

Chapter 17: Survival of Incident Patients

Summary

- The 1 year survival of incident renal replacement therapy patients ranges from 95% in young adults to 75% in those aged 65–74, and 50% in those over 85.
- Data from the past 5 years show a small but steady improvement in 1 year survival in all age groups.
- There is evidence that, as in the USA, patients from ethnic minorities may have a better survival than White patients.
- An analysis of variability in survival using Z-scores shows that there is no significant difference in survival between centres, with the exception that one centre has exceptionally good survival in the first year after 90 days.

Introduction

The Renal Registry database enables an analysis of the influence of different factors on patient survival. These factors are related to patient case mix (e.g. age, gender, ethnicity, underlying diagnosis and other comorbidity) or are dependent on treatment quality (e.g. haemoglobin achieved, mode of dialysis and serum phosphate level). For individual renal units, such analysis allows a comparison with performance in previous years and with other centres.

Survival rates can either be looked at in relation to:

- an *incident cohort*, in which patients who started renal replacement therapy (RRT) in a particular year are included;
- or
- a *prevalent cohort*, in which all (or a defined group of) patients undergoing RRT at a particular time are included.

The analyses presented in this chapter examine the survival while on RRT, including transplantation, of incident patients. Patients are censored when moving to a centre that does not report to the Registry.

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

Statistical methods

The ‘number of days at risk’ was calculated for each patient, the sum of these values for all patients divided by 365 representing the ‘number of patient years at risk’. The mortality rate was defined as:

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

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 are greater than 90%, the confidence intervals are only approximate.

In order to estimate the difference 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 diabetics compared with non-diabetics, for example, 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 period under consideration. The proportional hazards model was tested for validity in all cases.

Validity of the centre adjustment for proportional hazards

When the Cox model is used to adjust centre survival to a specific age (e.g. 60 years), it relies on, in addition to the assumption of proportionality within the period studied, the proportionality between centres of the slope of this relationship. If one centre had a relationship of survival with age with a slope of the graph that was different from those of the other centres, the adjustment would not be valid. Testing showed the slopes to be similar for all centres.

Survival of new patients by age

The incident cohort included in this analysis is all those patients starting RRT in 2000. Patients who recovered function within 90 days (i.e. patients with acute rather than chronic renal failure) have been excluded.

In Figure 17.1, the unadjusted survival has been shown for the first 90 days, the first year from day 0 of RRT, and the first year after day 90. The last figure allows comparison with many other Registries, including the US Registry, which record data only from day 90 onwards.

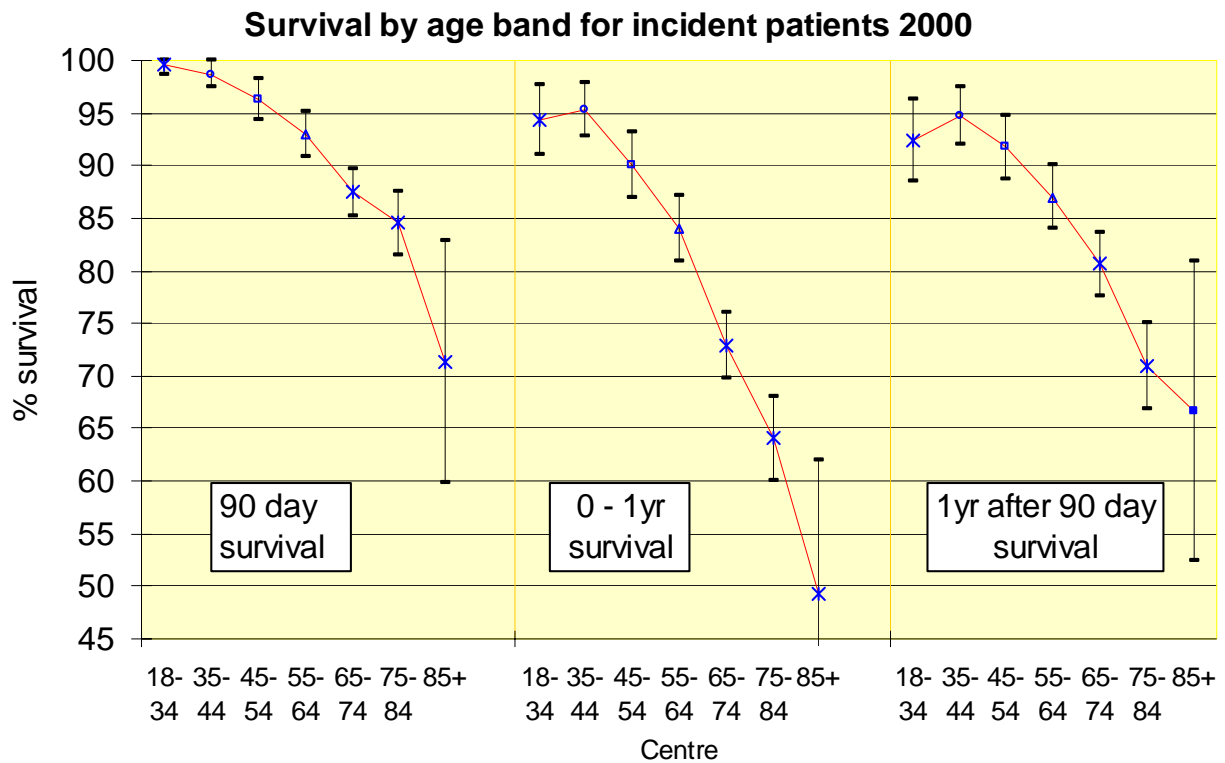


Figure 17.1: Unadjusted survival of incident patients, by age band

Age adjustment of survival in the first 90 days and thereafter

Analysing all the patients starting RRT between 1997 and 2000, the proportional hazards for each 1 year increase in age of the patients for the two time intervals of the first 90 days and the subsequent 365 days are shown in Table 17.1.

