Chapter 5: Adequacy of haemodialysis

Haemodialysis frequency

The Standards document states ***"Twice weekly haemodialysis is not recommended except where there is good preservation of renal function."***

The majority of patients in Registry units (92%) receive thrice weekly dialysis. Many units have a small proportion of patients (<8%), often with some residual renal function, who dialyse twice weekly, but some units have disproportionately large numbers of patients on twice weekly treatments. These latter units have informed the Registry that the high proportion on twice weekly dialysis is due to limited facilities and financial resources.

Solute clearance Standards

The Renal Standards Document recommends that all patients stable on three times a week haemodialysis should show :

A urea reduction ratio > 65%
Or ***Kt/V > 1.2 (dialysis and residual renal function)***

The Standards document considers both Kt/V and Urea Reduction Ratio (URR) as indicators of adequacy of haemodialysis. Several different methods are in use for calculating Kt/V and they give results which vary significantly. For meaningful comparisons, the Registry would need to calculate Kt/V by a single method from the raw data. This would require, as a minimum were the Daugirdas formula used for example, knowledge of pre and post dialysis weights and duration of treatment. This information is not available from many units. The simpler calculation of URR, the percentage fall in blood urea during a dialysis session, is possible and has been used again by the Registry. This has been shown to correlate with patient survival (Owen, Held).

Centre achievement of the Standard

The data below excludes patients known to be on home haemodialysis or dialysing less than three times per week.

