Chapter 7: Adequacy of Haemodialysis (Urea Reduction Ratio)

Summary

- Haemodialysis facilities are still in short supply. Twice-weekly dialysis was used in more than 5% of patients in 38% of renal units, and in more than 20% in 5% of units.

- In 2001, there was only a small improvement from 2000 in the adequacy of dialysis achieved in England & Wales, although there were large changes in some individual units.

- A telephone survey of dialysis units showed that there are diverse post-dialysis sampling methods in current use.

- Thirteen out of 45 dialysis centres surveyed were using one of the three post-dialysis sampling methods for urea measurement that are recommended in the third edition of the Renal Association Standards document.

Haemodialysis frequency

The Standards document states:
'*The frequency of dialysis should be three times per week in the majority of patients. Reduction of dialysis frequency to twice per week because of insufficient dialysis facilities is unacceptable.'*

In a Renal Association survey of all 71 renal units in the UK conducted by Dr John Scoble early in 2002, 10 units (14%) had no patients, and a total of 43 units (62%) had fewer than 5% of patients, dialysing fewer than three times a week (Figure 7.1). Six units had, however, more than 20% of patients dialysing twice weekly, the highest figure being 39%.

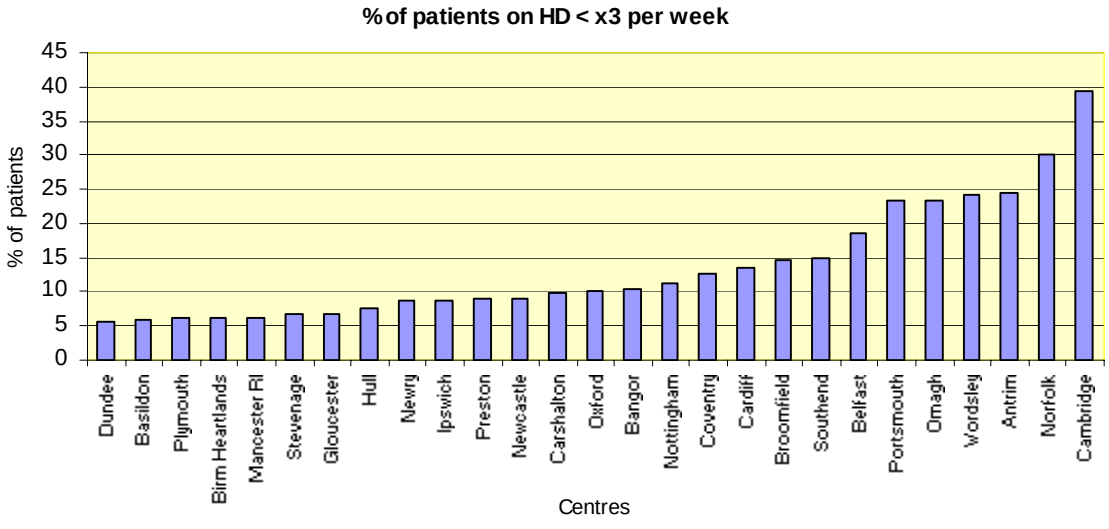

Figure 7.1: Renal units with more than 5% of patients dialysing less than three times / week

In renal units with a severely limited capacity for haemodialysis (HD), one might expect a greater proportion of patients to be on peritoneal dialysis (PD), with a high proportion also on twice-weekly HD. Figure 7.2 shows that there was no obvious relationship between the percentage of patients in a unit on PD and the percentage dialysing twice weekly. Looking at only those centres with more than 15% of patients on twice-weekly dialysis, there is an apparent relationship with the increased use of PD.

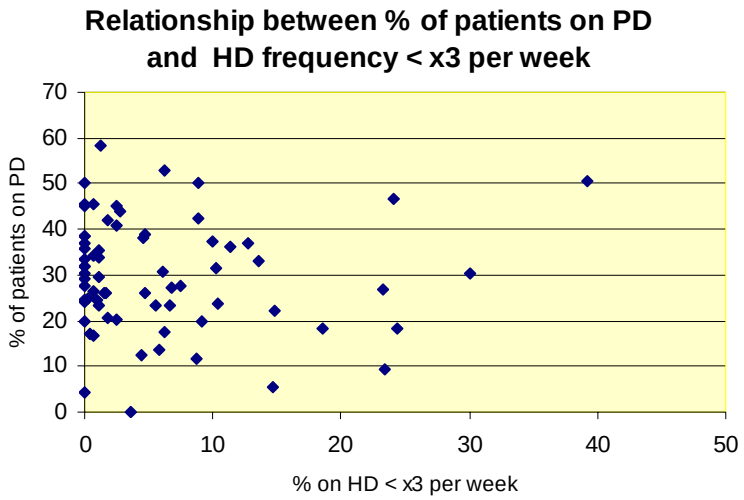

Figure 7.2: Relationship between PD use and percentage on HD less than three times /week

Solute clearance standards

The second edition of the Renal Standards document (SDII) considers both Kt/V and urea reduction ratio (URR) to be indicators of adequacy of HD and recommends that all patients stable on three times a week HD should have:

URR > 65%
or ***Kt/V > 1.2 (dialysis and residual renal function)***

Formulae for calculation of dialysis clearance

Several different methods are in use for calculating Kt/V, these giving results that vary significantly. Some calculations include the contribution from residual renal function and need the collection of post-dialysis blood urea samples from the previous dialysis. Other formulae ignore residual renal function and require, as a minimum, a knowledge of pre- and post-dialysis weights and duration of treatment. To obtain meaningful comparisons, the Renal Registry would need to calculate Kt/V by a single method from the raw data, data that are not currently available from many units. The simpler calculation of URR, the percentage fall in blood urea during a dialysis session, requires only a knowledge of pre- and post-dialysis blood urea level and thus remains the method used by the Registry. This ratio ignores any contribution to clearance by residual renal function or ultrafiltration. Despite the theoretical limitations, URR has been shown to correlate with patient survival (Owen, Held).