Interval	Proportional hazards	95% CI
First 90 days	1.058	1.050–1.065
1 year after first 90 days	1.041	1.035–1.047

Table 17.1: Survival at 90 days and 1 year

These data show that there is, in the first 90 days, a greater risk of death for every 1 year increase in patient age than there is in the subsequent period. This confirms, as stated in the Registry's previous reports, that it is incorrect to apply a single proportional hazards model for the first 365 days of starting RRT.

For every 10 year increase in patient age, there was an increase in the hazard of death of 58% (95% CI 50–65%) in the first 90 days, compared with 41% (95% CI 35–47%) in the subsequent 365 days.

Changes in incident patient survival, 1997–2000

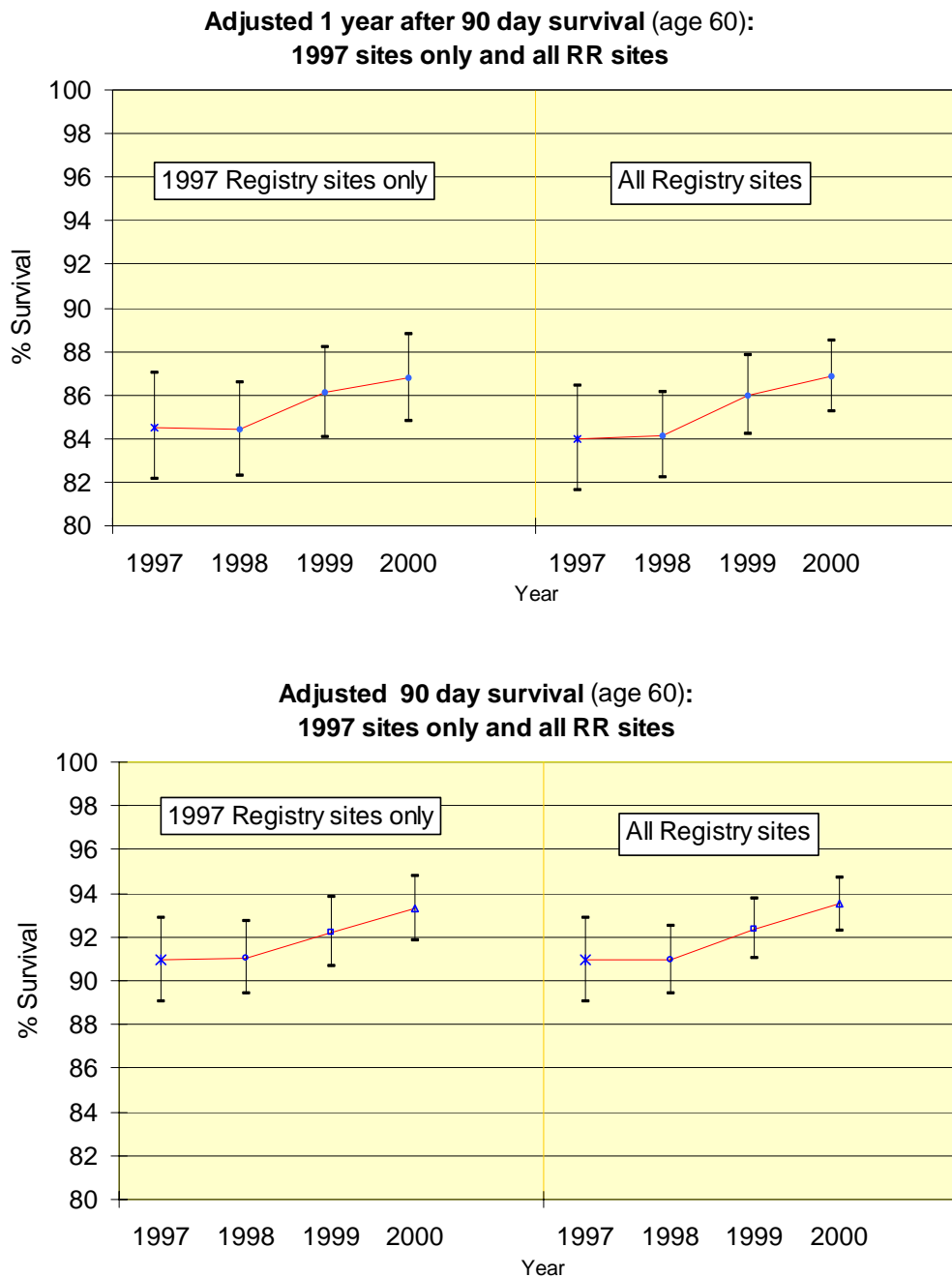


Figure 17.2: Change in survival, 1997–2000

In Figure 17.2, the right-hand graphs show the 90 day survival for all incident patients on the Registry in the years 1997–2000. There is an apparent improvement in 90 day survival, but this could be an artefact as many more centres have joined the Registry since 1997, and these centres may have had a better survival. The left-hand graphs show the same analysis just for those centres which joined in 1997. This shows the same overall improvement in survival, from 90.95 to 93.31%, which is a 26% reduction in 90 day mortality. This linear trend was significant ($p < 0.01$). These data also demonstrate that the survival profile of the 1997 centres is similar to that of the newer centres.

