

Blood urea sampling methods

Date written: November 2004

Final submission: July 2005

GUIDELINES

No recommendations possible based on Level I or II evidence

SUGGESTIONS FOR CLINICAL CARE

(Suggestions are based on Level III and IV evidence)

- Pre- and post-dialysis samples for urea measurement must be drawn at the same midweek treatment.
- The pre-dialysis sample should be drawn from the arterial needle without saline or heparin contamination. If there is a suggestion that the blood is contaminated, first withdraw 10 mL of blood before taking the sample (e.g. central venous catheter).
- It is suggested that the slow flow/stop pump sampling technique (described below) be used where possible to provide uniformity across dialysis units.
- The post-dialysis sample should be drawn from the arterial line port or arterial needle at 20 seconds after initiating slow (or zero) blood pump flow with attention to accuracy of timing (K/DOQI 2001, Guideline 8, Haemodialysis Adequacy). The 2–3 minute post-dialysis sampling practice is an acceptable alternative. Unit practice should be consistent, documented, and compared with standards with similar methodology.

Pre-dialysis urea sampling:

- It is self-evident that sampling immediately before (not after) the commencement of dialysis is necessary to ensure valid dialysis dose estimates (Hakim 1998). Distorting factors for urea levels may be saline or heparin contamination of the sample, taken from the arterial needle or the central venous catheter limb.

Post-dialysis urea sampling:

- Rapid post-dialysis blood urea level changes arise from 'rebound' due to recirculation and regional blood flow distribution (ANZDATA 1998, Klinkmann & Davison 1994). The optimal time for sampling for single pool urea clearance estimates (30–50 minutes) is not practical in daily dialysis practice (Bloembergen et al 1999, Leypoldt et al 1999). Comparison of delivered dose with intended prescription requires adherence to methods used in studies forming the basis for these standards.
- Current practices are not uniform but comparison with the outcomes of the recent multicentre prospective randomised trial (the Hemodialysis

[HEMO] Study) warrants support for its carefully validated methodology (van Ypersele et al 1991, Hakim et al 1994).

- The ANZDATA post-dialysis sampling time recommendation has been 2 minutes after initiation of slow blood flow (ANZDATA survey form, 2003). This avoids the urea level dilution from any angio-access recirculation and from cardiopulmonary recirculation of dialysed blood directly from the heart to the dialysis access (without passage through the arteriovenous circulation to remove urea generated in the rest of the body).
- The HEMO study post-dialysis preferred sampling method involves withdrawal of blood 15–20 seconds after three steps: 1) initiating slow blood pump flow (50–100 mL/minute), 2) stopping dialysate flow (or setting at the slowest flow the machine will allow), and 3) turning the ultrafiltration rate to zero to minimise dialysis treatment effects. The angio-access recirculation rebound effect is at least partly removed but the cardiopulmonary recirculation effect is not, if the 20-second sampling technique is used (Koda et al 1997, Schwalbe et al 1997). This potentially results in slight overestimation of urea reduction rate (URR) or Kt/V.
- Sampling after 20 seconds will include unpredictable effects on rebound from cardiopulmonary recirculation and regional blood distribution, and hence underestimate urea clearance to an unknown and inconsistent degree. Nevertheless, this may work in the patient's favour by ensuring that the dose delivered is at least that calculated.
- Increased use of high efficiency/high flux dialysers of larger surface area and high blood flow rates delivering rapid urea clearance require the use of equilibrated Kt/V standards or of Kt/V and URR standards that recognise the inherent overestimation of single pool urea clearance arising from increased urea rebound with these techniques.

Pre-dialysis sampling technique:

The sample is drawn:

- a. directly from arterial needle before introduction of any saline or heparin or
- b. from central venous catheter after withdrawing at least 10 mL of blood.

Post-dialysis sampling technique:

Slow/stop pump techniques:

- a. decrease ultrafiltration rate (UFR) to zero, set lowest dialysate flow rate, turn blood flow to 50–100 mL/minute, and
- b. after 20 seconds draw sample from arterial port or stop pump after 20 seconds and draw sample from arterial needle or arterial port after clamping arterial and venous lines.

An alternative technique is to withdraw a sample from the arterial port or needle after 2 minutes of slow flow. This results in a higher post-dialysis urea level with lower Kt/V values.

Background

The provision of dialysis replaces many of the functions of the failing kidney. In an effort to ensure that treatment is optimised for individuals undergoing dialysis, some measure of dialysis efficacy is required. The most common measures currently in widespread use (URR and Kt/V) are discussed in another guideline and are derived by measuring changes in serum urea concentration over the course of a single dialysis session. Blood urea concentrations undergo rebound after a haemodialysis session, so it is vitally important that the method of measurement is clearly defined and reproducible. This will allow results within patients and populations of patients to be reliably compared.

This guideline examined the available literature regarding different methods of sampling urea concentrations.