Post-dialysis urea samples

Unfortunately, even the apparently simple URR is flawed as a comparator because of the non-uniformity of post-dialysis sampling methods. This was discussed more fully in the 1999 Registry Report, but there appears to have been little progress by renal units in moving towards standardisation or even in using one of the methods recommended in the third edition of the Standards document (SDIII) or by the US organisation Disease Outcomes Quality Initiative (DOQI).

The goal of a reproducible comparison of URR while at the same time calculating valid Kt/V values continues to create debate. It may therefore not be surprising that progress towards standardisation has been slow. The Registry is not mandated for the task of increasing uniformity in sampling methods, but the following short analysis may be useful for highlighting the issues.

Recommended methods for post-dialysis blood sampling

The following three methods are recommended in SDIII. These all differ from the only technique recommended in SDII, which was the one current in 2001.

A. Simplified stop blood flow sampling technique:

- When you are ready to take the sample, turn the blood pump slowly down to 50 mL/min.
- **Start counting to 5**; if the venous pressure alarm has not already stopped the blood pump when you get to 5, stop the pump manually.
- Disconnect the arterial line and take a sample from the needle tubing (or the arterial connector of the catheter) **within 20 seconds** of slowing the blood pump to 50 mL/min.
- If more than one sample is required, the urea sample should be the first one taken, wash back blood, take patient off as normal.

Guidelines developed by EJ Lindley, V Osborne, S Sanasy, D Swales and M Wright, The Leeds Teaching Hospitals NHS Trust.

Timing is **important** in this technique.

B. Slow blood flow sampling technique:

- At the end of dialysis, turn the blood pump down to 100 mL/min.
- Override the alarms to keep the blood flowing.
- **Wait 15–30 seconds** and take samples from the 'A' line sampling post.
- If more than one sample required, the urea should be the first one taken, wash back blood, take patient off as normal.

Guidelines developed by F Gotch and M Keen, Davis Medical Centre, San Francisco, and used since 1990 by the Lister Renal Unit, East & North Herts NHS Trust.

Timing is **important** in this technique.

C. Stop dialysate – continue blood flow method:

- Turn off the dialysate flow, leaving the blood flow unchanged.
- Sample 5 minutes after this from any point in the extracorporeal circuit.

Developed by Drs Mactier, Geddes and Traynor at Stobhill Hospital Glasgow.

Timing is less critical in this technique. It is acceptable to stop the blood flow at 5 minutes and then sample immediately from the 'A' line.

The direct calculation of a 'single-pool' Kt/V with an 'equilibrated' post-dialysis urea level is possible only when blood sampling is deferred to at least 30 minutes after stopping dialysate/blood flow and 'washback'. A peripheral venous blood sample is then adequate. Most centres find this impractical in a busy dialysis unit, and many patients also find the extra wait unacceptable. Derby is the only renal unit included in the Registry that takes such a post-rebound sample. Sampling earlier than 30 minutes will lead to an underestimation of the degree of rebound in blood urea value.

To avoid the 30 minute wait after dialysis has ceased, a series of **early** blood sampling techniques have been developed; samples are taken within 10–30 seconds of stopping or slowing the blood pump in order to abolish access re-circulation. These vary in the sequence of recommended events. The rebound fraction can then be calculated and the results used in urea kinetic modelling (UKM). The variations depend on whether the blood flow is actually stopped (method A) or simply slowed (method B), and on how quickly the sample is taken. In other guidelines, it is recommended that the dialysate flow also be stopped, with a choice of the stop or slow (blood) flow methods (DOQI). The difference between stopping and slowing the blood flow is in the extent to which the desired sample is trapped in the arterial needle tubing or sampled from the circuit arterial port.

There is evidence from work in Scotland that a fixed delay before sampling of less than 30 minutes can give consistent results for the comparison of the URR; this is method C above. Such values may not be suitable for use in rigorous UKM and Kt/V calculations. Such techniques form a family of **late** sampling methods, with a continuation of the blood flow only over a relatively short (5 minute) interval or for the full rebound interval.

Consequences for URR comparison

The effect of 'late' sampling methods will be systematically to raise the measured post-dialysis urea values compared with early sampling methods, and reduce the calculated ratio (URR). Centres using these techniques will appear to have lower dialysis clearance and a lower achievement of the Standard compared with centres using 'early' sampling methods.

Sampling methods in use by renal units

When the Registry surveyed renal units with regard to removing anonymity, several units agreed with this on condition that the post-dialysis sampling technique in use at each centre was detailed. Registry staff subsequently telephoned nurses at all main dialysis units, and many satellites, to identify sampling methodologies. It was anticipated that a maximum of

four or five techniques would be in use, which could then be indicated by different symbols when displaying the URR results for each dialysis unit. A very different situation was, however, discovered, with a multiplicity of sampling techniques in use.

Conduct of the survey

The renal unit data managers, both experienced renal nurses, telephoned each main dialysis unit and each of its satellites and spoke to the most senior nurse available on the day. The following questions were asked:

1. What method do you use for post-dialysis blood sampling?
2. Does your dialysis unit have a policy?
3. Is this method the unit policy?

In some instances, the nurse went to look up the precise unit policy and called back. A total of 32 main dialysis units and 13 satellites were contacted.

It is recognised that a survey such as this may not accurately report the policy of the dialysis unit with respect to post-dialysis sampling as the respondent was not expecting the call, might have been busy at the time and might not have given a carefully considered answer. The answer given by the respondent may also not reflect the practice of many other staff. The survey does, however, highlight an organisational problem and reflects the actual practice of many of the senior staff in dialysis units. A postal survey of renal unit directors might have elicited different policies, but these policies may not necessarily be put into practice much of the time.

The results of this survey will be sent to the clinical director of each unit.

Results of the survey

Table 7.1 indicates the answers given.

	Yes	No	Don't know
Does your unit have a policy?	30	10	5
Do all staff use the same method?	40		5

Table 7.1: Responses to survey questions

With regard to the technique reported by the nurse questioned, no units appeared to be following the recommendation of the Standards document current in 2001. Of the methods defined above, 6 centres used method A, 3 used method B, 3 used method C, and 1 used a 30 minute sample. Centres reporting that they sampled at an unspecified time interval were not included in this total. The list provided in Table 7.2 may be as a source of advice for dialysis units looking to implement one of the three methods in the new Standards document.

