Chapter 16: Survival of patients on Dialysis

Introduction

The database of patients available in the 'Renal Registry' enables analysis of the influence of different factors on patient survival. These factors either reflect patient case mix [e.g. age, gender, ethnicity, underlying diagnosis & other co-morbidity] or are dependent on treatment [e.g. haemoglobin, mode of dialysis, phosphate level]. For individual renal units such analysis allows comparison with performance in previous years and with other centres.

Survival rates can either be looked at in relation to:

(a) An *'incident cohort'* in which patients who started renal replacement therapy in a particular year are included

or

(b) A 'prevalent cohort' in which all (or a defined group) of patients undergoing renal replacement therapy at a particular time are included

The analyses presented in this chapter examine survival whilst on dialysis of incident and prevalent patients. Patients are censored at transplantation or when moving to a centre which dos not report to the Registry.

Death rates in different centres contributing to the UK Renal Registry are reported here. These are very crude data. The analysis shows that adjustment can be made between centres on the basis of age, but there is need for more detailed information relating to co-morbidity and ethnic origin. With this lack of information about case mix, no significance can currently be attributed to any apparent differences in survival between centres.

Statistical Methods

The 'number of days at risk ' was calculated for each patient and the sum of these values for all patients divided by 365 represents the 'number of patient years at risk'. The mortality rate was defined as :

$$\frac{\text{Number of deaths on dialysis}}{\text{Number of patient years at risk}}$$

Patients were 'censored' from the relevant date if one of the following occurred:

1. He / she was 'transferred out' to a renal unit that did not contribute to the 'Renal Registry'.
2. He / she was transplanted.

If a patient died on the day of transplantation, the death was not included.

The unadjusted survival probabilities (with 95% confidence intervals) were calculated using the Kaplan Meier Method in which the probability of surviving more than a given time can be estimated for members of a 'cohort of patients' without accounting for the characteristics of the members of that cohort. Where centres are small or the survival probabilities greater than 90% the confidence intervals are only approximate.

In order to estimate the differences in survival of different subgroups of patients within the cohort a 'Stratified Proportional Hazards Model (Cox) ' was used where appropriate. The results from the Cox Model are interpreted using a hazard ratio. For example, for diabetics when compared with non-diabetics, the hazard ratio is the ratio of the estimated hazards for diabetics relative to non-diabetics, where the hazard is the risk of dying at time t given that the individual has survived until this time. The underlying assumption of a proportional hazards model is that this ratio remains constant throughout the time period under consideration. The proportional hazards model was tested for validity in all cases.

Survival whilst on dialysis of the incident 1997 and 1998 cohorts

Introduction

It has been widely recognised that the mortality rate of a cohort of patients during the first 90 days after starting renal replacement therapy exceeds the mortality rate during any subsequent 90-day period. In part this may be due to the inclusion in the analysis of patients whose death is inevitable from advanced an acute or chronic multi-system disease which is contributing to renal failure. There is also difficulty in classification of patients, and some patients who die with acute renal failure may be included by some centres.

This analysis examines the influence of age on the survival on dialysis of incident patients, and then compares the survival on dialysis, adjusted for age, of patients starting renal replacement therapy during one year.

Patient Cohort

Patients were included in the analysis if they had started renal replacement therapy with dialysis in one of 'Renal Registry' sites during 1997. the same analysis was repeated for 1998

Statistical methods

Adjusted survival probabilities were calculated using a 'Stratified Proportional Hazards Model (Cox)' adjusting for age and stratifying by centre. However this methodology cannot be applied to analyse death throughout the first 12 months of therapy because the risk of death is not constant when the first 90 days are included in the analysis. For this reason an analysis has been undertaken of survival during:

a. The first 90 days of treatment.
b. The 12 months after the first 90 days of treatment

The mean patient age of the cohort starting RRT in 1997 was 59.2 years and the survival probabilities estimated from the model for each centre were adjusted for a population of mean age 59.2 years for both 1997 and 1998 cohort (which had a median age of 60.3). Patients were classified according to the centre where they died, or where they were receiving treatment at the beginning of the follow up period.

Analysis adjustment

In the adjusted analysis most centres show an increased survival after adjustment to a median age of 59.2 years. Intuitively it seems wrong that an adjustment towards the mean population results in an improvement for the majority of centres. However this adjustment is correct. This is because the older patients die at a higher rate than the younger patients, leaving a younger cohort as the patient cohort progresses through the one year. In 1998 the cohort had a slightly older median age, but all centres have been adjusted to 59.2 at 90 days and 58.3 in the 1 year after 90 days, to directly compare the 1997 and 1998 incident survival.

The stratification method used in this adjusted analysis precludes any testing for statistical significance of the difference in survival between renal units

Results

The influence of age

In the units contributing to the UK Renal Registry 11.2% of patients die within the first 90 days of treatment in the 1997 cohort and 11.5% in the 1998 cohort. . Of those who survive the first 90 days of treatment, a further 13.3% die during the next 9 months and 17.6% within 12 months. The increase in hazard of death for every increase of 10 years in patient age differs considerably when comparing these 3 time periods (table 16.1)

Death during	Increase in hazard for every increase of 10 years in patient age (% [95% CI %])
First 90 days	75 [47-108]
90 days - 15 months	38 [21 - 58]

Table 16.1 Relationship of age and hazard of death in 1997 cohort

These results support the clinical impression that it is mainly elderly patients that die during the first 90 days of treatment. From the data it was possible to make adjustments for age in subsequent analyses.

Survival on dialysis during the first 90 days of treatment.