Search strategy

Databases searched: MeSH terms and text words for dialysis were combined with MeSH terms and text words for blood sampling and adequacy, and then combined with the Cochrane highly sensitive search strategy for randomised controlled trials. The search was carried out in Medline (1966 – February Week 4 2004). The Cochrane Renal Group Trials Register was also searched for trials not indexed in Medline.

Date of searches: 4 March 2004.

What is the evidence?

There are no trials examining the relationship between different methods of urea measurement and any clinical outcomes. The relationship between dialysis adequacy calculated from urea measurements and outcome is discussed in another guideline.

What do the other guidelines say?

Kidney Disease Outcomes Quality Initiative: 20-second sample after slowed blood pump flow (50 mL/minute or less) and ultrafiltration (UF) off and dialysate flow turned off (or at least to lowest setting). They do acknowledge the common practice of sampling after "run-back" or reinfusion of blood in dialysis circuit, which may be greater than 5 minutes after dialysis has been completed. (Guideline 8, Haemodialysis Adequacy)

British Renal Association: 20-second sample recommended. (Appendix 2, pp. 35-36)

Canadian Society of Nephrology: As per K/DOQI guidelines. They acknowledge that if reliance is on URR, as opposed to formal urea kinetic modelling (UKM)-based Kt/V, the 2-minute technique may be preferable. (Guideline 4.3.6, Delivery of Hemodialysis)

European Best Practice Guidelines: 20-second sample recommended. (Guideline I.4, Section I)

International Guidelines: No recommendation.

Implementation and audit

An audit of dialysis centres in Australia and New Zealand would be useful in defining current practice. Standardisation of methodology between units would allow more direct comparisons to be made.

Suggestions for future research

No recommendation.

References

- ANZDATA survey form, 18 Nov 2003. Available from:
<http://www.anzdata.org.au/forms/ANZDATABackFormNov2003.pdf>.
- Bloembergen WE, Hakim RM, Stannard DC et al. Relationship of dialysis membrane and cause-specific mortality. *Am J Kidney Dis* 1999; 33: 1–10.
- Canadian Society of Nephrology Committee for Clinical Practice Guidelines. Clinical practice guidelines of the Canadian Society of Nephrology for treatment of patients with chronic renal failure. *J Am Soc Nephrol* 1999; 10(Suppl 13): S289–S321.
- Collins AJ, Ma JZ, Umen A et al. Urea index and other predictors of hemodialysis patient survival. *Am J Kidney Dis* 1994; 23: 272–82.
- European Best Practice Guidelines. Section I: Measurement of renal function, when to refer and when to start dialysis. *Nephrol Dial Transplant* 2002; 17(Suppl 7): S7–S15.
- Hakim RM. Influence of the dialysis membrane on outcome of ESRD patients. *Am J Kidney Dis* 1998; 32(Suppl 4): S71–S75.
- Hakim RM, Breyer J, Ismail N et al. Effects of dose of dialysis on morbidity and mortality. *Am J Kidney Dis* 1994; 23: 661–69.
- Kerr P. Method and location of dialysis; pp.115-116. ANZDATA Registry Report 1998. Australia and New Zealand Dialysis and Transplant Registry. Adelaide, South Australia.
- Klinkmann H, Davison AM. The biocompatibility puzzle – partly solved, partly enigmatic. *Nephrol Dial Transplant* 1994; 9(Suppl 2): S184–S86.
- Koda Y, Nishi S, Miyazaki S et al. Switch from conventional to high-flux membrane reduces the risk of carpal tunnel syndrome and mortality of hemodialysis patients. *Kidney Int* 1997; 52: 1096–101.
- Leyboldt JK, Cheung AK, Carroll CE et al. Effect of dialysis membranes and middle molecule removal on chronic hemodialysis patient survival. *Am J Kidney Dis* 1999; 33: 349–55.
- NKF-K/DOQI Clinical Practice Guidelines for Hemodialysis Adequacy. New York, National Kidney Foundation, 2001; pp. 57–63.
- Owen WF Jr, Lew NL, Liu Y et al. The urea reduction ratio and serum albumin concentration as predictors of mortality in patients undergoing hemodialysis. *N Engl J Med* 1993; 329: 1001–06.
- Schwalbe S, Holzhauer M, Schaeffer J et al. Beta 2-microglobulin associated amyloidosis: a vanishing complication of long-term hemodialysis. *Kidney Int* 1997; 52: 1077–83.

The Renal Association and the Royal College of Physicians of London. Treatment of adults and children with renal failure. Standards and audit measures. 3rd edition. London: The Lavenham Press Ltd, 2002.

Van Ypersele de Strihou C, Jadoul M, Malghem J et al. Effect of dialysis membrane and patient's age on signs of dialysis-related amyloidosis. The Working Party on Dialysis Amyloidosis. *Kidney Int* 1991; 39: 1012–19.