Centre	Method
Bradford	Method A
Bristol main unit	Method C
Bristol Weston	Method C
Cambridge	Method B
Carlisle	Method C
Coventry	Method B

Centre	Method
Derby	Sample at 30 minutes
Leicester main unit	Method A
Leicester Lincoln	Method A
Leeds St James	Method A
Plymouth	Method A
Swansea	Method B
York	Method A

Table 7.2: Correct technique

In all the other units, either another technique or a variation of one of the recommended techniques was reported. In many instances, different techniques were reported in main units and their various satellites. A sample of the replies is given in Table 7.3. Venous sampling immediately after dialysis was stopped was reported in many cases: this will give relatively low post-dialysis blood urea values and thus an apparently high dialysis clearance.

Method A sample 1 min
Method B sample immediately
Method B sample after 1 minute
Method B sample after 2 minutes
Method B sample after 5 minutes
Method B Sample after unspecified time
Method B Sample after a 'few' minutes
Method C wait 10 minutes
Stop dialysate stop blood sample immediately (method in use at 15 centres)
Stop dialysate stop blood sample within 2 minutes
Stop dialysate wait 2 minutes. (Full speed blood pump.) Stop pump sample at 10 seconds
Continue dialysate continue blood flow sample

Table 7.3: Non-standard techniques currently in use

Most commonly used was an 'early' technique, misapplied as *stop dialysate, stop blood pump, sample immediately from A needle during wash back.* This was also the recommended technique for all the HD units managed by one commercial company. Measuring post-dialysis urea level in this way will give low urea values, which will tend to exaggerate the calculated adequacy of dialysis.

It is hoped that the publication of these data will help the move towards standardisation.

Interpretation of results

The figures show the achievement compared with the Renal Association Standard for each centre. Each centre on the graph has an abbreviated name (see Appendix D), and the number preceding this is the percentage data missing for the centre.

In the graph of the percentage of patients achieving a URR of over 65%, the centres indicated by a 'closed circle' ● on the data point are using the 'late' sampling methodology, which tends to give lower URR results.

URRs achieved

The median URRs achieved in each renal unit are shown in Figure 7.3; the results from satellite units are included with those from the parent renal unit. Patients who had not been established on HD for at least 3 months were excluded.

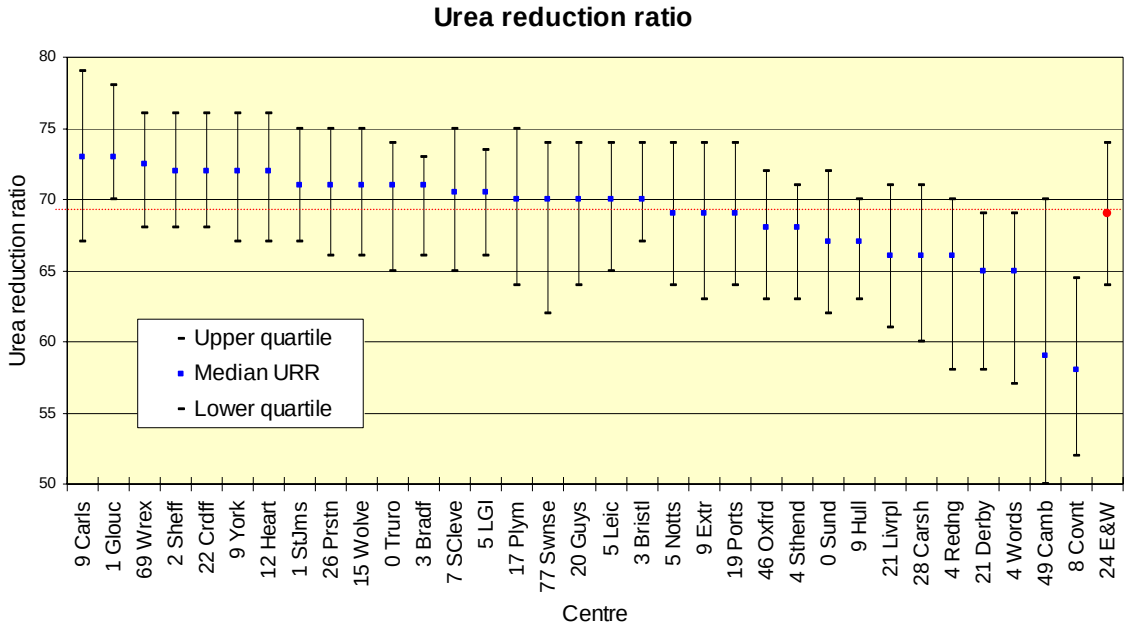

Figure 7.3: Median URR achieved in each renal unit

The high percentage of missing data from Swansea was found to be due to a clerical error in the renal unit's local data entry rather than to a lack of measurement of URR. The post-dialysis urea results had been entered into the pre-dialysis field so it was not possible for the Registry to calculate a valid URR result; the Registry has therefore counted the result as missing. URRs are measured every 3 months at the Swansea unit.

A proportion of the missing data for Wrexham resulted from pre-dialysis samples occurring in sequence after the post-dialysis sample, the local software being unable to correct for this. The software has now been updated to take account of this situation.

Derby is the only renal unit using the 30 minutes post-dialysis blood sample. This leads to a lower URR result than is seen in most other renal units.

The Coventry renal unit has shown an 'apparent' low achievement of dialysis adequacy from 1998 to 2001. Clearances may be low as many patients in Coventry are only receiving 3 hours of dialysis three times a week because of a shortage of facilities. It has, however, been practice in Coventry to collect the post-dialysis urea sample 15 minutes after the end of dialysis (a 'late' method). This will give a higher urea value than most sampling techniques and thus a lower calculated URR. In 2002, the Coventry unit changed to the Renal Association Standard methodology (method B), and the next Registry report will more accurately reflect the dialysis adequacy achieved in this renal unit.