The adjustment for age using the Cox proportional hazards method has been calculated for each of the above years in the two groups. There has been no change over these 4 years in the increase in hazard of death for each 1 year increase in age. This indicates that the improvement in survival occurs across all age bands.

Survival by ethnicity

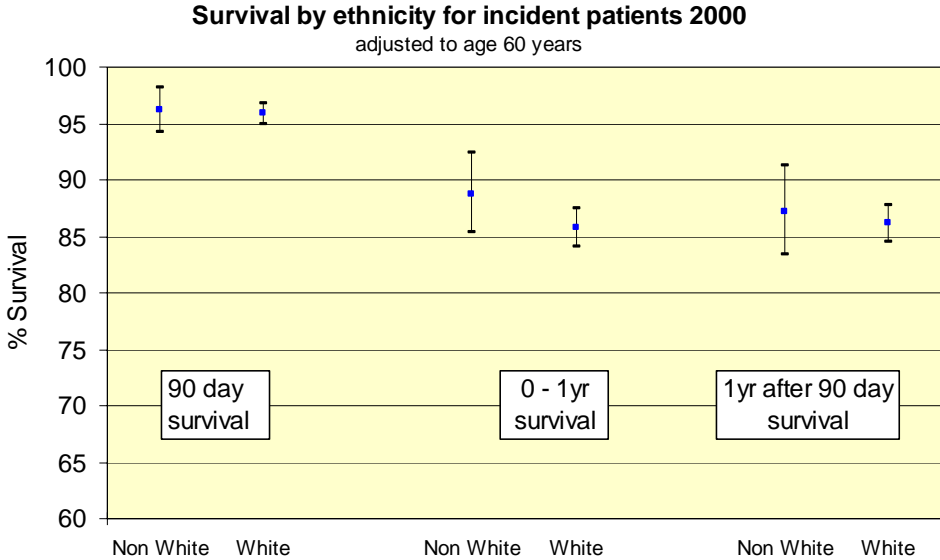


Figure 17.3: Survival by ethnicity

The overall completeness of ethnicity data is still poor, and data are available only from England. In 2002, ethnicity was recorded in 56% of incident patients. It appears that many of the centres with a high percentage of ethnic minority patients are more conscientious at collecting these data.

The number of ethnic minority patients is small, and the confidence intervals on survival estimates are therefore wide. As the median age of this cohort is less than that of White patients, the data have been age-adjusted to age 60. There is an apparent trend towards improved survival in the ethnic minority patients starting RRT when compared with those who are White (Figure 17.3). As a larger proportion of the ethnic minority patients are diabetic, who would be expected to have a worse survival, this difference in survival is probably even greater.

Survival of incident patients in 2000 by centre

Figures for survival within the first 90 days are heavily dependent on making sure that renal units include all their early chronic renal failure deaths and exclude all acute renal failure patients who have died. The 1 year survival will also be influenced by the deaths within the first 90 days, so the more important in Figures 17.4 and 17.5 with the 95% confidence intervals.