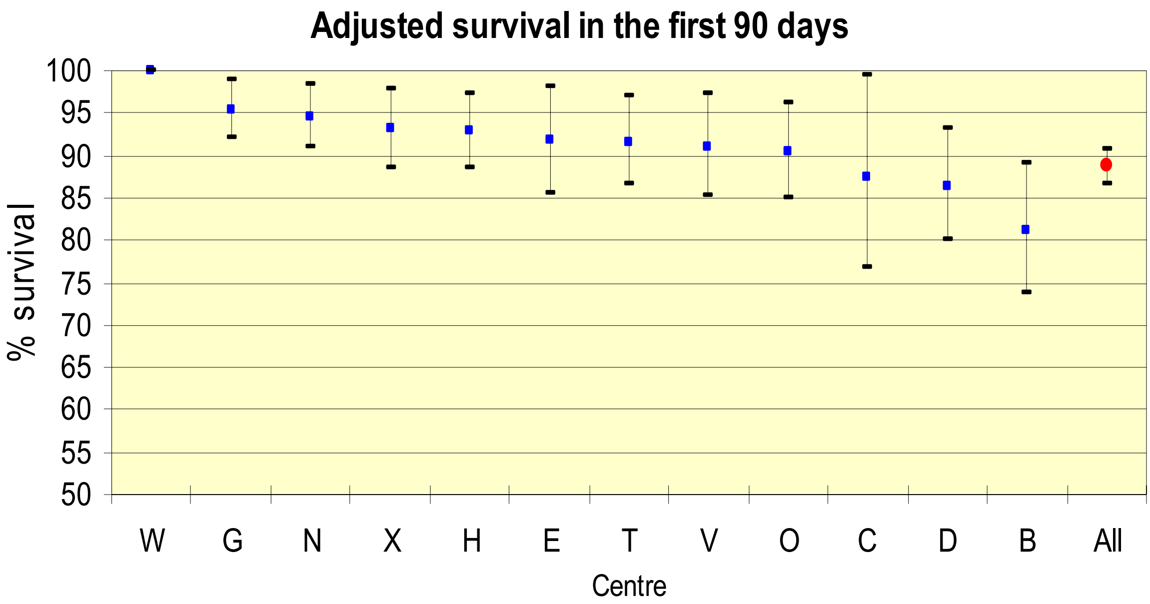
There was wide variation between centres in the unadjusted survival of patients during the first 90 days of treatment (table 16.2, figure 16.1). At one extreme in one small centre in 1997 cohort no patients died during the first 90 days of treatment, whilst at the other extreme only 77% of patients survived the first 90 days in another centre.

Centre	**Unadjusted 90 Day Survival 1998**		**Adjusted 90 Day Survival 1998**		**Adjusted 1997**
		95% CI			**KM**
	KM		*KM*	*95% CI*	
A	86.8	75.7 – 97.9	90.3	82.7 – 98.6	

Centre	Unadjusted 90 Day Survival 1998		Adjusted 90 Day Survival 1998		Adjusted 1997
		95% CI			**KM**
	KM		*KM*	*95% CI*	
B	74.5	67.5 – 81.5	81.5	75.3 – 88.3	81.1
C	94.5	87.0 – 100	95.6	89.8 – 100	87.3
D	87.1	79.1 – 95.1	91.3	86.1 – 97.0	86.4
E	84.6	75.6 – 93.6	90.7	85.4 – 96.5	91.7
F	88.9	82.9 – 94.9	92.2	87.9 – 96.6	
G	91.7	87.7 – 95.7	93.6	90.4 – 96.9	95.4
H	86.1	79.8 – 92.4	88.6	83.6 – 93.9	92.9
K	92.7	84.7 – 100	94.7	89.1 – 100	
L	90.6	85.4 – 95.8	93.2	89.5 – 97.0	
M	88.8	81.3 – 96.1	92.7	87.3 – 98.5	
N	91.3	85.8 – 96.8	93.9	90.3 – 97.7	94.6
P	88.5	83.1 – 93.9	92.4	88.7 – 96.2	90.4
Q	93.8	89.7 – 97.9	95.3	92.2 – 98.6	
R	85.0	77.0 – 93.0	86.9	80.4 – 94.1	
S	85.3	76.3 – 94.3	89.2	86.7 – 91.8	
T	89.6	84.2 – 95.0	89.4	84.1 – 95.0	91.6
V	89.8	82.5 – 97.1	92.1	86.6 – 97.9	91.0
W	93.8	86.8 – 100	96.7	93.0 – 100	100
X	88.8	81.3 – 96.1	91.8	86.5 – 97.4	93.1
E&W	88.1	88.0 – 88.2			88.7

(Adjusted on basis of the mean age 59.2 years)

Table 16.2 Survival during the first 90 days on dialysis 1998 cohort



Adjustment has been made on the basis of the mean patient age (59.2 years)

Figure 16.1a Adjusted survival during the first 90 days, 1997 cohort

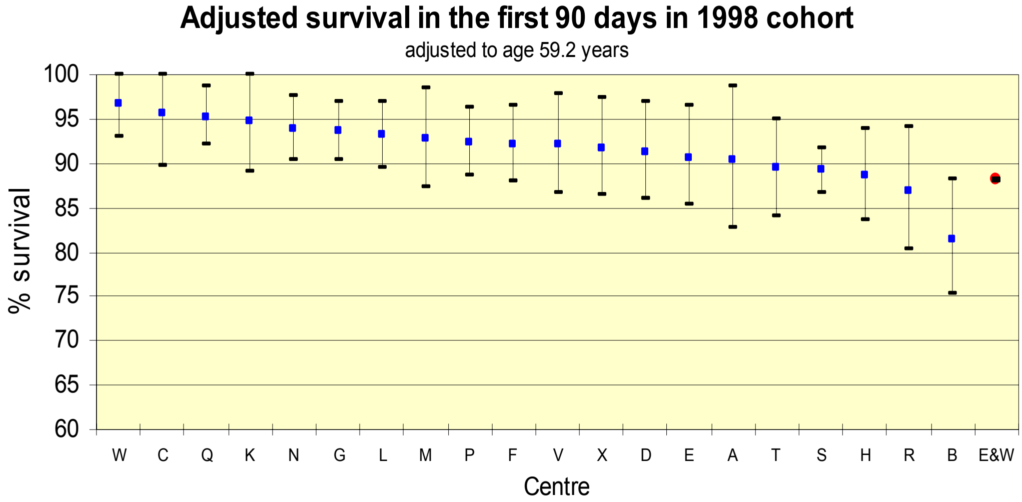


Figure 16.1b Adjusted survival during the first 90 days, 1998 cohort

From figure 16.1a and b, it can be seen that whilst the overall survival at 90 days was constant from 1997 to 1998 at about 89%, there was considerable volatility for some individual centres. This demonstrates the danger of drawing conclusions from survival figures derived from small numbers over short periods of time. As more data accumulates with time, it will be possible to analyse for consistent trends.

Survival during the year after the first 90 days of treatment

The results are shown in table 16.3 and figure 16.2.