Some units demonstrate a narrow quartile range, whereas in others it is wide, which suggests that some units have more effective procedures for monitoring URR and/or implementing therapeutic change. This is further illustrated in Figure 7.4.

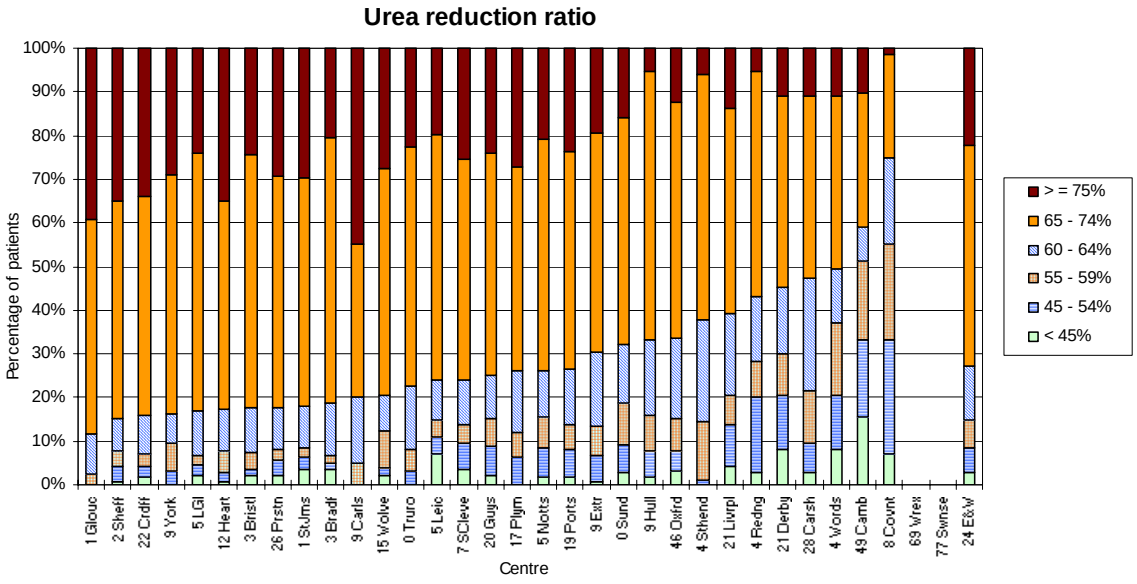

Figure 7.4: URR distribution, by centre

One effect of differing ranges of URR results between units is illustrated in Figure 7.5, which shows the percentage of patients in each unit achieving the recommended Standard for URR. When Figure 7.5 is compared with Figure 7.3, some of the units with an 'average' median URR have a relatively high attainment of the Standard as the quartile range is narrow, and relatively few patients fall below the Standard. Although two centres using the 'late' sampling methodology achieved a result below the average for England & Wales, there were also three centres with above-average results.

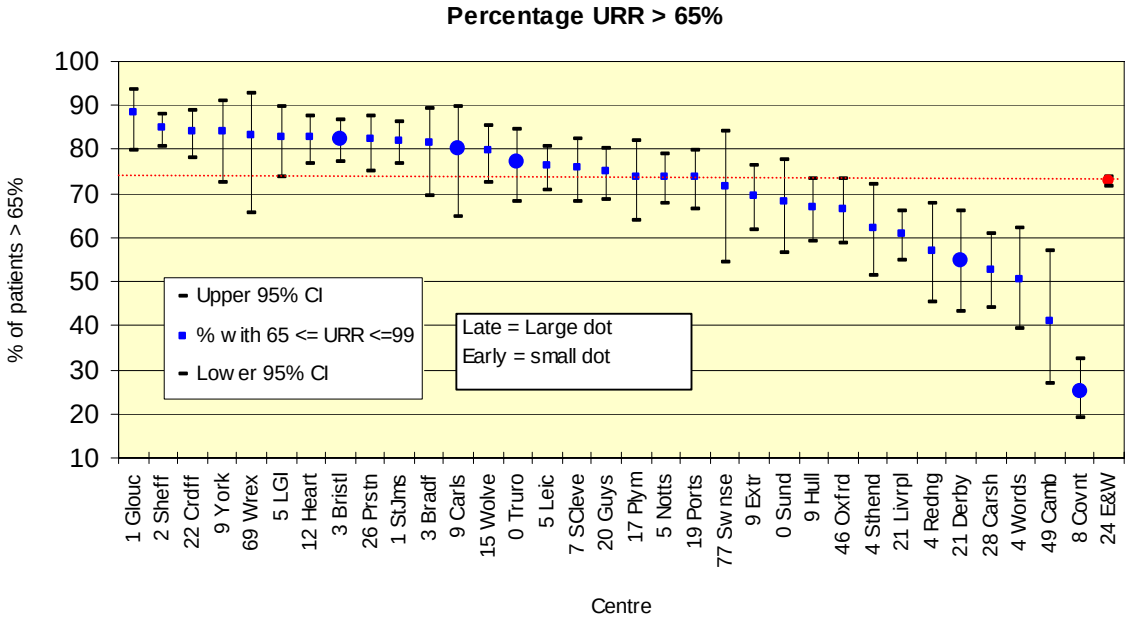

Figure 7.5: % patients, by centre, with a URR of 65% or more in the last quarter of 2001

