148,282	27.8
Uncertain or not determined	All	2,180	2.5	676	0.2	2,856	0.5
Total	All	86,860	100.0	446,175	100.0	533,035	100.0

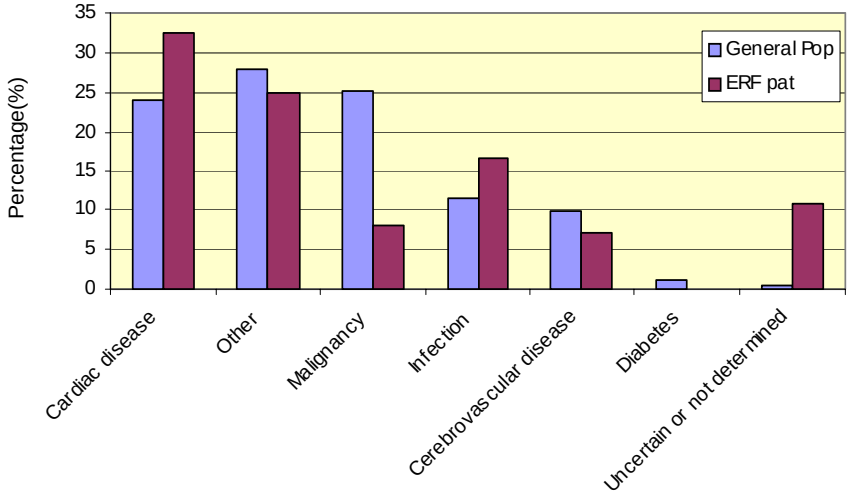

Figure 18.9. Causes of death in the general and ERF population

International comparisons of prevalent patients

Comparisons were possible with data from European, North American and Australasian Registries.[1–6]

USA

Using data from the USA Renal Data System (USRDS) 2001 annual report,[1] rates of death for UK patients were compared by age band (Tables 18.22 and 18.23). Rates of death in the UK were significantly lower than in the USA in all age bands in both the combined dialysis and transplant cohort and dialysis patients alone ($p < 0.05$) with the exception of 20-44 year old dialysis patients where rates were similar. The differences, especially in the elderly, may be due to the fact that in the USA, patients with very high rates of co-morbidity (but who survive more than 90 days) all start RRT, whereas in England & Wales, take-on rates are much lower and there is selection bias.

In the USRDS report, causes of death categories were divided into many subgroups within the cardiac causes. With the larger patient number, cardiac deaths were split by myocardial infarction, cardiac arrest, cause unknown and cardiac other. The data showed that cardiac disease was the most common cause of death across all RRT modalities, although most transplant patients died of unknown cause (31.7 per 1000 pt yrs exp).

Table 18.22. Death rate, by age, for all prevalent patients and comparison with the USA

Age	E&W Pop mid-98 (000)	E&W Deaths	E&W/ 1000 pop	Ren Reg exposure years	Ren Reg deaths	UK RR deaths per 1000	USA ERF deaths per 1000	UK/USA
20–44	18,776.8	17,371	0.9	3218.4	95	29.5	56.1	0.53
45–64	12,103.1	68,188	5.6	5285.8	375	70.9	136.3	0.52
65+	8,288.0	446,175	53.8	3679.1	801	217.7	340.4	0.64
Total	39,167.9	531,734	13.6	12183.4	1271	104.3	179.3	0.58

Table 18.23. Death rate, by age, for dialysis prevalent patients and comparison with the USA

Age	E&W Pop mid-98 (000)	E&W Deaths	E&W/ 1000 pop	Ren Reg exposure years	Ren Reg deaths	UK RR deaths per 1000	USA ERF deaths per 1000	UK/USA
20–44	18,776.8	17,371	0.9	911.1	60	86.2	93.7	0.92
45–64	12,103.1	68,188	5.6	1,991.9	242	139.7	179.3	0.78
65+	8,288.0	446,175	53.8	2,124.7	689	261.9	360.3	0.73
Total	39,167.9	531,734	13.6	5,027.7	991	195.9	239.0	0.82