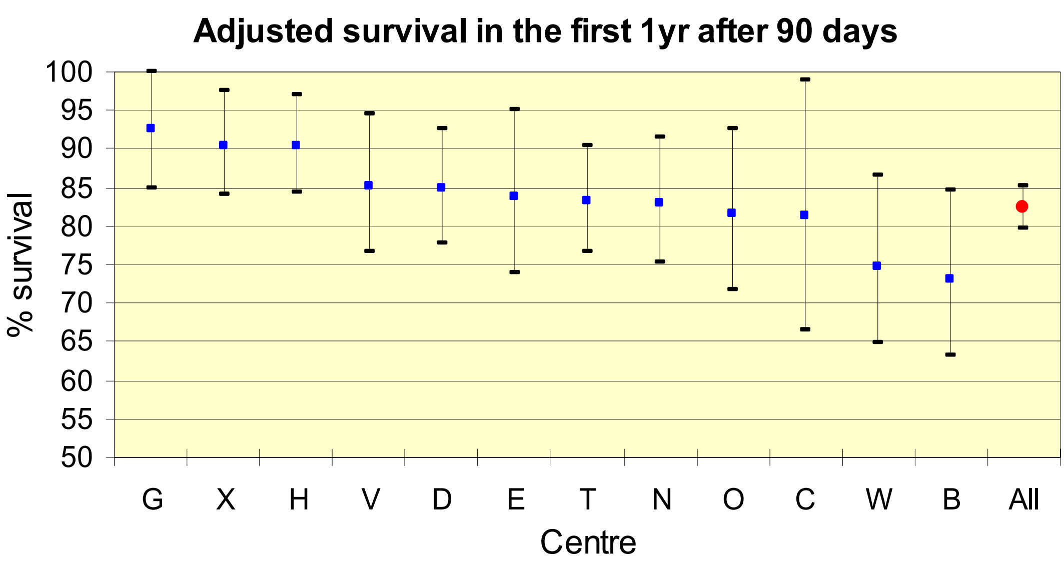
Centre	Unadjusted 1 Year Survival (after the first 90 days) 1998		Adjusted 1 Year Survival (after the first 90 days) 1998		Adjusted 1997
	KM	95% CI	*KM*	*95% CI*	KM
A	80.2	65.7 – 94.7	83.8	72.8 – 96.3	
B	74.7	64.3 – 85.1	78.8	70.5 – 88.1	74.7
C	78.9	63.5 – 94.3	81.2	69.0 – 95.6	84.1
D	79.6	69.9 – 89.3	83.4	75.8 – 91.7	75.8
E	66.7	52.0 – 81.4	74.8	64.0 – 87.3	82.2
F	94.3	89.7 – 98.9	95.5	92.1 – 99.1	
G	84.3	78.1 – 90.5	86.5	81.3 – 92.0	83.2
H	85.6	78.7 – 92.5	87.7	82.1 – 93.8	90.9
K	81.8	70.2 – 93.4	85.2	76.3 – 95.2	
L	77.0	68.5 – 85.5	81.9	75.3 – 89.0	
M	89.7	82.3 – 97.1	84.7	77.4 – 92.7	
N	84.2	76.9 – 91.5	88.5	83.2– 94.0	84.9
P	84.4	78.0 – 90.8	88.7	84.0 – 93.6	82.1
Q	85.2	77.9 – 92.6	87.2	81.1 – 93.8	
R	88.0	80.0 – 96.0	90.2	84.0 – 96.9	
S	79.5	75.7 – 84.3	82.9	79.6 – 86.4	

Centre	Unadjusted 1 Year Survival (after the first 90 days) 1998		Adjusted 1 Year Survival (after the first 90 days) 1998		Adjusted 1997
T	89.4	83.6 – 95.2	88.9	83.2 – 95.0	84.4
V	82.4	72.7 – 92.1	83.1	74.6 – 92.7	86.2
W	71.3	56.6 – 86.0	81.5	72.1 – 92.2	92.8
X	89.7	82.3 – 97.1	91.5	85.7 – 97.7	90.6
E&W	82.7	81.0 – 84.4			82.4

Table 16.3 survival of patients over 1 year after first 90 days in 1998 and 1997 cohort.

Centre	Adjusted survival (after the first 90 days) *KM*	95% CI
A	83.2	71.9 – 96.2
B	77.6	68.9 – 87.2
C	81.4	69.1 – 95.8
D	83.3	75.6 – 91.7
E	71.7	60.0 – 85.5
F	95.2	91.6 – 99.0
G	85.6	80.1 – 91.4
H	87.3	81.5 – 93.5
K	85.4	76.5 – 95.2
L	81.2	74.5 – 88.6
M	84.2	76.7 – 92.5
N	87.8	82.3 – 93.7
P	87.6	82.6 – 92.9
Q	87.0	80.7 – 93.6
R	90.0	83.6 – 96.8
S	82.4	79.0 – 86.0
T	88.3	82.4 – 94.7
V	83.1	74.5 – 92.6
W	79.1	68.9 – 91.0
X	90.9	84.7 – 97.5

Table16.4 Survival probabilities during the year after the first 90 days, adjusted by quartiles.



Adjustment has been made on the basis of the mean patient age of 58.3 years

Figure 16.2a Survival during the year after the first 90 days, 1997

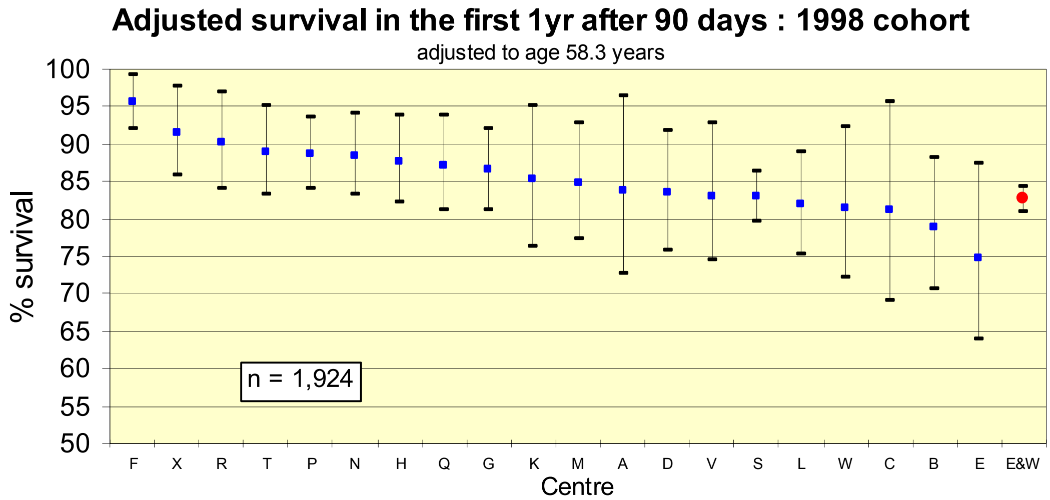


Figure 16.2b Survival during the year after the first 90 days, 1998 cohort

As with the 90 day survival the overall subsequent one-year survival is constant at about 83%, but there is volatility from year to year for some individual centres.