Changes in meeting the URR Standard during 2001

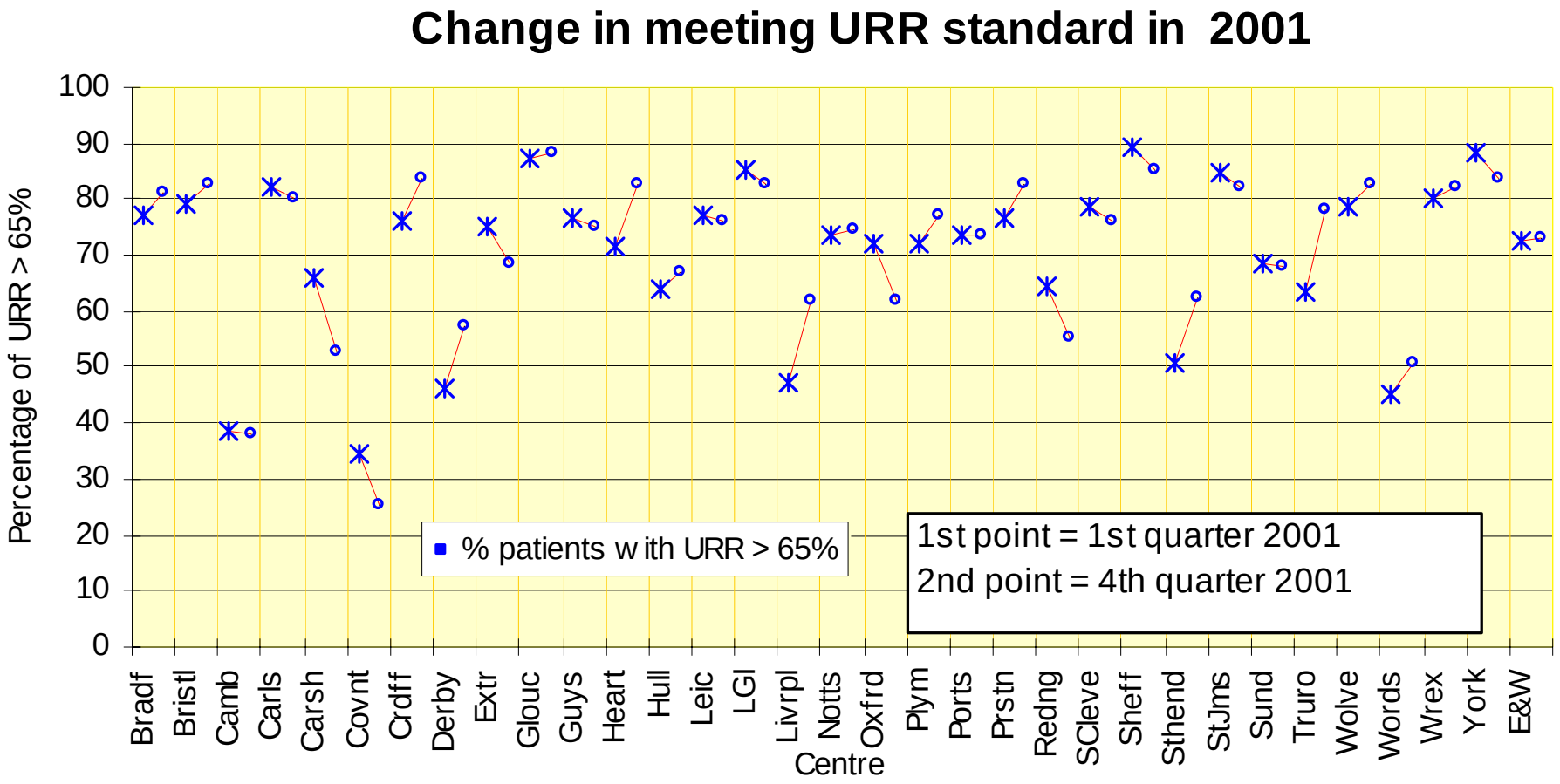

Figure 7.6: Change in meeting the URR Standard in 2001

The change in the percentage of patients achieving the recommended Standard for URR in each participating renal unit from the first to the last quarter of 2001 is shown in Figure 7.6.

Change in achievement of URR Standard during 1997–2001

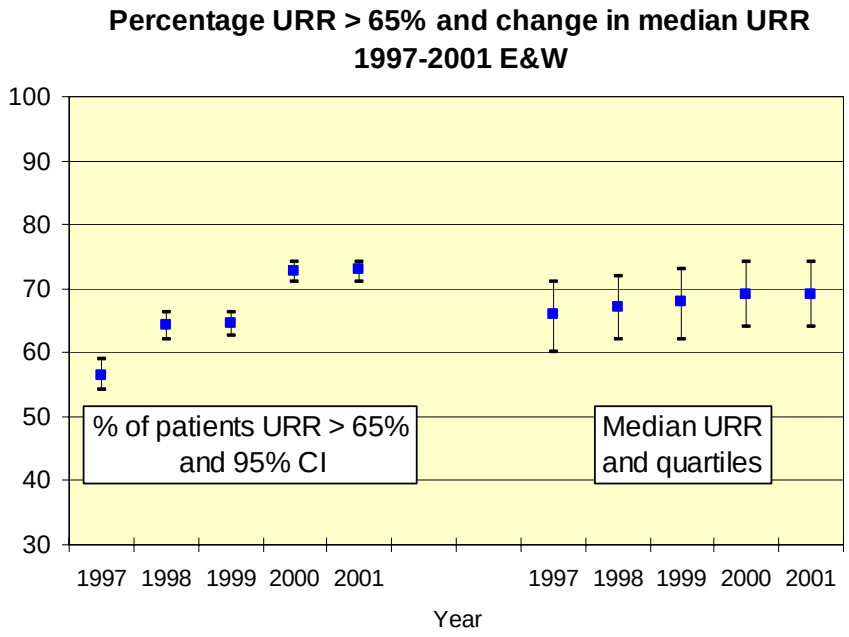

Figure 7.7: % URR over 65% and change in median URR 1997–2001, England & Wales

In the past 4 years in England & Wales, there has been a substantial rise in the percentage of patients achieving a URR of over 65%, to the current level of 72% (n=4426 in 2001, n=3280 in 2000, n=2560 in 1999 and n=2405 in 1998), but there was only a small improvement in the achievement of dialysis adequacy during 2001 (Figures 7.6 and 7.7). The median URR in England & Wales was 69% at the end of 2001. The England & Wales results appear to be less satisfactory than those from the USA, where 82% of patients achieve the recommended URR, with a median URR of 71.4% (sample size 8416).[1] The US department of the Veterans Health Administration reported separately and showed results more similar to those from England & Wales: only 75% of their patients achieved a URR of over 65%, with a median URR of 69.5% (sample size 1759). The standardisation of post-dialysis sampling may have been more successful in the USA.[1]

The improvement in attainment of the URR Standard in England & Wales from 1997 to 2000 looks impressive (Figure 7.7), but some caution must be used in interpretation as there is an increasing number of renal units each year, and thus different renal units included. That the improvement is real is suggested by the significant improvement in performance of participating units when sequential data are analysed for each individual renal unit (Figure 7.8).