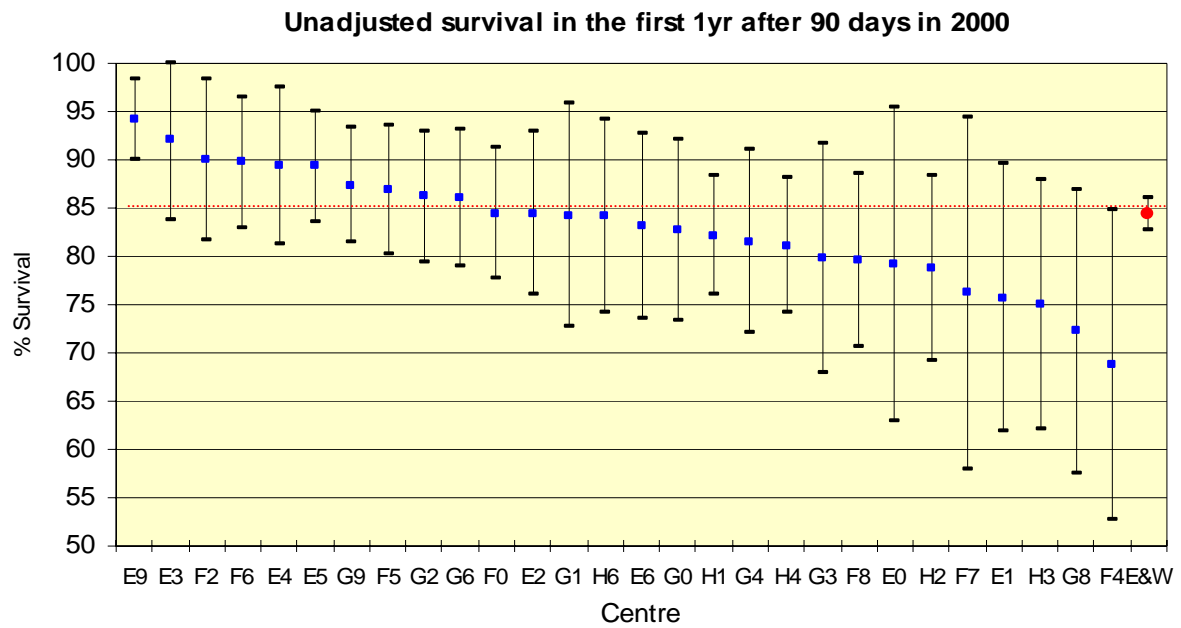


Figure 17.4: Unadjusted survival 1 year after 90 days in 2000

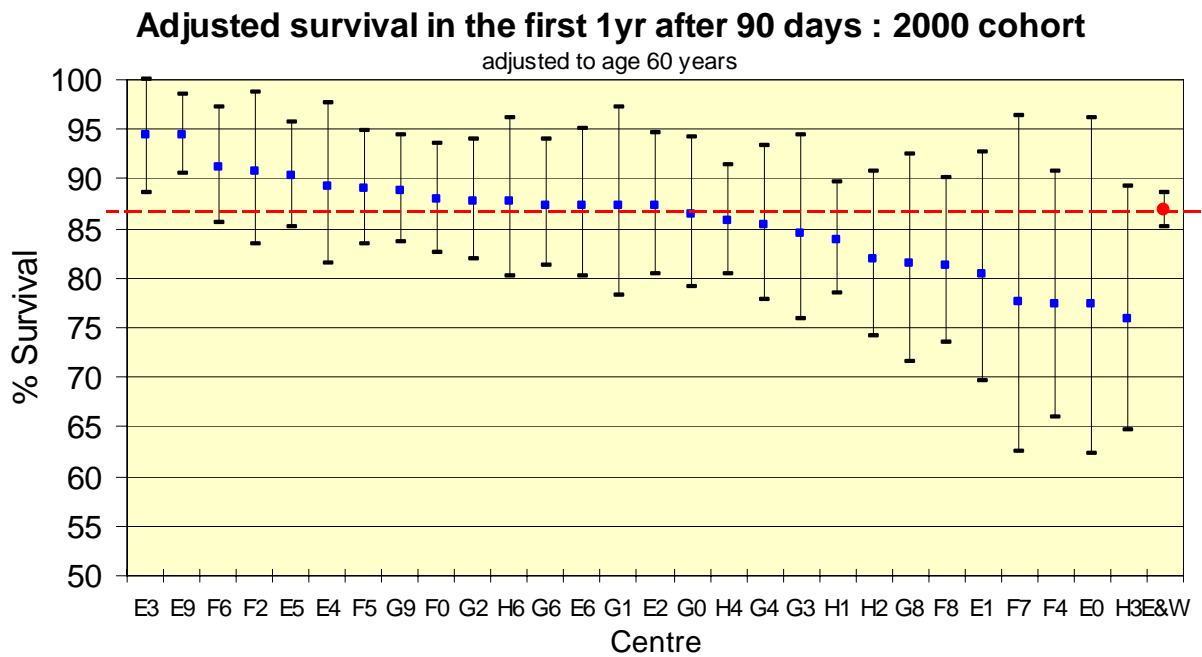


Figure 17.5: Adjusted survival 1 year after 90 days in 2000

Some of the smaller centres have wide confidence intervals. An analysis for any significant differences between centres is described below.

Analysis of variability in survival in 1 year after 90 days

The enquiry into the excess of paediatric cardiac deaths at the Bristol Royal Infirmary defined an outlier as lying beyond 3 standard deviations from the mean, using the statistical methodology of Shewhart's control theory. This analysis relies on the centre sizes, and hence their standard deviation, being very similar. Renal units in the UK vary greatly in size, catchment populations varying from 300,000 to over 2 million. There is a consequent variation in the total patient number on RRT so the figure for the standard deviation will vary greatly between centres. The standard deviation for the total RRT population is not an appropriate number as this will be very small. Therefore, the Shewhart methodology cannot be applied. The Registry has thus investigated other accepted statistical techniques to identify any outliers.

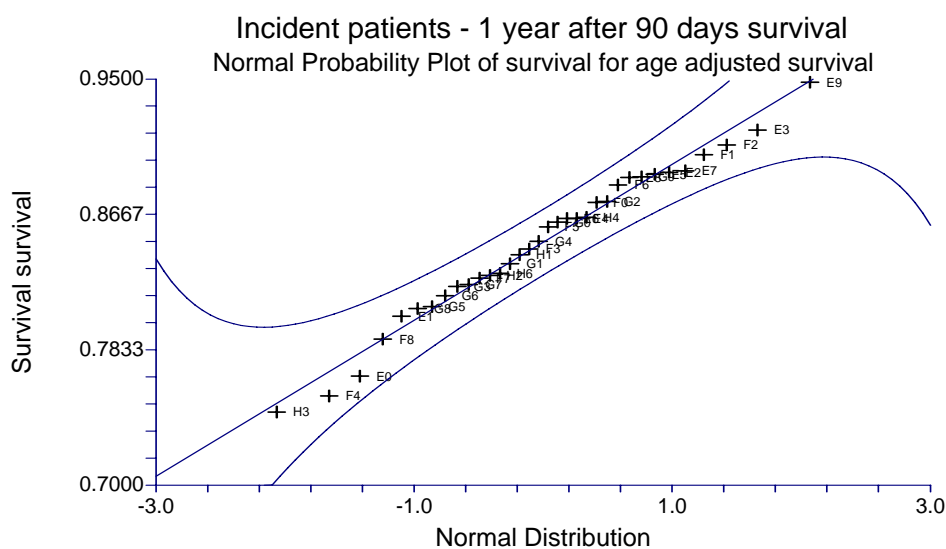


Figure 17.6: One-year after 90 day survival by expected Z-score

A normal probability plot can be drawn to look at the distributions of the adjusted survival scores. This graph would have on the y-axis the observed values and on the x-axis the expected values given that this sample had come from a normal distribution. If it is true that these observations are normally distributed, they should lie on a straight line. Figure 17.6 has been plotted using the adjusted survival data for each centre and shows that the results are relatively close to a normal distribution. The 95% confidence intervals have been plotted for these data. This analysis does not take into account the size of the centre and hence the standard error attached to each centre's survival score. In order to do this, a Z-score must be calculated, which is an adjustment for the size of the centre, and these data should be normally distributed.