There was evidence in the analysis to suggest that the relationship between risk of death and patient age was not completely linear. For this reason the adjusted analysis was repeated by categorising the age of patients into quartiles of ≤ 47, 48 – 62, 63 – 71 and ≥ 72 years (table 16.4).

Comparison of survival on dialysis at 90 days and during the subsequent year

Variations between centres in survival during the first 90 days may partly be due to misclassification of some acute renal failure patients dying in this period. If this were the case the effect would, by definition, be lost after 90 days, and the variation in survival would be smoothed. To examine this hypothesis survival at the two time periods was compared (figure 16.3). There is no obvious smoothing. Centres with the best survival at 90 days do not necessarily have the best survival at one year.

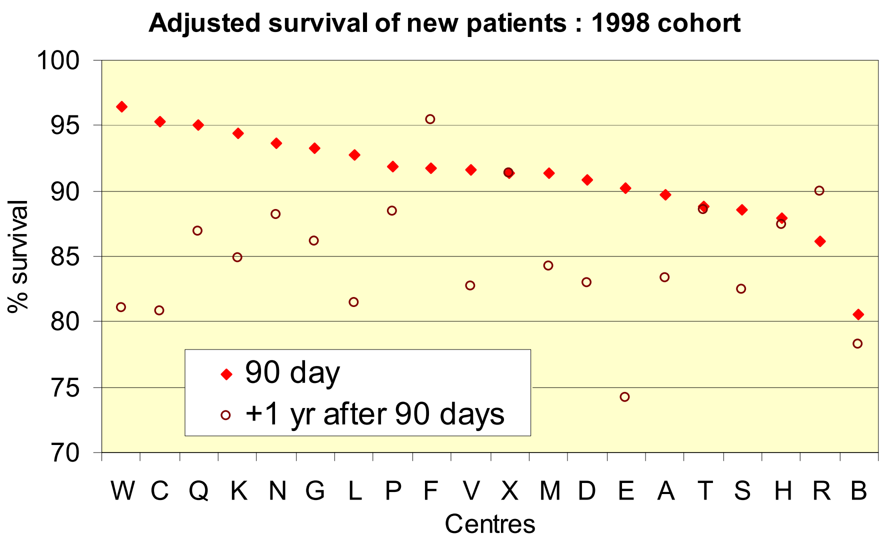


Figure 16.3 Comparison of the 90 day and 1 year survival on dialysis

Relationship between acceptance rate and survival on dialysis

Centres with a high acceptance rate for dialysis might accept more elderly and other patients with many co-morbid conditions, and might be expected to have a higher early death rate. On the other hand centres with large ethnic minorities may have larger numbers of young patients starting dialysis. In figure 16.4 survival is compared with acceptance rate. There is no obvious relationship.

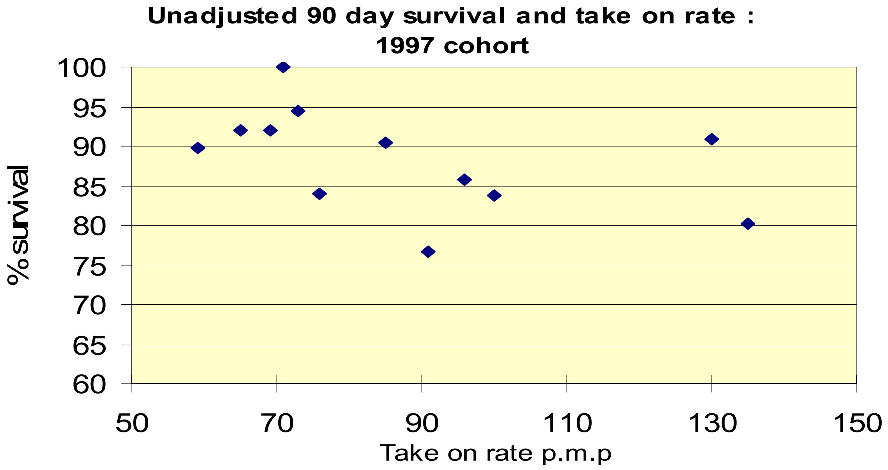


Figure 16.4 Relationship between acceptance rate and survival on dialysis

Discussion

The 1997 patient cohort UK Renal Registry unadjusted 1 year death rate for new patients on dialysis after the first 90 days of treatment is 19.3 per 100 patient years

The one-year survival is 82.4%. This compares with the 1997 United States Renal Data Systems (USRDS) 1-year survival of new patients on dialysis (again after the first 90 days of treatment) of 80.1%. However it is important to recognise that the case mix of the two incident populations differs in several potentially important respects (table 16.5)

	UK Renal Registry 1998	USRDS 1997
1 year survival from day 90	82.4%	80.1%
Mean Age (years)	58.3	60.9
Diabetes (%)	16	44.5
Black patients (%)	3	28
Male to female ratio	1.64	1.12

Table 16.5 UK and USA new patient characteristics

These differences in case mix have to be taken into account when interpreting the differences in survival.

The first 90 days of renal replacement therapy is an intense period of treatment with a high mortality. Information about this period is important. In the USA, the USRDS does not report data relating to the first 90 days of treatment. This approach reduces the discrepancy that can arise consequent on inconsistency in classification of acute and chronic renal failure but misses helpful information. If sufficient detail regarding comorbidity were available accurate information could be gained from analysis of survival during the first 90 days of treatment. The UK Renal Registry will be attempting to improve data quality to enable meaningful analysis of this period.

Survival of patients established on dialysis – the prevalent cohort

The effects of age, gender and diabetes.

This analysis examines the survival of a clearly defined *'prevalent cohort'* of dialysed (peritoneal dialysis and haemodialysis-) patients in which all had been treated with renal replacement therapy for at least a year. Those who had only recently started treatment are excluded because of the increased mortality that occurs during the first few months of treatment. The following analyses were undertaken:

The effect of 'Length of Time on Renal Replacement Therapy' on 1-year survival.
The effect of 'Age', 'Gender' and 'Diabetes (when the cause of Renal Failure)' on 1-year survival.
The variation between dialysis centres in 1-year survival.
The variation between dialysis centres in 2-year survival.