Large changes are likely to depend on the systematic use of larger dialysers or a rationalisation of dialysis duration. The consistency shown by some units may be due to application of protocols while centres showing variation on a year-to-year basis may be working less systematically.

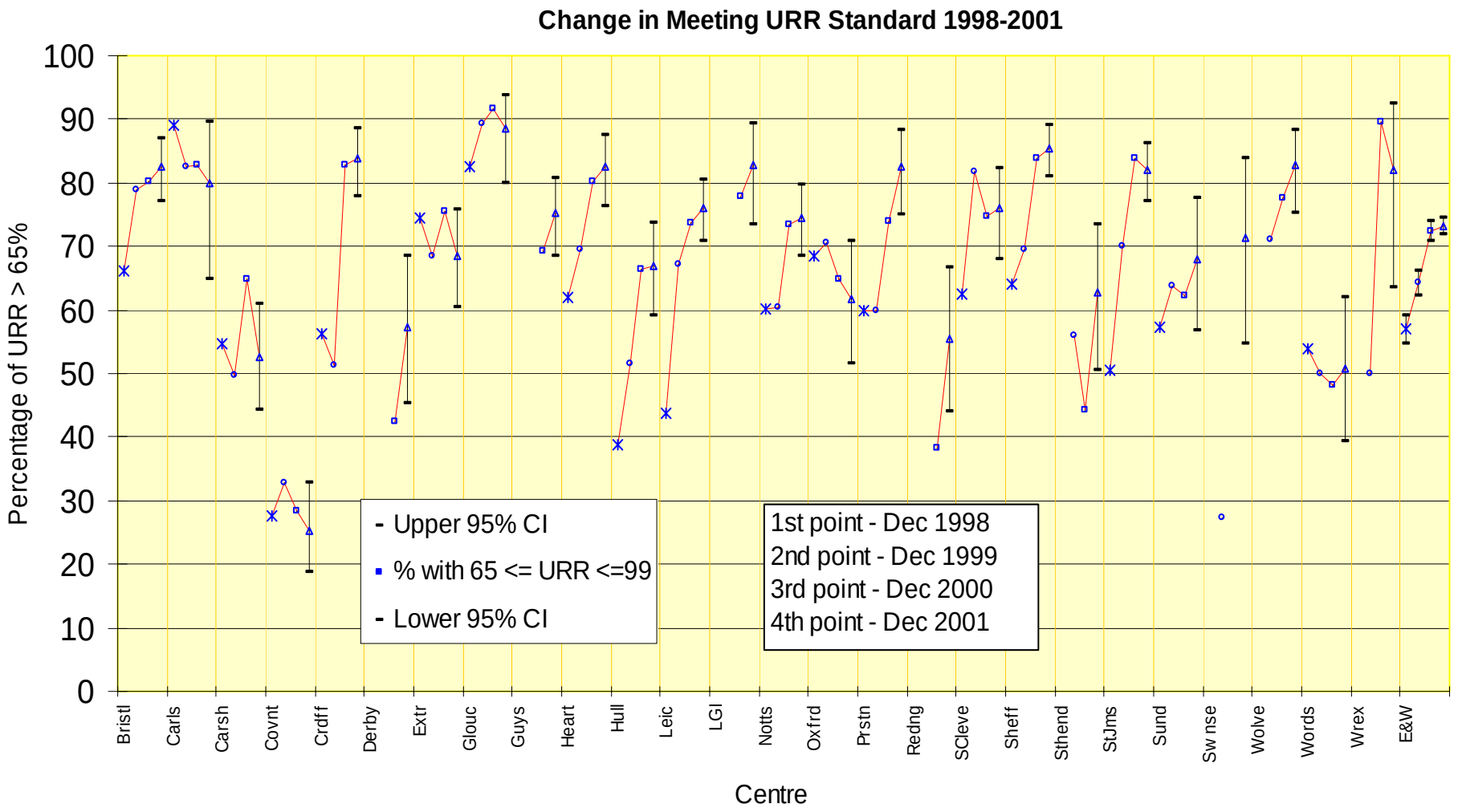

Figure 7.8: Change in meeting URR Standard in 2001

The median URR in England & Wales is 69%. Because of the steepness of the distribution curve around this point, there need only be a small change in median URR to achieve a large change in achievement of the Standard, as is illustrated in Figure 7.9.

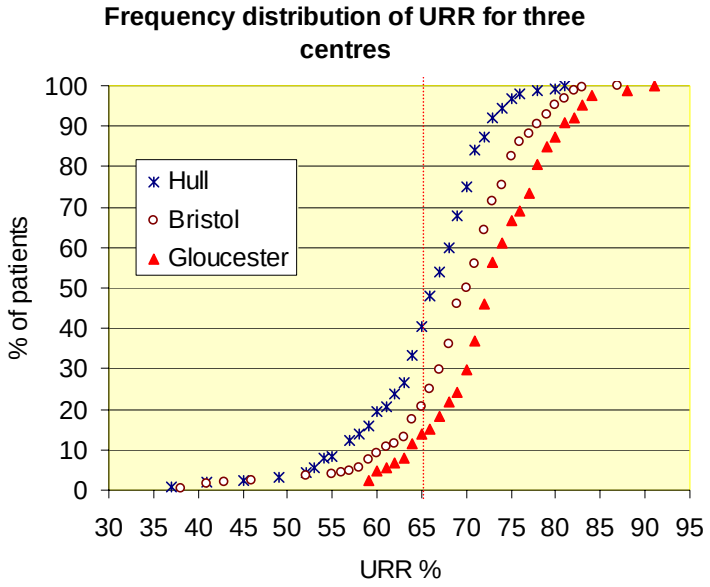

Figure 7.9: Frequency distribution of URRs for three centres

In Figure 7.10, the predictive line of identity between the achievement of URR and the median is identical to that calculated in the last report using data from 2000. The US data sit on the England & Wales predictive line of identity, which this indicates that distributions of data and working practice in the two countries may have close similarities. The previous comments on the necessary outcome median values (overachieved) to reach Standard recommendations remain valid.