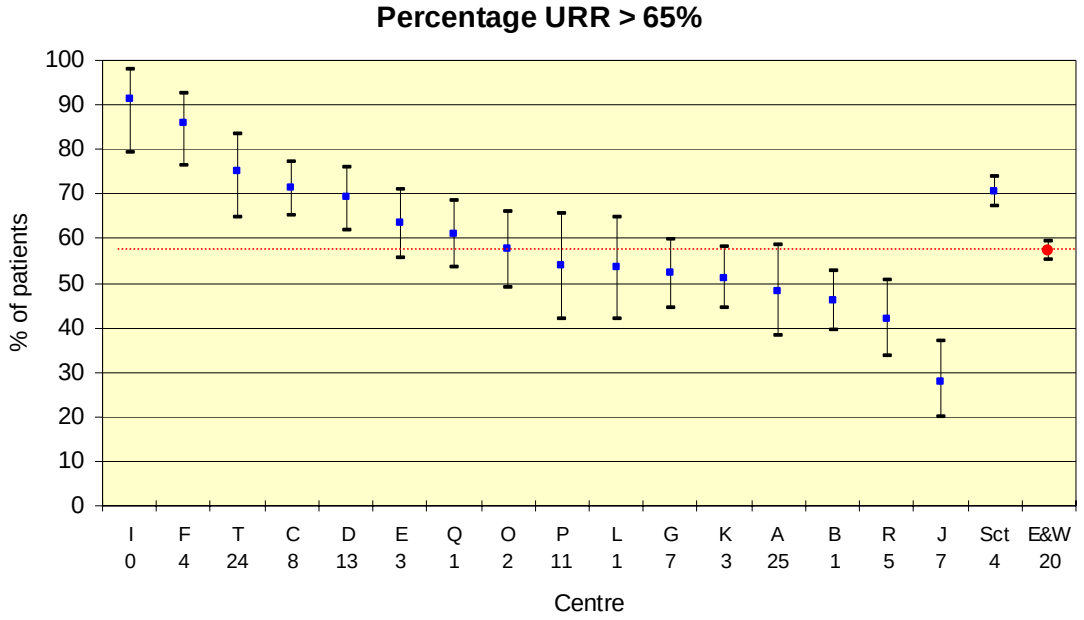

Figure 5.1 Percentage patients with URR > 65%

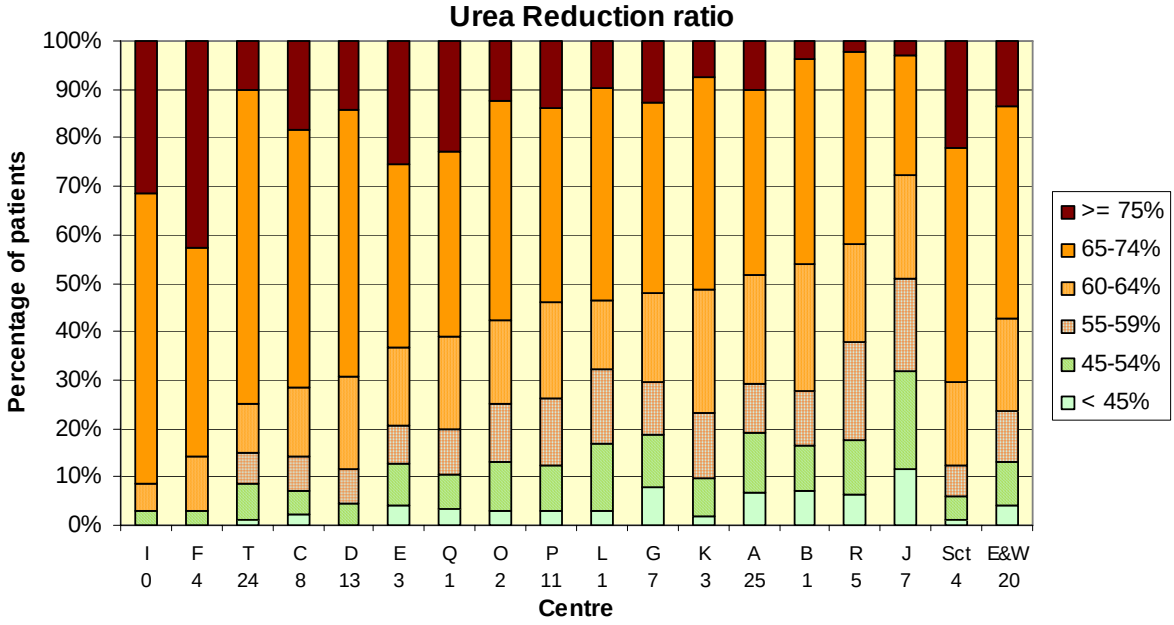

Figure 5.2 Urea reduction ratio

Interpretation of results

Urea rebound and timing of blood samples

The URR, like all methods of calculating haemodialysis adequacy, requires a precise and reproducible method of pre-dialysis, and more importantly, post-dialysis blood sampling. The standardisation of post-dialysis blood sampling is critical to limit the overestimation of urea removal that is inevitable if no account is taken of post-dialysis urea rebound. The dilutional effects of access recirculation (in patients dialysing using arterio-venous fistulae), and cardiopulmonary recirculation cease within a few minutes

of stopping haemodialysis. The remaining rebound is due to intercompartmental urea disequilibrium, with equilibration taking 30-45 minutes. The percentage increase in urea after 30 minutes may be as much as 17 – 45% (Abramson).