Patient Cohort

Patients were included in the analysis of **1-year survival (1998)** only if they satisfied each of the following criteria:

1. They were being treated with dialysis on 1/1/1998 at one of the Renal Registry sites.
2. They had started renal replacement therapy on or before 1/1/1997.
3. They had been treated with dialysis for at least 6 months on 1/1/1998 if they had had a failed renal transplant.

There were 3,332 patients included.

In a separate, but similar analysis, the **2-year survival (1997 - 1998)** of those patients who had been treated with renal replacement therapy for at least a year and were on dialysis on 1/1/1997 was undertaken. There were 2,105 patients. A proportion but not all these patients were included in the 1-year survival analysis.

The effect of Age, on the survival of Established Dialysis Patients

Statistical Methods

A Cox Proportional Hazards Model was used to analyse the relationship between age, and risk of death over the one year follow up period and the analysis was adjusted for centre effect. Survival estimates were calculated using the Kaplan-Meier method.

Results

The unadjusted 1-year survival (1998) of patients in age (years) groups 18 – 34, 35 – 44, 45 – 54, 55 – 64, 65 – 74, ≥ 75 were as shown in Table 16.6.

Age (yrs)	No. of patients	No. of deaths	1 year survival	
			KM	95% CI
18 – 34	390	17	95.3	92.5 – 97.0
35 – 44	457	31	92.5	89.5 – 94.7
45 – 54	590	58	89.6	86.7 – 91.8
55 – 64	710	106	84.4	81.5 – 87.0
65 – 74	867	185	78.2	75.2 – 80.8
≥ 75	541	156	71.1	67.1 – 74.7

Table 16.6 Age and 1 year survival of dialysis patients on RRT for at least a year.

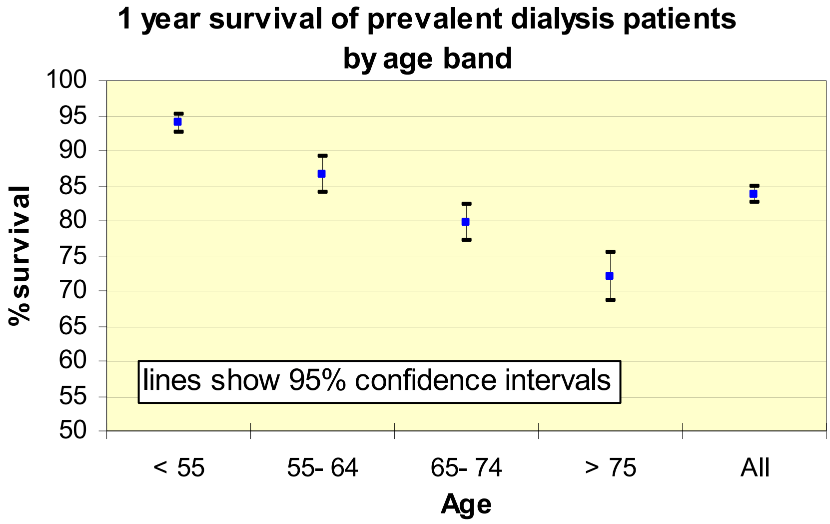


Figure 16.5 1 year survival of prevalent dialysis patients by age band

An increase in one year of age was associated with an increase in hazard of death of 1.039 [95% CI: 1.032 – 1.046]. An increase in age by 10 years was associated with an increase in hazard of death of 1.47 [95% CI: 1.38 – 1.57].

The effect of 'Length of Time on RRT' on Survival of Established Dialysis Patients.

Data from this Registry and elsewhere have demonstrated that there is increased mortality of patients during the first 90 days of renal replacement therapy. This suggests that the use of 'prevalent cohorts' that include patients who have recently started renal replacement therapy would not allow meaningful comparison between different units. Thus when using a 'prevalent cohort' to compare the one year survival of prevalent patients from different centres it is important to establish whether subsequent length of time that individuals have previously been on renal replacement therapy affects the 1 year survival of that cohort. This could be important if one centre has more than 50% of patients dialysed for between 1 and 3 years, and another has only 25% of patients dialysed for between 1 and 3 years. One of the aims of this analysis is to establish whether the use of 'prevalent cohorts' which exclude patients who have been on renal replacement therapy for less than a year allows meaningful comparison between units.

Patient Cohort

As described in Introduction for 1 year survival (1998).

Statistical Methods

A Cox Proportional Hazard model including the variables age and length of time on renal replacement therapy, stratified by treatment centre, was used. To determine whether the relationship between length of time on RRT and risk of death varied for patients of different ages, an interaction between length of time on RRT and age was fitted into the model.

Patient age was included as a continuous variable. The length of time on RRT was calculated in years, and was then categorised into quintiles [1 year, 2 years, 3 – 4 years, 5 – 8 years and ≥ 9 years]. Patients with an unknown length of time on RRT were excluded from the analysis, reducing the sample to 3,445 patients.

Results.

After adjusting for age, the risk of death was not found to differ significantly for increasing length of time on RRT ($p = 0.0946$). This means that for a patient of any given the risk of death during 1998 did not increase with increasing time on renal replacement therapy. The results from this analysis are shown in table 16.7 below.

Length of time on RRT	Hazard Ratio [95% CI]
1 year	REF
2 years	1.36 [1.04 – 1.76]
3 – 4 years	1.35 [1.06 – 1.73]
5 – 8 years	1.30 [0.99 – 1.72]
≥ 9 years	1.16 [0.85 – 1.58]
p-value	0.0946

Table 16.7 Time on RRT and risk of death (Hazard ratio) for dialysis patients on RRT for at least a year.

Summary

For a cohort of dialysed patients who have all been on renal replacement therapy for more than a year, the one-year survival is not affected by the duration of renal replacement therapy of the individuals.

The effect of Gender and Diabetes on the Survival of Established Dialysis Patients.

The previous analysis was repeated investigating the effect of gender and diabetes on the one-year survival of dialysis patients who had been on renal replacement therapy for at least one year.

Patient Cohort

As described in Introduction for 1-year survival (1998), but because of incomplete data the number in the analysis was reduced from 3,332 to 3,328 in the analysis of the effects of gender and to 3,304 in the analysis of the effect of diabetes.
For the purposes of this analysis patients were classified as having diabetes only if the diagnosis was registered as the primary cause of renal failure (and not as concurrent co-morbidity).

Statistical Methods

A Cox Proportional Hazards Model was used to analyse the relationship between age, gender, diabetes and risk of death over the one year follow up period and the analysis was stratified by treatment centre.