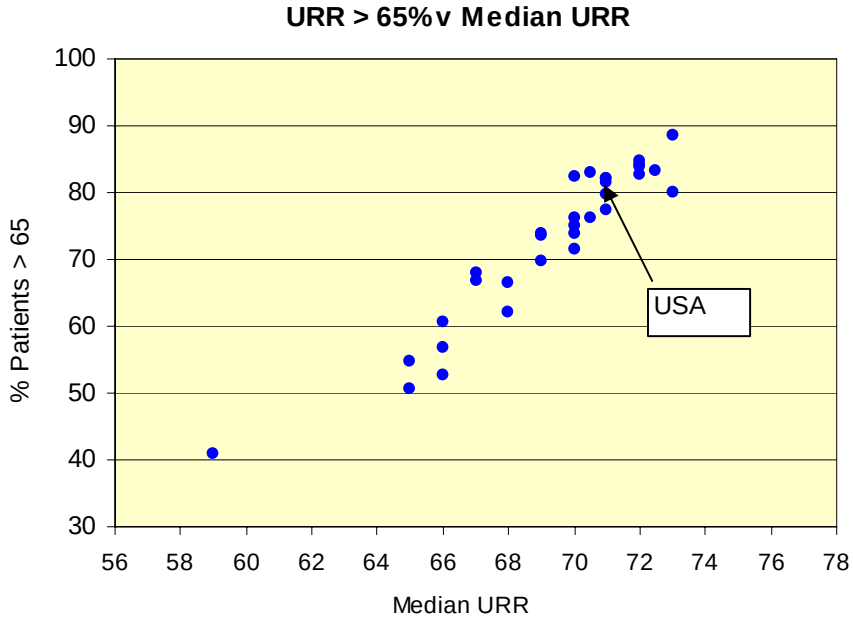

Figure 7.10: URR achievement and median URR at each renal unit

URR in new renal replacement therapy patients starting HD

The URR results for patients in the first 3 months of HD are shown in Figure 7.11.

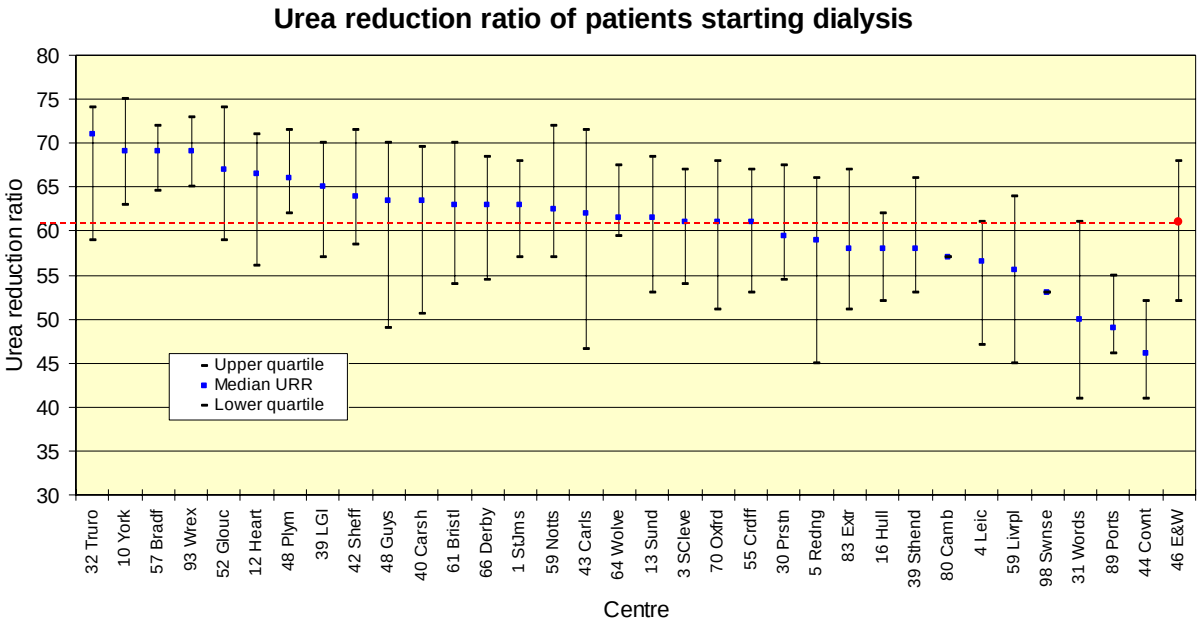

Figure 7.11: Median URR in each dialysis centre within the first 3 months of HD

As reported before, URRs were lower in patients starting HD than in other HD patients at the same unit who had been established on HD for at least 3 months. This may in part be due to initial uncertainties related to the appropriate dialysis prescription for each individual and to its subsequent modification. The International Dialysis Outcomes and Practice Patterns Study vascular access research shows that the UK has a high percentage of patients starting dialysis using central lines: these provide lower clearances than fistulae because of a combination of lower flow rate and increased recirculation. It is also likely that patients who are starting renal replacement therapy (RRT) for the first time have a degree of residual renal function and do not need such a high dialysis clearance. The number of units measuring residual renal function and combined Kt/V is unknown.

Figure 7.12 shows that, at later treatment periods, an increasing proportion of patients remaining on HD have a URR above 65%. The median URR is 64% at 3 months and 69% at 2 years. These data do not indicate that the URRs of individuals remaining on HD necessarily increase. At each time point, these are different cohorts of patients. As discussed in last year's report, those who survived and remained on HD might initially have had higher URRs than those who died or transferred to another modality. To investigate this, the Registry has analysed the URRs of HD technique survivors compared with non-survivors.