Z-scores are derived from:

$$\frac{\text{Survival for centre X} - \text{survival for all centres}}{\text{Standard error for centre X}}$$

Plotting the observed values on the y-axis against the expected value on the x-axis should produce a straight line. In Figure 17.7, centres above the line have a better than expected

survival, whereas those below it have a worse than expected survival. Centres are identified as outliers if they are outside the 95% confidence interval.

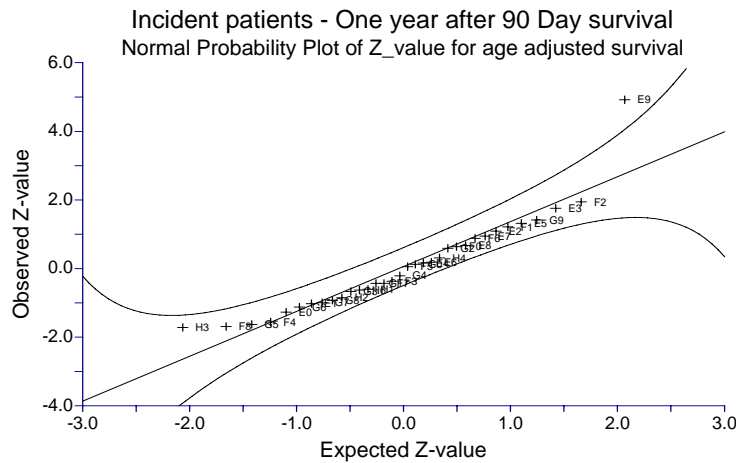


Figure 17.7: Z-score for 1 year after 90 day survival

Centre E9 appears as an outlier with a better than expected adjusted survival at 1 year after 90 days. This analysis indicates that this variation is unlikely to be the result of chance.

The two largest factors influencing patient survival are age and diabetes. Both the median age of new patients and the percentage of diabetic patients for this centre are close to the Registry mean. This centre reprocesses high-flux dialysers for nearly all patients, has a dedicated dialysis adequacy nurse and has a high achievement of dialysis adequacy according to Registry data. Case mix may also be important. In the year 2000, this centre had a lower than expected take-on rate owing to limitations in the facilities available. Thus, some patients with high comorbidity scores may not have started on RRT in 2000.

Analysis of centre survival within the first 90 days

The unadjusted and age-adjusted 90 day survivals of patients incident in 2000 are shown in Figures 17.8 and 17.9.