Effect of Gender

A significant association was found between gender and risk of death (p = 0.0074, n = 3,328) such that the hazard of death for males was 1.28 [95% CI: 1.07 – 1.53] times that for females. Since the median age of males was 60 years compared with 58 years for females, the analysis was repeated adjusting for age. When this was done, the association between gender and risk of death remained statistically significant (p = 0.0397, n = 3,328) such that the hazard of death for males was 1.21 [95% CI: 1.01 – 1.45] times that for females. There was no significant interaction between gender and patient age fitted as a continuous variable, indicating that the risk of death for males compared with females did not vary for patients of different ages.

Effect of Diabetes

The relationship between the risk of death for diabetics of different ages compared with non-diabetics is shown in figure 16.6. A significant interaction for risk of death was found between a diagnosis of diabetes and patient age (p = 0.0372, n = 3,304) indicating that the relationship between diabetes and risk of death is dependent upon the patients age. The increased hazard for young diabetics compared with others on RRT is much more than for older diabetics. Thus a 25 year old diabetic has an increase in the hazard of death of HHH compared with a non-diabetic patient of the same age; a 57 year old diabetic patient, has an increase in the hazard of death of only 1.92 [95% CI: 1.50 – 2.46] compared with a non-diabetic patient of the same age. This is probably due to the high incidence of cardiovascular disease in young diabetics compared with others on RRT. In the general older patients this increases towards the diabetic incidence.

The relationship between the risk of death and age differs in diabetic and non-diabetic patients. Diabetics have an increase in hazard of death of 1.023 [95% CI: 1.005 – 1.040] for a one year increase in age. In contrast non-diabetics have an increase in hazard of death of 1.043 [95% CI: 1.035 – 1.050] with a one year increase in age.

Some caution is required in the interpretation of these findings because of the potential inclusion of a degree of bias in the calculation of survival probabilities of diabetic dialysis patients compared with non-diabetic patients. This arises because of the policy that all patients are censored at the time of transplantation. In the under 55 age group, a larger proportion of diabetic patients (with greater co-morbidity) may be deemed unsuitable for transplantation than non-diabetic patients of the same age.

When gender was added in the Cox Model (adjusting for age and diabetes), the hazard ratios for males changed marginally from 1.20 to 1.21 [95% CI: 1.01 – 1.45] times that of females (p = 0.0437, n = 3,300).

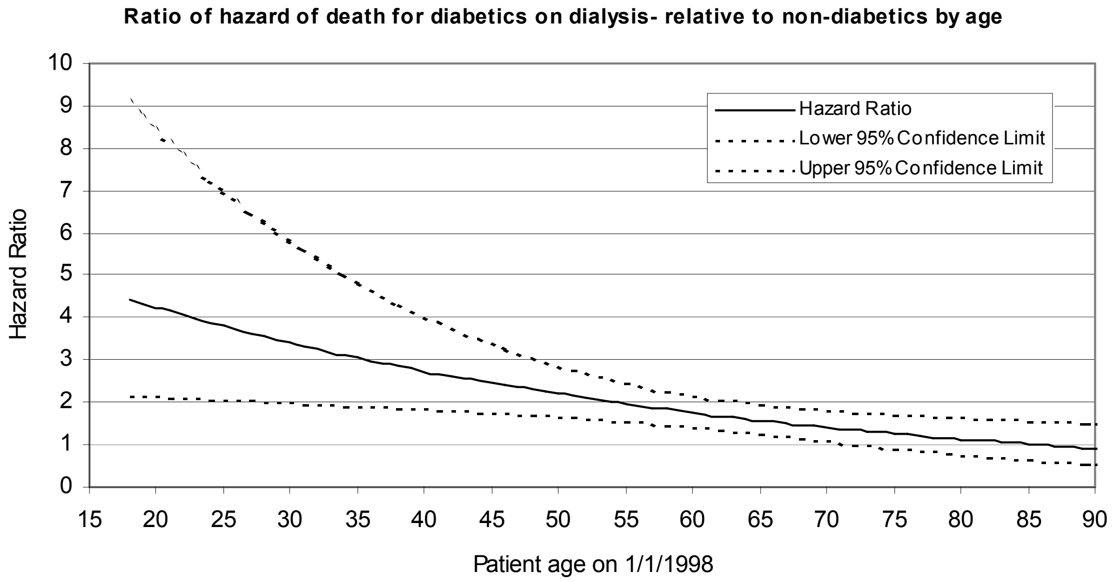


Figure 16.6 The 1 year survival of diabetic and non-diabetic dialysis patients of different ages on RRT for $\geq$1 year.

Waugh et al when comparing the relative hazard of death in diabetic and non-diabetic patients in the general population showed a similar reduction of the increased relative risk of death of diabetics with advancing age. In the patient population studied by Waugh, the diabetic relative risks for mortality from all causes were 5.5, 2.3, 1.7, 1.3 for age ranges 15-44, 45-64, 65-74, and 75 and over, respectively.

Summary

1-year survival of dialysed patients deteriorates with increasing age. Males of all ages have an increased risk of death. Diabetes increases the risk of death considerably especially in younger patients. The relative increased hazard of death for a diabetic in renal failure compared with non diabetic patients on RRT is similar to that of diabetic not in renal failure comparing with the general population.

Variation between centres of 1 year survival (1998) of established dialysis patients

Patient Cohort

As described in Introduction for 1 year survival (1998).
Data relating to 3,332 patients from 19 renal units in England & Wales were available for analysis.

Statistical Method

The Kaplan Meier Method was used to calculate the unadjusted one-year survival probabilities (with 95% confidence intervals) for each centre. The survival probabilities can be interpreted as the probability of a patient surviving more than a year or as the proportion of patients surviving more than a year.

The adjustment process used in this section gives estimates of the survival and death rates that would have arisen for the cohorts, had they all had the same age, sex, diabetes as a cause of ESRF, and duration of renal replacement therapy as the overall registry prevalent population. As the adjusted survival curves are all adjusted to the same reference population, any remaining differences between them is due to factors other than age, sex, diabetes and duration of ESRD.

A Cox Stratified Proportional Hazards Model was used to estimate the survival probabilities at each centre, adjusting for age and stratifying by centre. Age was entered into the model as a continuous variable. Stratifying by centre enables a separate underlying hazard to be estimated at each centre although it assumes that the effect of age on the hazard is the same at each centre.

For the 1998 sample (n=3,332), the mean patient age was 57.0 years and the one-year survival probabilities at each centre were estimated from the model, for a population with a mean age of 57.0 years.