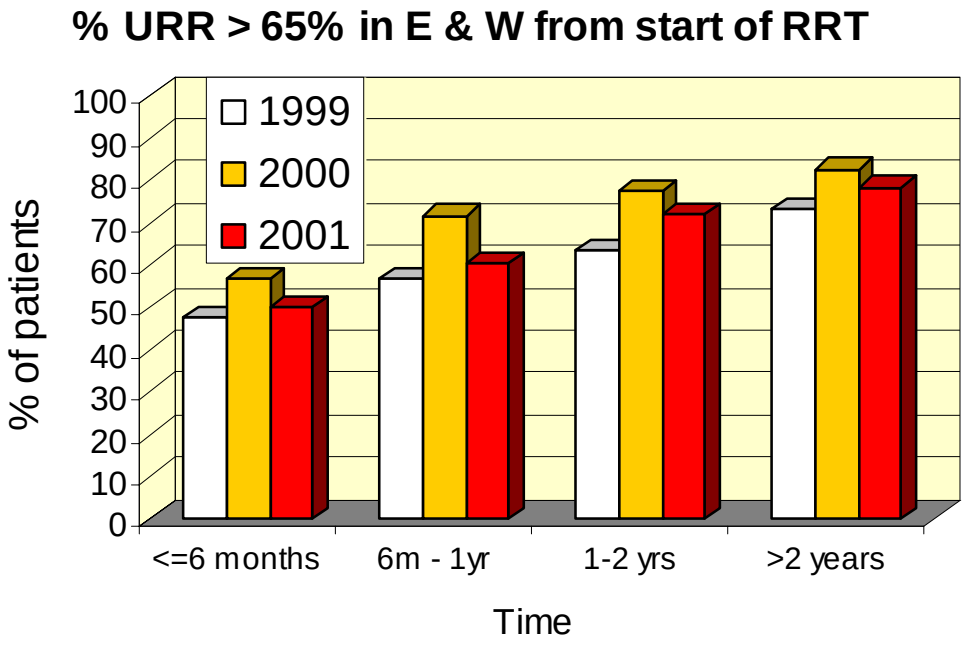

Figure 7.12: Change in URR by length of time on RRT in 1999–2001

This figure shows 'cross-sectional' results for all patients at the year-end on dialysis for the specified time since the start of RRT.

Analysis of URR in the 1999 incident cohort: 2 year survivors versus non-survivors

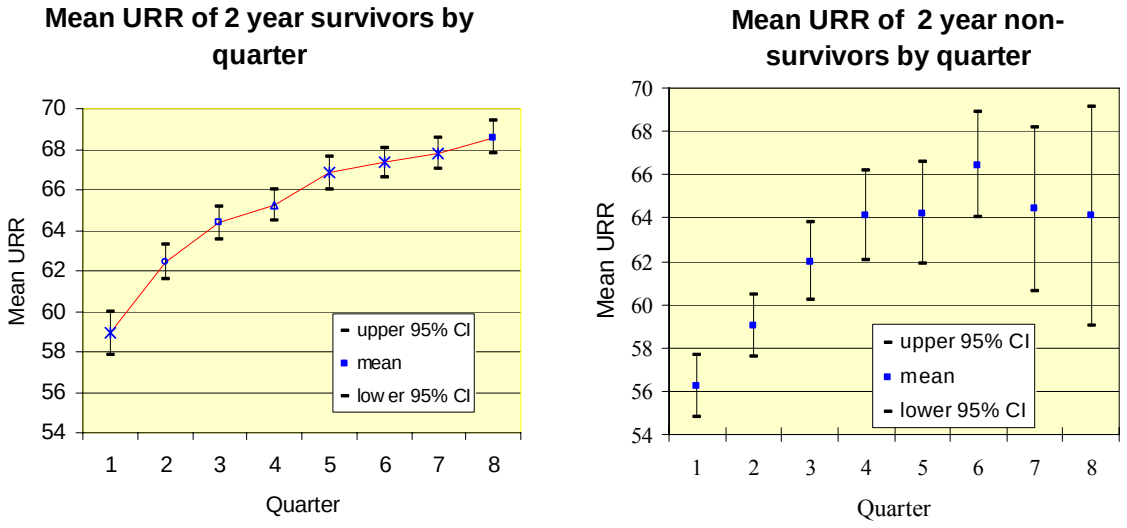

Figure 7.13: Mean URR, survivors versus non-survivors

All patients starting RRT on HD in 1999 (n=1281) were included in this analysis, of whom 473 died within 2 years. The URR was monitored from the time of starting RRT. Data were not available for every patient each quarter. As all patients died in the non-survivor group, there are fewer readings in this group in each sequential quarter: with only 33 alive in the last (eighth) quarter, there are wide confidence intervals.

In the left-hand panel of Figure 7.13, the mean sequential URR over 2 years is shown for 'survivors'. This clearly demonstrates that the mean URR has risen on a quarterly basis for the same patient cohort. Part of this rise is due to the overall rise in dialysis adequacy for all prevalent patients in this period. The patients who died within the first 2 years (right-hand panel, Figure 7.13) had a significantly lower URR than the survivors in the first 6 months (two quarters) only.

These data indicate that those patients who die within the first 6 months are probably a separate clinical cohort from the survivors and are have lower URRs. These data are also consistent with the high death rates shown by the Registry in the first 4–5 months of starting RRT. It is not suggested that the lower URRs in this group are a causal factor in their death. More probably they reflect patients with more comorbidity, especially cardiovascular, who also may more frequently have temporary lines.

Conclusion

The URRs achieved in the UK in the past 4 years have increased, although this increase is slowing and these results are still lower than those obtained from the USA. These data show a marked variation between renal centres, but how much of this is due to a variation between methods of post-dialysis urea sampling is unknown. Through highlighting in this report the diverse sampling methods in current use, it is hoped to encourage centres to introduce an approved method. The consistency shown by some units may result from the application of protocols, whereas centres showing variation on a year-to-year basis may be working less systematically. The easy treatment gain of moving all patients to larger dialysers can only be made once, and further improvement is likely to be more difficult to achieve. Some centres with a low achievement of the recommended URR Standard have indicated that this is because of a severe limitation of resources, especially HD facilities.

References

1. Centre for Medicare and Medicaid Services. *Report Title Here Please*. Place of publication: CMMS, 2001.