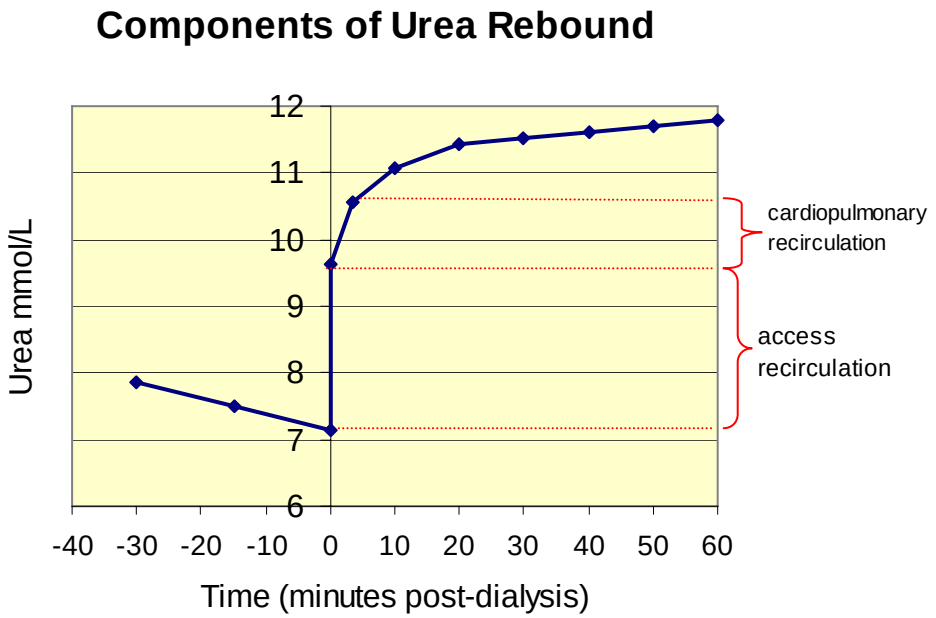

Figure 5.3 Components of urea rebound (from the DOQI report)

Practical problems of timing of blood samples

It is not practical to ask patients to wait for such a delayed blood sample to be taken and estimations of this late rebound are often used. Methods of sampling are considered in some detail in the Standards document (page 98). The Renal Association and National Kidney Foundation Dialysis Outcomes Quality Initiative (DOQI) guidelines currently advise "slow flow methods" of post-dialysis blood sampling since they negate the effects of access recirculation and allow partially for cardiopulmonary recirculation (Renal Association Standards document). However both of these methods involve four steps and require accurate timing of blood samples during the early period of most rapid urea rebound: this may be difficult to achieve in a busy renal unit. In North America dialysis centres have revealed that at least 20 methods of post-dialysis blood sampling were recently in use and more than 40% of the haemodialysis centres used a method of post-dialysis sampling that did not attempt to allow for the effects of access and cardiopulmonary recirculation (Beto et al).

The observation that patient survival in the USA improves as URR increases up to 60% was made using undefined post-dialysis sampling methods which are likely to have been similar to the post-dialysis methods described more recently in North American haemodialysis facilities.

Current UK practice in blood sampling

An informal survey by the Registry of the methods of post-dialysis sampling used by participating UK renal units has shown a wide range of sampling techniques in use. Many units obtain the post-dialysis blood sample immediately at the end of the dialysis session with no "slow flow" period. A similar observation was made in a survey of all adult renal units in Scotland in early 1998 (Mactier). This widespread use of immediate post-dialysis sampling will overestimate urea removal during dialysis and hence the URR, as the sample is diluted by access recirculation of 'just dialysed blood', and there is no account of cardiopulmonary recirculation and the disequilibrium component of the urea rebound.

For good comparative audit, it is essential that a standardised post dialysis sampling technique is used which is simple and reproducible.

In the absence of a formal programme of standardisation of dialysis methods in the UK only one method of sampling has been in evaluation. In the past year all the renal units in Scotland, and some in England, have utilised a standardised method of post-dialysis blood sampling from any point in the extracorporeal circuit 5 minutes after stopping the dialysate flow while the dialyser blood flow rate remains unchanged (Traynor et al). This "stop dialysate flow" method does not require exact timing of blood sampling, permits blood sampling from the arterial or venous limbs of the extracorporeal circuit and is practical to perform in a busy unit. This has proved reproducible, allowing for both access and cardiopulmonary recirculation, if not for the disequilibrium component of urea rebound. This technique has been verified in 117 patients. During the same haemodialysis session the URR was 69.1 (s.d. 9.3%) when using the "stop dialysate flow" method compared with 71.7 (s.d. 8.3%) when blood sampling was performed immediately at the end of haemodialysis ($p < 0.0001$). The method is being further evaluated. It should be noted that the extent of urea rebound depends on the intensity of dialysis in terms of K/V and t, so that a wide range of treatment conditions are required to validate any sampling method. The 'stop dialysate flow method is not suitable for conversion to estimate Kt/V, unlike versions of 'slow flow', so that international and historical data comparisons may be compromised by concentration on this method.

Implications for URR results calculated by the Renal Registry

Without a standardised post dialysis sampling technique in use by all units, it must be accepted that many units will be overestimating URR by taking immediate "no slow flow" samples. This is part of a wider problem with URR, however, because it takes no account of urea removal by ultrafiltration. This distorts the equivalence of URR 65% and Kt/V 1.2, which is further flawed because of the effects of variable dialysis time, t. For these reasons URR is not a reliable indicator of haemodialysis dose, despite its relationship to outcomes.