Results

The unadjusted patient survival for 1998 was 83.7%, which equates with a death rate of 17.8 per 100 patient years. The equivalent figures for 1997 had been 82.3% and 19.5 per 100 patient years. The similarity between the survival figures for the 1997 and 1998 is noteworthy as different centres were included in the compilation of this analysis.

The results for individual centres are shown in table 16.8

Centre	**Unadjusted One Year Survival 1998**		**Adjusted One Year Survival 1998**		**Adjusted One Year Survival 1997**
	KM	**95% CI**	*KM*	**95% CI**	
A	84.2	66.0 – 93.1	86.5	70.9 – 94.0	
B	80.4	71.7 – 86.6	83.9	76.4 – 89.1	88.9 [82.1 – 93.2]
C	83.9	72.8 – 90.8	86.7	77.2 – 92.4	74.8 [62.9 – 83.3]
D	85.0	78.1 – 89.9	86.4	80.1 – 90.8	82.1 [75.6 – 87.0]
E	87.9	79.7 – 93.0	91.6	85.6 – 95.2	

F	85.4	79.9 – 89.5			
G	84.9	80.7 – 88.2	87.8	84.2 – 90.6	85.8 [82.0 – 88.9]
H	81.0	74.9 – 85.7	83.5	78.0 – 87.7	87.0 [82.2 – 90.6]
K	84.1	75.4 – 90.0	86.4	78.7 – 91.4	
L	79.6	73.5 – 84.4	82.7	77.2 – 86.9	
N	86.5	81.8 – 90.0	88.9	84.9 – 91.9	88.0 [83.9 – 91.1]
O	82.1	73.8 – 87.9	85.9	79.1 – 90.6	87.3 [80.9 – 91.6]
P	78.1	71.5 – 83.3	83.9	78.7 – 88.0	
Q	85.4	81.0 – 88.9	88.3	84.6 – 91.2	
R	85.4	79.3 – 89.8	86.0	80.1 – 90.3	
T	81.5	76.6 – 85.4	82.6	77.9 – 86.3	84.2 [79.7 – 87.7]
V	88.8	84.1 – 92.2	90.4	86.2 – 93.4	85.9 [81.3 – 89.3]
W	83.6	71.7 – 90.9	88.8	80.2 – 93.8	81.4 [71.2 – 88.2]
X	81.0	74.4 – 86.0	84.6	78.7 – 89.0	89.9 [84.2 – 93.6]
All	83.7	82.4 – 84.9			

Table 16.8 One Year Survival Rates for all patients in 1998

Age, diabetes and gender have been included in the adjusted analysis while differences between centres of ethnicity and other co-morbidity have not been accounted for.

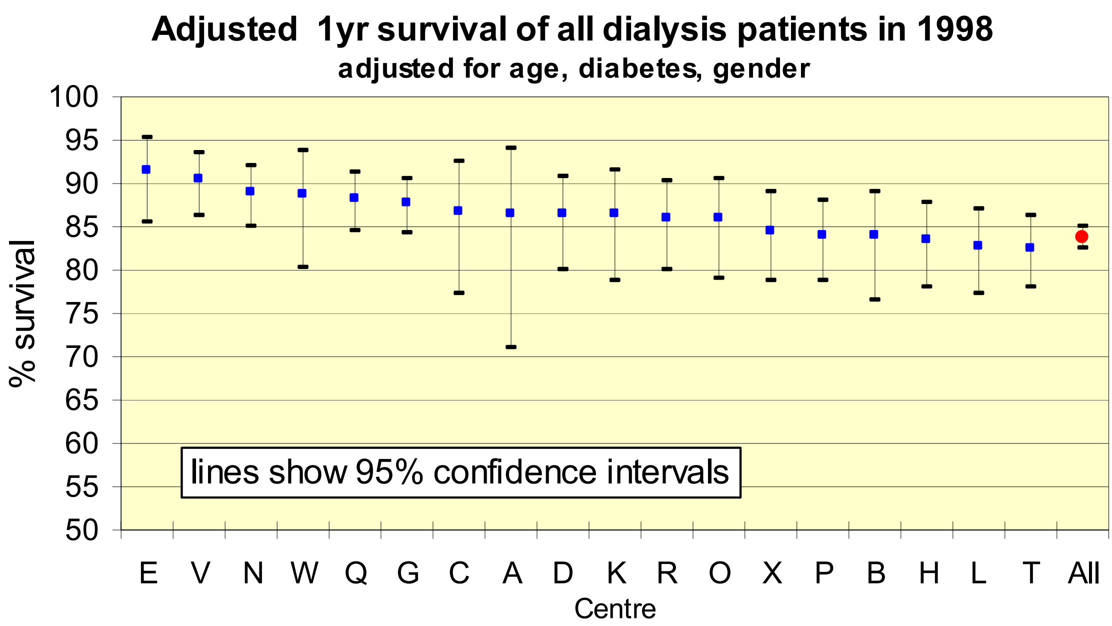


Figure 16.7 Adjusted 1-year survival of all dialysis patients in 1998
* centre H is missing from the adjusted analysis as many of the dead patients had a missing diagnosis, and no adjustment was possible.

Summary
There is variation in 1-year patient survival between units when adjustment is made on the basis of age, gender and diabetes. However no account was taken of ethnicity or comorbidity in this analysis both of which could potentially have a significant impact.

Variation between centres in 2-year survival (1997-98) of established dialysis patients.

Patient Cohort
As described in the Introduction.
Data relating to 2105 patients from 11 renal units in England were included in the analysis.

Statistical Method
As for 1 year survival.

In the 2-year survival analysis the mean patient age was 56.3 years. The two-year survival probabilities at each centre were estimated from the model, for a population of age 56.3 years.

Results

The results are shown in table 16.9, and illustrated in figure 16.8. The unadjusted two-year survival for 1997-98 was 68.8%, compared with the one-year survival of 82.3% for the same cohort.