Canada

The 2001 Canadian report, based on data from RRT patients in 1999,[2] provided details on 2652 deaths in 26,209 prevalent patients (10.1%). Cardiac disease remained the most common cause of death (38.2%), although the proportion was higher than in UK patients (32.5%). The next most common cause was 'social' (15.4%), and although this category included suicide as well as treatment withdrawal, the rate was comparable to that recorded for the UK (13.5%). Infection was believed responsible for only 9.7% of deaths, much less common than the 16.8% for the UK cohort.

Norway

The registries of Norway and Finland both quoted cause of death by proportions, and their categories differed slightly from those used in the UK. Of 278 deaths in prevalent patients on RRT in 2001 in Norway,[3] 11% died from treatment withdrawal, 33% from cardiac causes, 23% from infection, 20% from vascular disease and 12% from malignancy. Results are comparable with those from the UK for cardiac disease and treatment withdrawal, but proportionately more Norwegian than UK patients died from infection and malignancy.

Finland

In Finland, cardiac and cerebrovascular diseases were combined as a cause of death, this category accounting for 48% of all deaths on RRT.[4] The proportion of deaths from infective causes was similar to the UK Registry figures (18% versus 16.8%), but other diagnostic categories were not suitable for direct comparison.

Australia and New Zealand

In the combined Australia and New Zealand Registry report,[5] deaths were analysed by proportion and per 100 patient years at risk. This included all patients treated during the year 2000. Within Australia, 12% of dialysis patients died (15.7 deaths/100 pt yrs exp), compared with 2.9% of those with a functioning transplant (3.2 deaths/100 pt yrs exp). The rates in New Zealand differed, with 19.2 deaths per 100 patient years for dialysis and 2.5 for transplant recipients. In both dialysis patients and transplant recipients, cardiac events were the most common cause of death (46% versus 29% in Australia, 43% versus

24% in New Zealand). Within the dialysis cohort, treatment withdrawal accounted for 21% and 22% of deaths respectively in Australia and New Zealand, the majority of these cases having underlying diabetes. The proportion of cardiac deaths in Australia was higher than in England & Wales (46% versus 33%). The treatment withdrawal rate was also substantially higher in Australia (48% of dialysis patients) and New Zealand (18%), compared with England & Wales (14%), whereas the infection rate was lower in Australia (12% in dialysis patients).

European ERA-EDTA Registry

The ERA report for 2000 included data from Austria, Belgium, Finland, France, the Netherlands, Norway and Scotland. The ERA has analysed data on causes of death from the years 1991–99.[6,7] During this period, there were 19,851 deaths, and the distribution of causes of death did not change. The most common cause of death was cardiac, accounting for the deaths of 36% of dialysis patients and 35% of transplant patients (Figure 18.10), followed by infection and malignancy in decreasing order of frequency. All these data were comparable with the results from the UK (31% and 37% respectively).

Diabetes and cause of death

Patients with Type I and II diabetes were analysed as a single group. Patients were included in this analysis if they had diabetes as the primary diagnosis for the cause of their renal disease or if it was recorded as a co-morbidity response. Prevalent and incident patients were assessed separately. There were 548 incident diabetic patients who died, of whom 52 had diabetes as co-morbidity.

Incident patients with diabetes

In the incident patients, diabetics had a lower rate of death in the first 90 days than non-diabetics (Table 18.24), possibly because of their younger age at start of RRT (68 versus 72 years). Of the 679 deaths in the first 90 days, only 94 (14%) occurred in patients with diabetes. Of these, only 58 had a recorded cause of death. Diabetic patients had a significantly higher proportion of deaths from cardiac disease than non-diabetics (60% versus 31%, $p < 0.01$; Table 18.25).