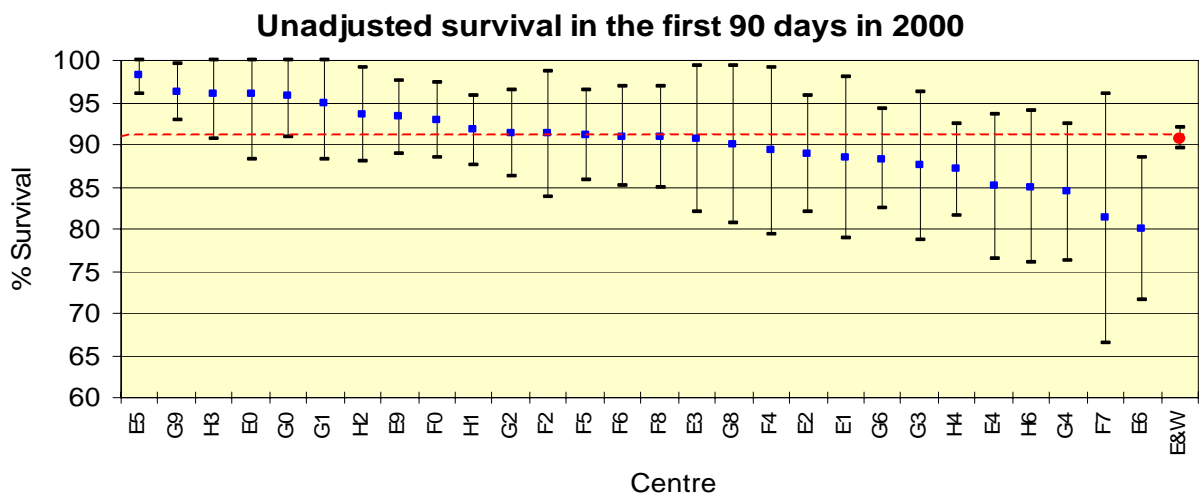


Figure 17.8: Unadjusted survival in the first 90 days, 2000 cohort

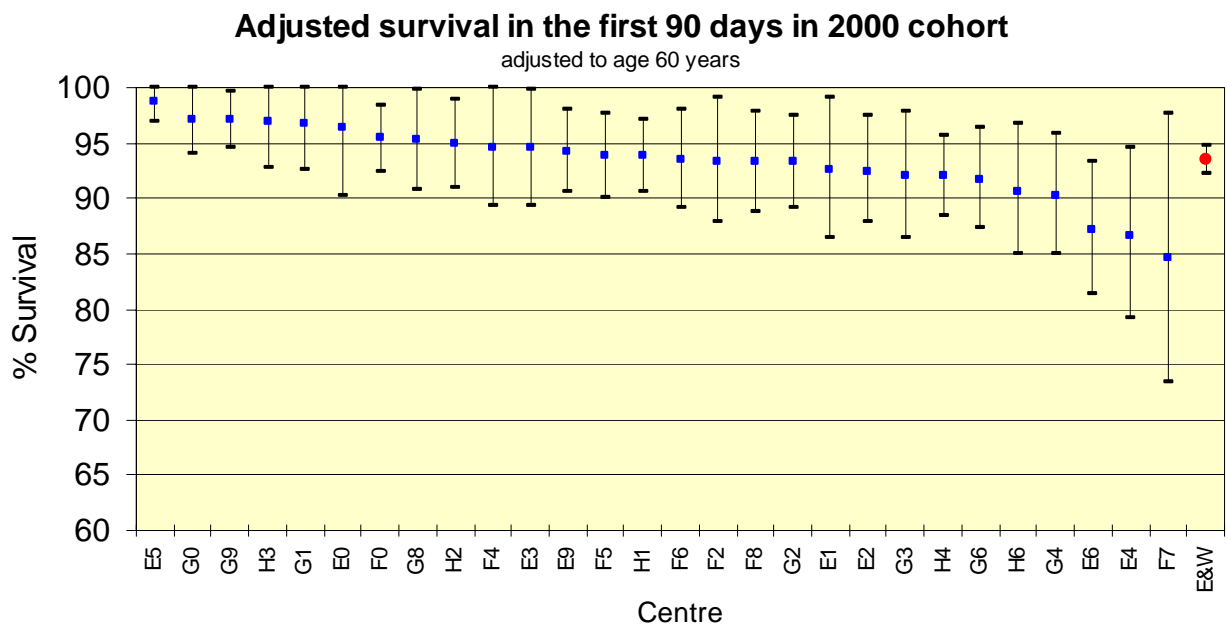


Figure 17.9: Adjusted survival in the first 90 days, 2000 cohort

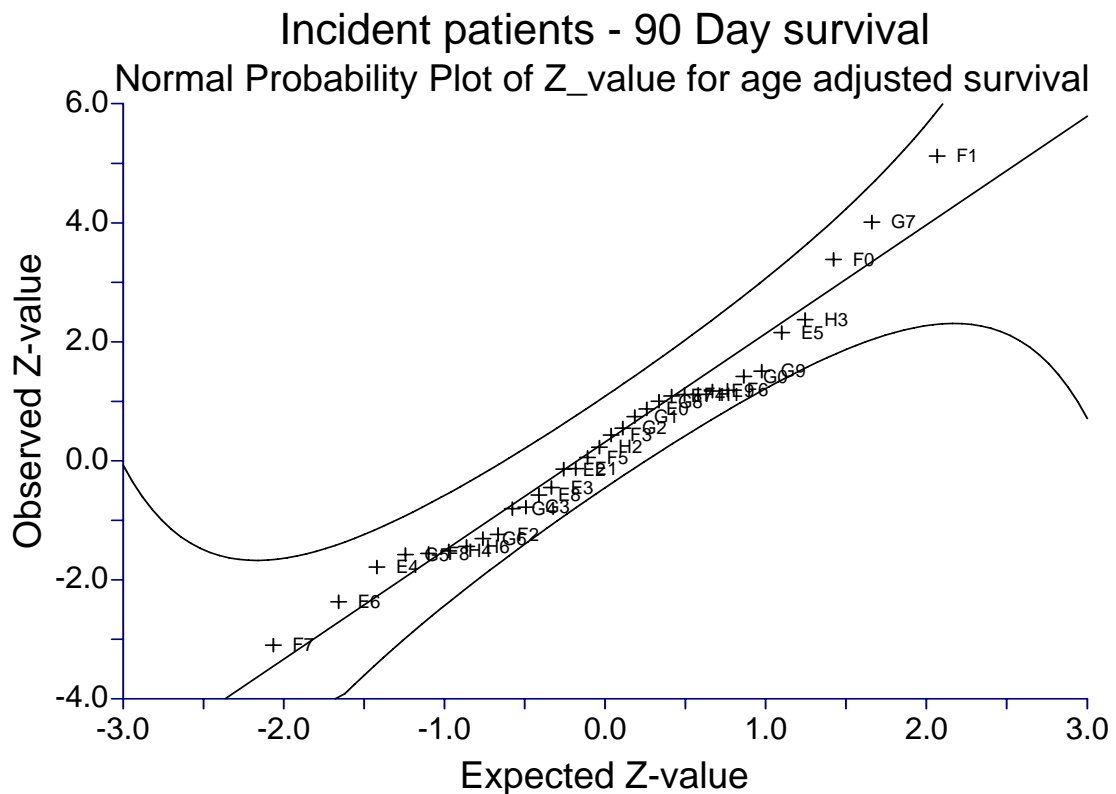


Figure 17.10: Z-score for survival within the first 90 days

The Z-scores indicate that all centres fall within the 95% confidence intervals.

