Appendix D: Measurement of Dialysis Adequacy

D:1: Urea rebound and timing of blood samples

The urea reduction ratio (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 (Figure D.1). The remaining rebound is caused by intercompartmental urea disequilibrium, equilibration taking 30–45 minutes. The percentage increase in urea after 30 minutes may be as much as 17–45%.[1]

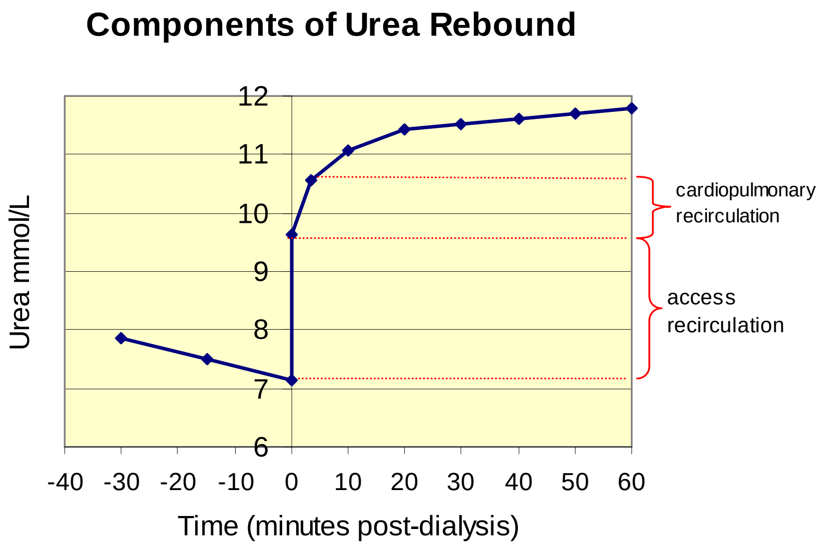

Figure D.1: Components of urea rebound (from the Disease Outcomes Quality Initiative report)

D:2: 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, so estimations of this late rebound are often used. Methods of sampling are considered in some detail in the second edition (page 98) and third edition (pages 27 and 35) of the Standards document. The National Kidney Foundation Dialysis Outcomes Quality Initiative guidelines[2] currently advise 'slow flow methods' of post-dialysis blood sampling since they negate the effects of access recirculation and partially allow for cardiopulmonary recirculation. The third edition of the Renal Association document includes three acceptable methods for post dialysis sampling. However the 'early' sampling methods involve four steps and require accurate timing of the 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.[3]

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

D:3: Current UK practice in blood sampling

A survey in 2002 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.[4] This widespread use of immediate post-dialysis sampling will overestimate urea removal during dialysis, and hence URR, as the sample is diluted by the 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 that 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 under evaluation. Most 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.[5] This 'stop dialysate continue blood flow' method does not require an exact timing of blood sampling, permits blood sampling from the arterial or venous limb 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 is 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 concentrating on this method.

D:4: Implications for URR results calculated by the Renal Registry

Without a standardised post-dialysis sampling technique being used 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 a variable dialysis time, *t*. For these reasons, URR is not, despite its relationship to outcomes, a reliable indicator of haemodialysis dosage.

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 the Standard. Values well above (or below) the Standard will be scarcely affected. The chapter on dialysis adequacy shows clearly that a very small change in the median URR achieved can make a profound difference to compliance with the Standard.

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

References

1. Abramson F, Gibson S, Barlee V, Bosch JP. Urea kinetic modelling at high urea clearances: implications for clinical practice. *Adv Renal Replace Ther* 1994;1:5–14.

2. National Kidney Foundation Dialysis Outcomes Quality Initiative. *Clinical Practice Guidelines for Haemodialysis Adequacy*. DOQI, 1997; 25–61.

3. Beto JA, Bansal VK, Ing TS, Daugirdas JT. Variation in blood sample collection for determination of haemodialysis adequacy. *Arn J Kid Dis* 1998;31:135–41.

4. Clinical practice guidelines of the Canadian Society of Nephrology for the treatment of patients with chronic renal failure. *J Am Soc Nephrol* 1999;10:S307.

5. Traynor J, Geddes CC, Walbaum D, et al.. A new method of post-dialysis blood sampling: the 'stop dialysate flow' method. *Nephrol Dial Transplant* 1999; 14:2063A.

6. Held PJ, Port FK, Wolfe RA, et al. The dose of hemodialysis and patient mortality. *Kidney Int* 1996;50:550–6.

7. Leblanc M, Charbonneau R, Lalumiere G, Cartier P, Deziel C. Postdialysis urea rebound: determinants and influence on dialysis delivery in chronic haemodialysis patients. *Am J Kidney Dis* 1996;27:253–61.

8. Owen WF, Lew NL, Liu Y, Lowrie KG, Lazarus JM. The urea reduction ratio and serum albumin as predictors of mortality in patients undergoing haemodialysis. *N Engl J Med* 1993;329:1001–6.

9. Renal Association. *Treatment of Adult Patients with Renal Failure. Recommended Standards and Audit Measures*. Renal Association, 1998; 21-22.

10. Scottish Renal Registry. Audit of quality of hospital haemodialysis in Scotland. *Nephrol Dial Transplan*t 1997;12:29-32.

11. Scottish Renal Registry. The quality of hospital haemodialysis in Scotland – improvement with audit. *Health Bull* 1999;57:237–40.

12. Seghal AR, Snow RJ, Singer ME, et al. Barriers to adequate delivery of hemodialysis. *Am J Kidney Dis* 1998;31:593–601.