In the 1 year after 90 days period (Table 18.26), the death rate was higher in diabetics than non-diabetics (213 versus 178/1000 pt yrs exp respectively) despite their younger average age at start of RRT (64 versus 71

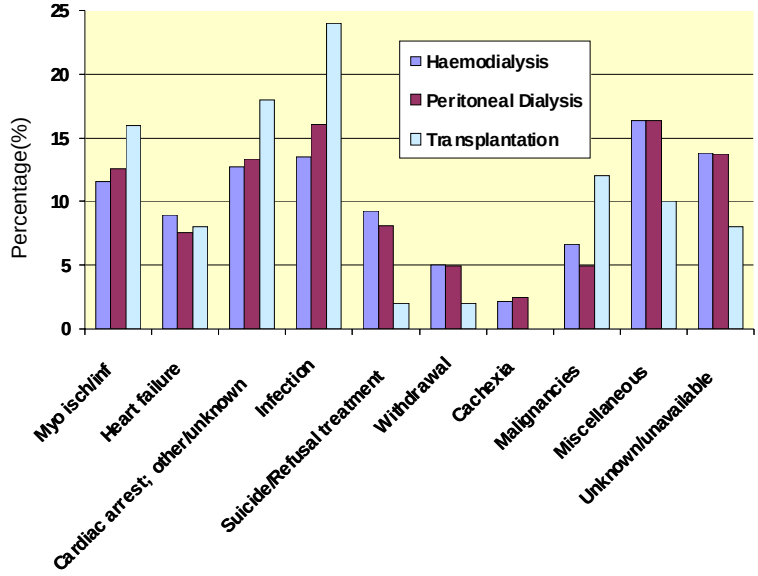

Figure 18.10. ERA-EDTA causes of death
Myo isch/inf = myocardial ischaemia/infarction

Table 18.24. Death rate, by diabetes, in incident patients at 90 days

	Exposure days	Exposure years	Deaths	Rate/ 90 day period	Rate/1000 yrs exposed	Lower 95% CI	Upper 95% CI
Non-diabetics	459952	1259.3	585	0.11	464.6	429.1	500.0
Diabetics	107498	294.3	94	0.08	319.4	257.4	381.4

Table 18.25. Cause of death, by diabetes, in incident patients at 90 days

	Non-diabetic Number	Non-diabetic %	Diabetic Number	Diabetic %	Total Number	%	p	Adjust p
Cardiac disease	105	30.6	35	60.3	140	34.9	<0.001	<0.001
Cerebrovascular disease	27	7.9	2	3.4	29	7.2	0.23	NS
ERF treatment stopped	47	13.7	3	5.2	50	12.5	0.07	NS
Infection	75	21.9	5	8.6	80	20.0	0.02	NS
Malignancy	34	9.9	0	0	34	8.5	0.01	NS
Others	22	6.4	5	8.6	27	6.7	0.54	NS
Uncertain or not determined	33	9.6	8	13.8	41	10.2	0.33	NS
Total	343		58		401			
No data	242		36		278			

NS, not significant

Table 18.26. Death rate, by diabetes, in incident patients at 1 year after 90 days

	Exposure years	Deaths	Rate/1000 yrs exposed	Lower 95% CI	Upper 95% CI
Non-diabetics	3920.2	697	177.8	165.8	189.8
Diabetics	950.5	202	212.5	186.5	238.5

years). Again, cardiac death was more common in the diabetic patients but this did not reach statistical significance (35% versus 27%, p = 0.44; Table 18.27). The only statistically significant difference was the lower proportion of diabetics dying from cancer (p = 0.02).

Prevalent patients with diabetes

Of the 1271 prevalent patients in Table 18.28, 255 (20%) were diabetic, and their rate of death was significantly higher than that of non-diabetics (189 versus 94/1000 pt yrs exp, p < 0.01). Of these diabetics, 123 (48%) had a cause of death recorded. In analysing those with data (Table 18.29), diabetics had a higher proportion of cardiac deaths compared with non-diabetics (41% versus 30%); this did not reach statistical significance.

