Urea kinetic modeling measures the delivered dose of hemodialysis and is used to monitor dialysis adequacy. Obtaining samples for adequacy calculations is a challenge for home hemodialysis (HHD) patients. Ideally, the urea reduction ratio (URR) should be measured at a typical dialysis session; therefore, for HHD patients test specimens should be drawn at home and transferred to a clinical laboratory. Would blood urea nitrogen (BUN) remain stable if samples were mailed to the laboratory? To answer this question, BUN was measured in pre- and postdialysis samples from 20 patients over 8 days of laboratory storage. While BUN values varied among the patient population, neither pre- nor postdialysis values showed any significant variation during the 8-day storage time. These results suggest that BUN values are sufficiently stable for specimens to be drawn at home and mailed to a testing laboratory.


Key words
Hemodialysis adequacy, blood urea nitrogen stability, urea reduction ratio

Introduction
According to the National Kidney Foundation Dialysis Outcomes Quality Initiative guidelines [1], the prescribed hemodialysis dose should be routinely measured using urea kinetic modeling to monitor the delivered dose of hemodialysis. Mortality is lower [2], and the number of hospital days per patient per year also decreases [3] when a sufficient hemodialysis dose is delivered. Measuring hemodialysis dose presents a challenge for the home hemodialysis (HHD) patient. Ideally, Kt/V should be measured at a typical dialysis session; therefore, for HHD patients, test specimens should be drawn at home. It may be difficult to exactly reproduce all parameters of a home dialysis treatment when home patients come to an outpatient dialysis clinic for Kt/V determination. Specimens drawn at home may give a truer representation of the treatment, provided that the blood urea nitrogen (BUN) concentrations remain stable until measured in the laboratory.

The purpose of this study was to determine if BUN values remained adequately stable to permit mailing from home to a testing laboratory.

Material and methods
Samples for this study were obtained from 20 patients dialyzed at a local clinic. Pre- and postdialysis blood samples were drawn for routine monthly evaluations. Postdialysis samples were obtained using a variation of the low-flow sampling technique [4]. At the completion of dialysis, the dialysate flow was turned off, blood flow was decreased to 80 mL/min, and, after a 20-second delay, the specimen was drawn from the arterial sampling port. Predialysis samples were drawn in serum separator tubes (SST Gel and Clot Activator, Vacutainer Systems, Becton Dickinson, Franklin Lakes, NJ, U.S.A.) and centrifuged for 20 minutes at 3000 revolutions per minute in a Clay Adams Dynac Model 420101 centrifuge (Becton Dickinson). Postdialysis samples were drawn into Vacutainer tubes containing lithium heparin. All samples were delivered to RenaLab, Inc., a local laboratory, on the same day they were drawn. The laboratory measured BUN values from both the pre- and postdialysis samples on each of 8 consecutive days. The samples were stored at room temperature throughout the study. Blood urea nitrogen measurements were done using Boehringer Mannheim’s standard assay on a Hitachi 747-100 analyzer (Roche Diagnostics Corp., Indianapolis, IN, U.S.A.). Urea reduction ratios (URRs) were calculated using the formula

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\text{URR} = \left(\frac{\text{predialysis urea} - \text{postdialysis urea}}{\text{predialysis urea}}\right) \times 100
\]

Results
Daily predialysis BUN values had a broad range of 43 – 83 mg/dL, due to patient-to-patient variations (Table I). Repeated values for individual patients were more consistent; differences from day 1 ranged between –2 and +4 mg/dL, corresponding to a maximum deviation of 2.3% of an individual patient’s average BUN value for the entire testing period. Similarly, daily postdialysis BUN values for all patients ranged from 9 to 31 mg/dL; values for any individual varied by –2 to +5 mg/dL, corresponding to a maximum deviation of 10.7% of a patient’s average value (Table II). Average day-to-day percent differences were well within acceptable testing standards according to the College of American Pathologists’ accuracy-based evaluation criteria.

Correspondence to:
Gay L. Case, RN, Renal Care Group, Inc., 3925 West Northside Drive, Jackson, Mississippi 39209 U.S.A.
email: GCASE@RenalCareGroup.com
Comparison of average pre- and postdialysis values for each patient revealed URRs ranging from 59.2% to 82.9% (Table III). Table IV presents the differences in URRs between day 1 and subsequent days. The ratios are essentially unchanged until day 6. The maximum deviation from day 1 did not exceed –2.8 or +2.7. The differences between day 1 and days 7 and 8 were higher, with an average difference of 1.1 and maximum deviations ranging from –7.7 at day 8 to +
3.9 at day 7. Even at days 7 and 8, where the differences were clinically important in some patients, these differences were not statistically significant.

**Discussion**

Typically, HHD patients come into the center to dialyze when adequacy testing is done. Ideally, adequacy testing should be measured at a typical dialysis session; therefore, for HHD patients test specimens should be drawn at home. Specimens drawn during a HHD session may give a truer representation of the treatment. Before implementing adequacy testing at home for HHD patients, we needed to assure that BUN levels are stable if samples are to be mailed to the laboratory. Blood specimens drawn in a dialysis clinic are typically tested within
24 hours. It was reasonable to assume that specimens mailed from home would arrive at a testing laboratory within 3 to 5 days. Therefore, we chose to study BUN stability over 8 days of storage. Pre- and postdialysis samples from 20 different patients were sent to our local testing laboratory and were stored at room temperature; BUN was determined on each of 8 consecutive days.

The resulting data demonstrated that pre- and postdialysis BUN values were essentially stable for 6 days of storage. Urea reduction ratios calculated from these values did not differ on days 1 – 6. Urea reduction ratios on days 7 and 8 were only minimally lower. Clinically, these changes were not significant, except for 2 patients on day 7, where the maximal deviations from day 1 were –4.7 and –5.1, and 2 patients with deviations of –4.7 and –7.7 on day 8.

In conclusion, BUN values from blood delivered to the laboratory and spun on the same day are stable at room temperature over the 3 to 5 days of estimated mailing time. Further studies are in progress to address the effect of actual mailing and to assess patient compliance with correct protocol.

References