Centre	**Unadjusted Two Year Survival 1997 - 1998**		**Adjusted Two Year Survival 1997 - 1998**	
	KM	**95% CI**	*KM*	**95% CI**
B	68.9	60.7 - 77.2	74.3	67.5 - 81.8
C	60.9	49.8 - 72.1	66.8	57.6 - 77.6
D	68.	61.7 - 75.3	70.7	64.4 - 77.5
G	68.9	64.4 - 73.4	73.2	69.2 - 77.4
H	65.5	59.5 - 71.6	69.6 []	64.2 - 75.5
N	72.6	67.7 - 77.5	77.0 [	72.8 - 81.5
O	66.8	58.9 - 74.7	73.2	66.6 - 80.3
T	67.5	62.5 - 72.5	68.2	63.4 - 73.3
V	73.5	68.3 - 78.6	76.7	72.2 - 81.6
W	61.7	50.5 - 73.0	73.0	64.8 - 82.3
X	68.4	61.8 - 74.9	71.8]	66.0 - 78.2
All	68.8	66.9 - 70.6		

Table 16.9Two-year survival rates 1997-1998

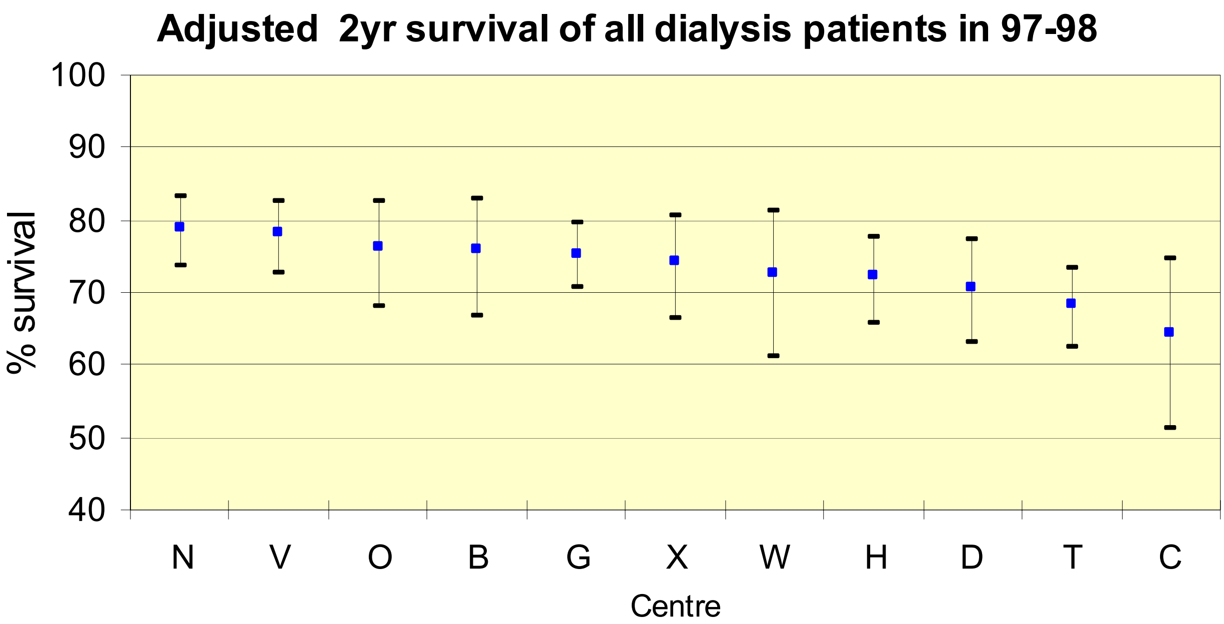


Figure 16.8 Adjusted 2-year survival of all dialysis patients in 1997-1998

Summary
As for 1-year survival there are demonstrable differences in 2-year patient survival between units when adjusted for age, gender and diabetes. However these differences may be due to ethnicity or comorbidity.

Discussion

The unadjusted UK Renal Registry 1 year mortality rate for dialysed patients established on renal replacement therapy for at least a year was 19.4 per 100 patient years in 1997 (n = 2,103) and 17.8 per 100 patient years in 1998 (n = 3,332). The USRDS database, which includes information relating to the majority of dialysed patients in the USA (n = 240,022), gives a higher 1-year mortality rate during 1998 of 27.9 per 100 patient years. It is important to recognise that there are differences in methodology and case mix between the two datasets.

In the USRDS report patients are included in the 'prevalent cohort' analysis of 1-year survival after 90 days of renal replacement therapy whereas in this UK report patients have been included in the analysis only if they have been on renal replacement therapy for at least a year. This may have a slight impact on the comparison between mortality rates.

Probably of greater importance are the differences in case mix of the patients included in the two registries. In the units submitting to the UK Renal Registry in 1998 11% of patients starting renal replacement therapy were of non-white ethnic origin (3% black) and 16% had diabetes as the primary cause of renal failure. In the USA (1995) 38% of patients starting renal replacement therapy were of non-white ethnic origin (31% black) and 41% of patients were diabetic.

The life expectancy of black dialysis patients in the USA exceeds that of whites of the same sex at every age. In an unadjusted analysis of dialysed patients (aged 45 - 64 years) whites have an annual mortality rate of 20.7 per 100 patient years whereas blacks have a rate of 14.7 per 100 patient years. Survival in different between ethnic groups in the UK has not yet been evaluated.

The potential impact of the differences in proportion of diabetic patients starting renal replacement therapy in the two countries on patient survival is emphasised by the USRDS report. Non-diabetic haemodialysis patients (aged 45 - 64 years) have a mortality rate of 14.1 per 100 patient years while diabetic haemodialysis patients have a rate of 20.5 deaths per 100 patient years. For peritoneal dialysis the respective figures are 14.6 and 28.2 per 100 patient years.

These differences emphasise the need to consider case-mix when comparing dialysis patient survival between countries and from one unit to another.

The Registry will in time be able to further explore the factors that influence patient survival and allow comparison of performance year to year as well as between different centres and countries.

Adjusting for confounders in survival analyses using the proportional hazards model relies on the underlying assumptions of this model being valid. These assumptions were tested and valid in all cases for the prevalent cohort. It is noteworthy that Johnson et al commented in a recent meta-regression analysis of papers referring to the effect of age, diabetes and co-morbidity on patient survival that only 4 of the 23 studies using proportional hazards tested the assumption of proportionality.

Age and diabetes were shown to be major determinants of survival as predicted. The increase in hazard for every increase of 10 years in patient age was similar for the one and two year survival. This was 50% [95% CI 42-59%] in 1998, and 51% [95% CI 43-60%], in 1997 - 98. These data compare closely with the findings of Johnson et al. whose analysis when undertaken using prevalence cohorts of established dialysis patients, produced a pooled risk increase of 48% per 10-year increase in age (relative risk 1.040 per year).

The relative risk associated with diabetes was 1.91 (95% CI 1.67 - 2.17) from the meta-analysis and 1.92 (95% CI 1.50 - 2.46) from the Renal Registry, but varied with age.

As more information relating to other aspects of patient comorbidity becomes available for analysis by the Renal Registry the factors that influence the success of dialysis treatment will become apparent. This will in turn enable the development of more informed guidelines for optimal standards of care.

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