Conclusion

The UK analysis of causes of death in patients on RRT confirm the analyses by other national Renal Registries, that cardiac disease is the most common cause of death in patients on RRT. This was independent of age although it appeared proportionately more common in the ≥65-year age group (p > 0.05). There were significant differences in the proportions of deaths from cardiac

Table 18.27. Cause of death, by diabetes, in incident patients at 1 year after 90 days

Cause of death	Non-diabetic Number	Non-diabetic %	Diabetic Number	Diabetic %	Total Number	%	p	Adjust p
Cardiac disease	96	26.7	43	35.0	139	28.8	0.08	NS
Cerebrovascular disease	27	7.5	15	12.2	42	8.7	0.11	NS
ERF treatment stopped	66	18.3	23	18.7	89	18.4	0.93	NS
Infection	58	16.1	19	15.4	77	15.9	0.86	NS
Malignancy	45	12.5	4	3.3	49	10.1	0.004	0.024
Others	29	8.1	5	4.1	34	7.0	0.14	NS
Uncertain or not determined	39	10.8	14	11.4	53	11.0	0.87	NS
Total	360		123		483			
No cause of death sent	337		79		416			

NS, not significant

Table 18.28. Death rate for prevalent diabetic patients

	Exposure years	Deaths	Rate/1000 yrs exposed	Lower 95% CI	Upper 95% CI
Non-diabetics	10835.0	1016	93.8	88.3	99.3
Diabetics	1348.41	255	189.1	168.2	210.0

Table 18.29. Effect of diabetes on cause of death in prevalent patients

Cause of death	Non-diabetic Number	Non-diabetic %	Diabetic number	Diabetic %	Total Number	Total %	p	Adjust p
Cardiac disease	136	30.3	50	40.7	186	32.5	0.03	NS
Cerebrovascular disease	25	5.6	15	12.2	40	7.0	0.01	NS
ERF treatment stopped	64	14.3	13	10.6	77	13.5	0.29	NS
Infection	71	15.8	25	20.3	96	16.8	0.24	NS
Malignancy	41	9.1	5	4.1	46	8.0	0.07	NS
Others	61	13.6	5	4.1	66	11.5	<0.01	<0.05
Uncertain or not determined	51	11.4	10	8.1	61	10.7	0.30	NS
Total	449		123		572			
No cause of death sent	567		132		699			

NS, not significant

disease in the dialysis and transplant prevalent cohorts, 30.7% in the dialysis group compared with 36.6% in the transplant group ($p < 0.001$). Although cardiac disease appeared more common in the diabetic population, this didn't reach statistical difference except in the first 90 days. This may in part be due to the small numbers involved making significant differences harder to prove, and the younger age at start of treatment in diabetics.

Death rates, as expected, increased with increasing age and there were significant differences between incident and prevalent

cohorts with the highest rates occurring in the first 90 days. Death rates were also similar in the age group 20–44 years amongst patient cohorts, but there were significant differences for the age bands 45–64 and 65+ in the incident and prevalent cohorts. The very much higher rate in the first 90 days may be due to the fact there is misdiagnosis/misclassification of some acute renal failure patients as chronic. Likewise, there may be a significant number of chronic patients who, referred late to a nephrologist, require RRT imminently, and it is known these patients have a poorer prognosis. Most other international renal registries do not include the first 45–90 days in their analyses thus excluding this period of high death rates. As a consequence, for comparative purposes, it is important to look at our 1 year after 90-day death rates. In the younger age group, 20–44 years, these effects seem to have less impact and it may be related to their relatively better underlying general health and better co-morbidity. More work would need to be done to look at these cases individually, to look for differences between the survivors and non-survivors.

Gender did not appear to have any statistically significant impact on death rates though there may have been a tendency for females to have a better outcome, particularly in incident patients.