This is particularly important when the distribution of unit results clusters around the Standard 65% value, because even a small bias in the data will profoundly shift the percentage compliance with Standard. Values well above (or below) the Standard will be scarcely affected. There are several examples of this from Figs 5.1 and 5.2, where it is clear that a very small change in median URR achieved can make a profound difference to the compliance with the Standard.

However, any attempt to increase URR values will tend to increase delivered dialysis doses. In very large scale mortality studies these niceties appear to be less relevant. It should be stressed again that the observation that patient survival in the USA improves as URR increases up to 60% was made using undefined post-dialysis sampling methods.

Results of UK comparative audit

There is wide variation between units, in the proportion of patients who achieve the current minimum Standard URR. For England and Wales, the percentage of hospital haemodialysis patients with a compliant URR (>65%) averaged 57% in all of the 16 units but varied from 97% in centre F to 28% in centre J. Discussions with centre J indicate most patients are on 3 hours dialysis due to lack of funding. In 1999 these hours are being increased.

In the early cycles of the hospital haemodialysis audit reported by the Scottish Renal Registry from 1994 to 1998, when the total number of hospital haemodialysis patients almost doubled, the proportion of patients in Scotland with a URR above 65% increased from 42% to 75%, whilst in one unit the percentage of patients with URR greater than 65% rose from zero to 85%. This suggests a benefit from such regular comparative audit, although during this period attitudes changed in the nephrology world as a whole, with clinicians accepting the need for an increase in the haemodialysis prescription. In other studies the most important feature has been the lack of aspiration in prescription of haemodialysis, rather than underperformance of the technique or other social factors [Seghal) The 95% confidence intervals for the % URR above 65% shown in figure 5.1, indicate that there are true differences of achievement between the units sampled here.

Higher urea reduction ratios have been associated independently with older patients, females and lower body weight. Centre F has the oldest median age of haemodialysis patients (70) while Centre J with the lowest performance against the Standard has a combination of the youngest patients (median age 58) and the highest proportion of males (69%). Centre F has all patients on at least 4 hours dialysis. Centre C is probably performing very well as the median age is 54 with 66% males.

Centre	Median age	% Male	M:F ratio
A	64	61	1.66
B	60	63	1.69
C	54	66	1.95
D	62	62	1.65
E	63	63	1.71
F	70	64	1.78
G	64	58	1.39
H	66	67	2.09
I	66	62	1.65
J	58	69	2.26
K	61	62	1.65
L	65	65	1.84
M	64	64	1.81
N	69	63	1.68
O	63	52	1.08
P	59	65	1.90

Q	61	59	1.42
R	61	61	1.54
T	67	76	3.21
Scotland	59	60	1.48
E&W	62	63	1.72
UK	62	62	1.66

Table 5.1 Median age and M:F ratio by centre

The URR results of three of the units, N, M and H, may not have been representative since a substantial proportion of the patients had no data recorded, and have not been included in the
analysis.