Comparison of the 90 day and 1 year after 90 day survival

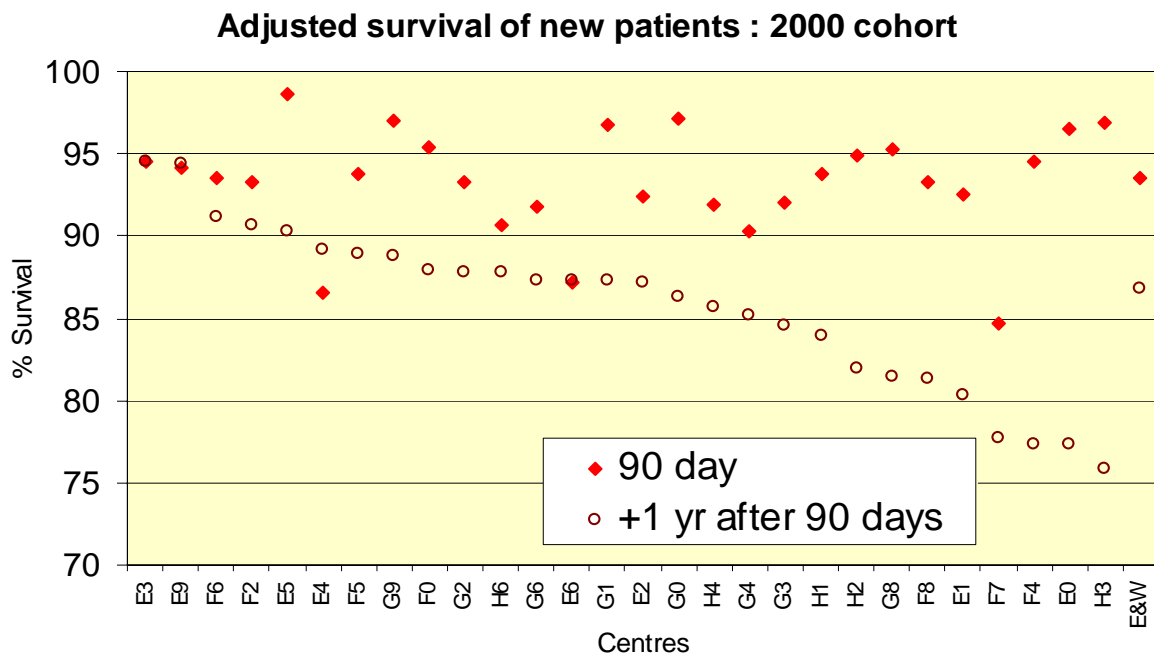


Figure 17.11: Adjusted survival of new patients, 2000 cohort

In Figure 17.11, there is no relationship apparent between the 1 year after 90 day survival and the survival of patients within the first 90 days. This supports the view that problems related to the definition of acute renal failure patients make interpretation of the first 90 days difficult.

Changes in survival

Changes in survival in individual units are shown in Figures 17.12 and 17.13. In the 2001 Registry report, Figure 9.14 of serial 90 day survival data was incorrect, as the data were of the 1 year survival of prevalent patients. The correct data are shown in Figure 17.12, with the current data from 2000 added.