Incident and prevalent patients had similar causes of death in similar proportions. Except for treatment withdrawal, the length of time a patient has spent on RRT had no effect on the overall main cause of death; 41% of patients on RRT for 3–5 years died from cardiac disease compared with 32% who had been on treatment for <3 years. With increasing time on RRT, however, proportionately fewer people withdrew from treatment as a cause of death (18%, 15%, 12% at 1 year after 90 days, <3 years and 3–5 years).

Treatment withdrawal was an important cause of death in both incident and prevalent cohorts, especially in the older age group. As patients get older, they tend to have more associated co-morbidity and this may well lead to stopping treatment, especially in the first 90 days when dialysis may prove to be problematic. There was also a significant difference in the proportion of transplant patients withdrawing from treatment compared with those on dialysis (3.3% and 12.5% respectively, $p < 0.001$). Transplant patients often die with a functioning graft so it would only be the small number of patients with a failing transplant who did not want to go back onto dialysis that would potentially fall into this category. Age had no impact in the transplant cohort.

When compared with the general population of England & Wales, cardiac deaths were proportionately more common in patients on RRT – a 35% increase. This may be a reflection of the co-morbidity present at the start of renal replacement, the ageing RRT population and the effect of ERF itself.

Infection-related deaths were much more common in patients with established renal failure than the general population (16.8% versus 11.5%) representing a 1.5-fold increase. It was the second commonest cause of death in incident patients and appeared more common in the cohort aged ≥65 years. In the prevalent cohort, similar proportions of death were attributable to infection in both the dialysis and transplant patients with little effect of age. These deaths will be related to a combination of factors, including importantly, immunosuppression induced by renal failure itself and immunosuppressive drugs used in transplant and some dialysis patients. Infections related to neck lines, and to a lesser extent PD catheters, will also play an important role.

In those patients with co-morbidity data and a recorded cause of death, 56% of patients with cardiac disease on starting RRT died of a cardiac cause. Generalised vascular disease did not appear to affect the risk of dying from cardiac or cerebrovascular disease. Unfortunately, inadequate co-morbidity data meant we were unable to assess the impact of individual categories on cause of death, and in particular, smoking

status was very poorly recorded.

The underlying primary renal diagnosis had a significant effect on death rate, irrespective of age. Those patients with malignancy had the poorest outcomes, whereas cystic/polycystic patients had the best. Pyelonephritic patients had comparable rates of death with those with glomerulonephritis, cystic/polycystic patients had better outcomes and most others had significantly worse outcomes.

Diabetics had higher death rates and were more likely to die from cardiac disease.

All patients on RRT have a much higher relative risk of death compared with the general population. This is most pronounced in the young; 20–24 year olds with ERF had a 41-fold higher risk of all cause death compared with someone of the same age in the general population. The disparity diminished with longevity; a 4-fold increase in the rate of death in 80–84 year old patients on RRT. In the general population, younger people have a much lower rate of death than the older generations with their concomitant co-morbidity, hence the impact of renal failure is much greater in the young. When looking at just dialysis patients i.e. excluding those prevalent patients with a transplant, the relative risk of death was higher again compared with the general population such that 20–24 year olds on dialysis had a 121-fold higher risk of death and 80–84 year olds a 5-fold increased risk. This suggests that transplant patients have significantly lower rates of death than dialysis patients.

Most international renal registries have only analysed cause of death in their prevalent patients and in general, the UK data were similar. When compared with USRDS data, UK prevalent renal patients had significantly lower rates of death across all age bands. UK data were not adjusted for ethnicity, yet the USRDS has shown that African-Caribbean males on dialysis have an improved survival. They had a death rate of 169.2/1000 pt yrs exp, compared with 288.4 in Whites.[1] Differences between ethnic groups were also seen in women, albeit to a lesser extent (204.0 versus 295.2/1000 pt yrs exp for African-Caribbean individuals and Whites respectively). The UK better rate of survival may be because of differences in case mix. A lack of uniformity in categorisation impedes the comparison of data from international sources.