Change in URR during 1998

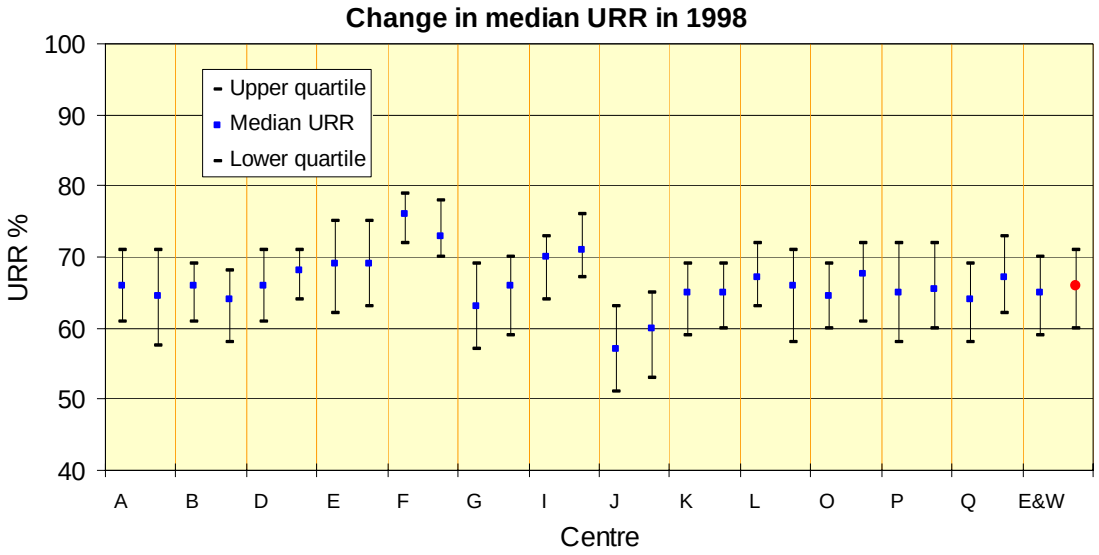

Figure 5.4 Change in median URR in 1998

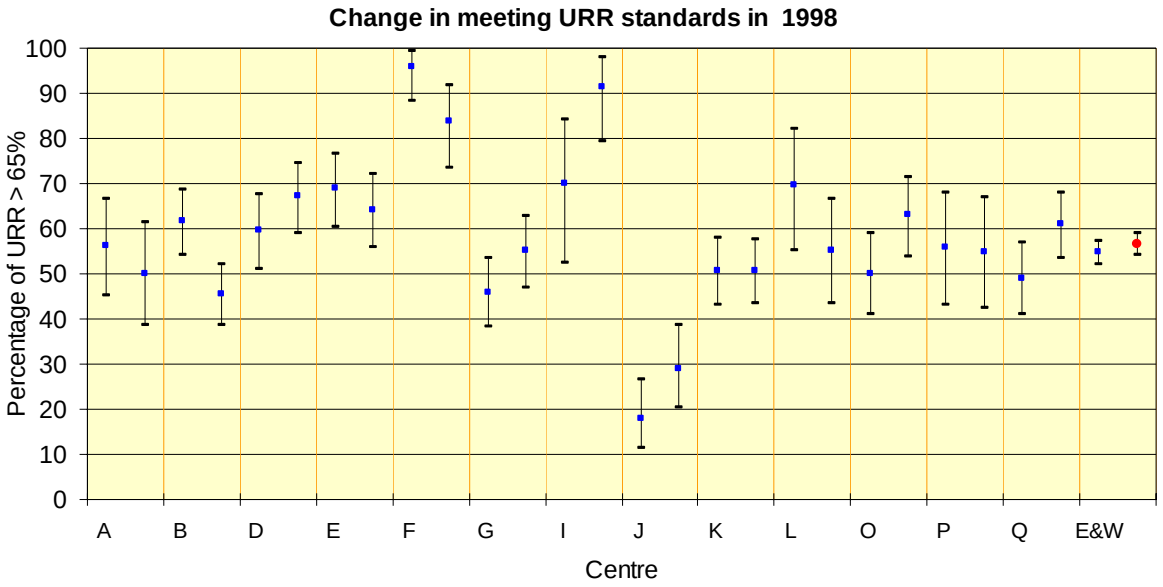

Figure 5.5 Change in meeting URR Standard in 1998

The stability of URR distributions in most units across 1998 suggests that no major programme of change was introduced in them

If full KT/V values including residual renal function are calculated, in some patients with significant residual function dialysis may be reduced. As the URR calculation does not include any allowance for residual renal function, estimation of dialysis clearance will underestimate the true clearances in such patients where this approach is used. Registry enquiries have found only one current registry unit where there is widespread use of this approach.

Conclusions

A standardised method of measuring the URR is required to permit meaningful comparative audit among participating renal units. This will need to be addressed in the Renal Association Standards Group, but as yet there has been no formal programme in the UK to study this problem. The Renal Registry data demonstrate that 'adequate' URR results can be achieved in most patients in some centres. It is hoped that the wide variation in URR achieved in these early cycles of audit of hospital haemodialysis will decrease as the beneficial effects of re-audit are seen, together with a shift in perception of satisfactory dose regimens.

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