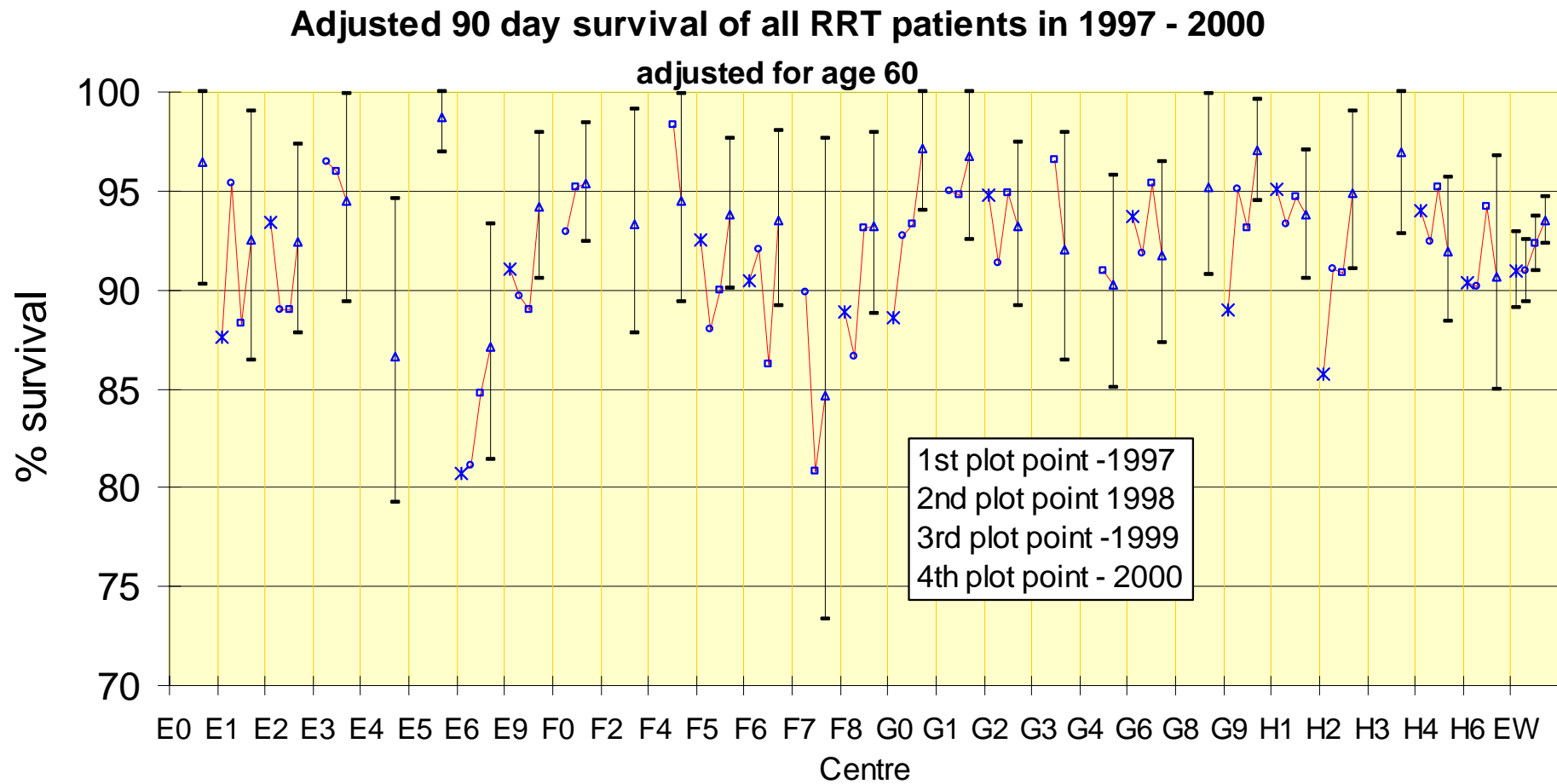


Figure 17.12: Survival in the first 90 days, 1997–2000

Changes in survival from individual units are shown in Figures 17.12 and 17.13.

**Adjusted 1yr after 90 day survival of all RRT patients in 1997 - 2000
adjusted for age 60**

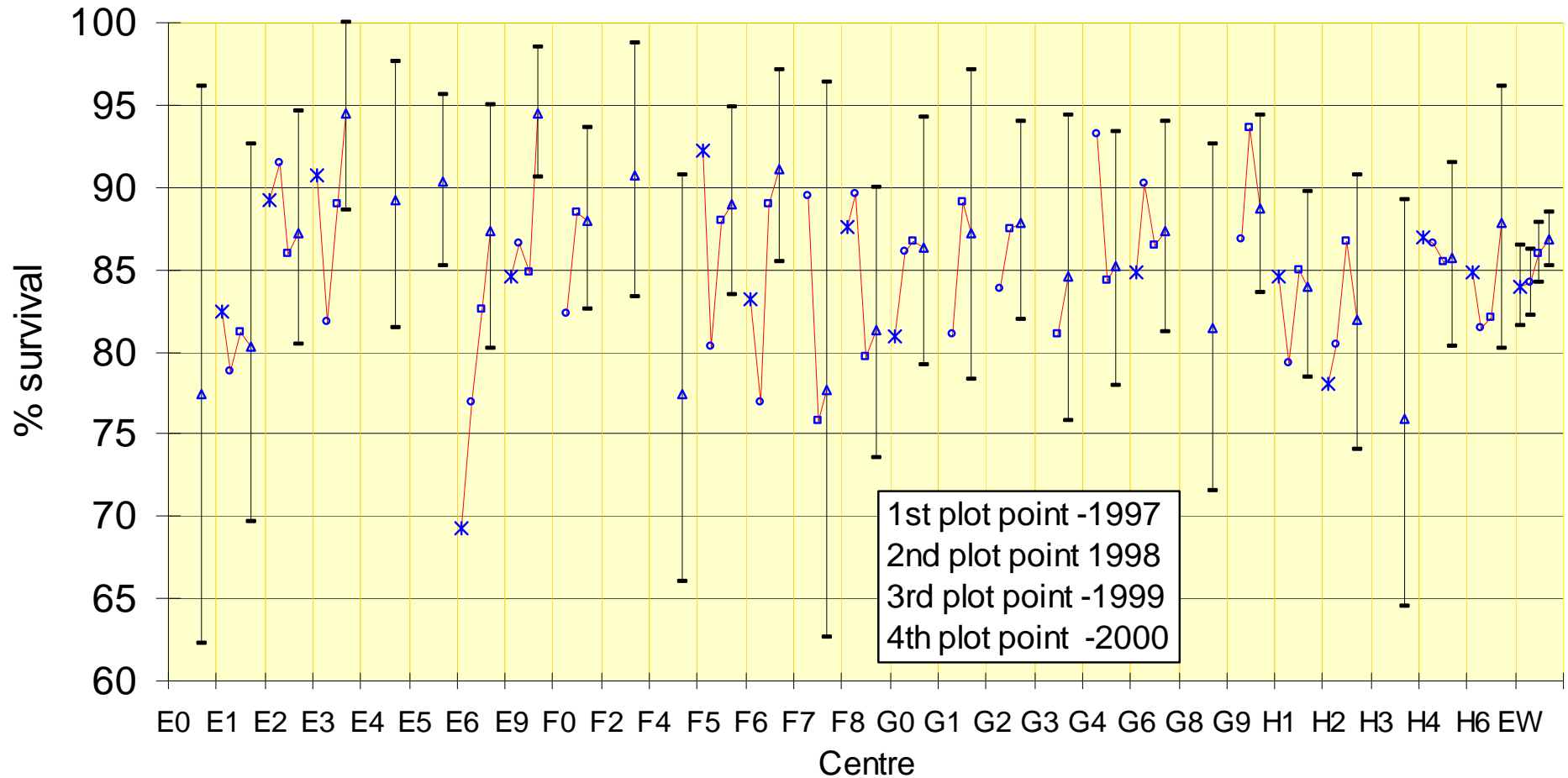


Figure 17.13: Adjusted survival, 1 year after 90 days, 1997–2000