With improved data returns and increasing numbers of units joining, the Registry will be able to analyse further the effects of co-morbidity and ethnicity on cause and rate of death. It will also be possible to analyse in greater detail particular diagnoses and their associated risk of death, and examine the effect of treatment modality.

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Table 18.30. Collation of EDTA codes for cause of death

EDTA	Title	Subgroup B
0	Cause of death uncertain/not determined [0]	Uncertain or not determined
11	Myocardial ischaemia and infarction [11]	Cardiac disease
12	Hyperkalaemia [12]	Others
13	Haemorrhagic pericarditis [13]	Others
14	Other causes of cardiac failure [14]	Cardiac disease
15	Cardiac arrest/sudden death; other cause or unknown [15]	Cardiac disease
16	Hypertensive cardiac failure [16]	Cardiac disease
17	Hypokalaemia [17]	Others
18	Fluid overload/pulmonary oedema [18]	Cardiac disease
21	Pulmonary embolus [21]	Others
22	Cerebrovascular accident, other cause or unspecified [22]	Cerebrovascular disease
23	Gastrointestinal haemorrhage (digestive) [23]	Others
24	Haemorrhage from graft site [24]	Others
25	Haemorrhage from vascular access or dialysis circuit [25]	Others
26	Cerebral haemorrhage from ruptured vascular aneurysm (not code 22 or 23) [26]	Others
27	Haemorrhage from surgery (except digestive haemorrhage) [27]	Others
28	Other haemorrhage, other site and/or other cause [28]	Others
29	Mesenteric infarction [29]	Others
31	Pulmonary infection (bacterial) [31]	Infection
32	Pulmonary infection (viral) [32]	Infection
33	Pulmonary infection (fungal or protozoal; parasitic) [33]	Infection
34	Infections elsewhere except viral hepatitis	Infection
35	Septicaemia [35]	Infection
36	Tuberculosis (lung) [36]	Infection
37	Tuberculosis (elsewhere) [37]	Infection
38	Generalised viral infection [38]	Infection
39	Peritonitis (all causes except for peritoneal dialysis) [39]	Infection
41	Liver disease due to hepatitis B virus [41]	Others
42	Liver disease due to other viral hepatitis [42]	Others
43	Liver disease due to drug toxicity [43]	Others
44	Cirrhosis – not viral (alcoholic or other cause) [44]	Others
45	Cystic liver disease [45]	Others
46	Liver failure – cause unknown [46]	Others
51	Patient refused further treatment for ESRF [51]	ERF treatment stopped
52	Suicide [52]	Others
53	ESRF treatment ceased for any other reason [53]	ERF treatment stopped
54	ESRF treatment withdrawn for medical reasons [54]	ERF treatment stopped
61	Uraemia caused by graft failure	ERF treatment stopped
62	Pancreatitis [62]	Others
63	Bone marrow depression (aplasia) [63]	Others
64	Cachexia [64]	Others
66	Malignant disease in patient treated by immunosuppressive therapy [66]	Malignancy
67	Malignant disease: solid tumours except those of 66 [67]	Malignancy

Table 18.30 (continued)

68	Malignant disease: lymphoproliferative disorders (except 66) [68]	Malignancy
69	Dementia [69]	Others
70	Peritonitis (sclerosing, with peritoneal dialysis) [70]	Others
71	Perforation of peptic ulcer [71]	Others
72	Perforation of colon [72]	Others
73	Chronic obstructive pulmonary disease [73]	Others
81	Accident related to ESRF treatment (not 25) [81]	Others
82	Accident unrelated to ESRF treatment [82]	Others
99	Other identified cause of death [99]	Others
100	Peritonitis (bacterial, with peritoneal dialysis) [100]	Infection
101	Peritonitis (fungal, with peritoneal dialysis) [101]	Infection
102	Peritonitis (due to other cause, with peritoneal dialysis) [102]	Infection