Estimation of 24-hour urine protein quantity by the morning-urine protein/creatinine ratio

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Abstract

Background. Many reports have described a correlation between the morning-urine protein/creatinine ratio (morning urine P/Cr) and the quantity of 24-h urine protein (Up), as well as regression formulas for Up with morning-urine P/Cr. However, there is no universal regression formula that can be used at all facilities. It is still controversial whether a qualitative calculation is required at outpatient clinics. To develop a practical and universal method, we used receiver operating characteristic (ROC) analysis to estimate Up from morning-urine P/Cr.

Methods. The subjects were 34 children (309 specimens) with kidney disease who had been admitted to Miyazaki Prefectural Hospital. We examined the correlations of P/Cr with Up and Up/body surface area (Up/BSA) using morning and daytime urine. We determined the cutoff values to estimate Up/BSA from morning-urine P/Cr with an ROC analysis. Next, we applied the values to specimens obtained from other facilities to show the universality of this approach.

Results. Up/BSA for samples in one hospital was significantly correlated with morning-urine P/C. When the morning-urine P/Cr ratio is ≥1.0 or ≥2.0, the Up/BSA ratio will exceed 0.5 or 1.0 (g/m² per day), respectively, and the efficiency was sufficiently high (efficiency for Up/BSA of ≥0.5: 88.0%, efficiency for Up/BSA of ≥1.0: 90.9%). When we analyzed samples from two other facilities with these cutoff values, both the sensitivity and specificity were greater than 80% for both facilities.

Conclusions. The use of cutoff values of 1.0 and 2.0 for morning-urine P/Cr determined by ROC analysis could be a universal method for quantitatively estimating Up/BSA ≥0.5 and 1.0, respectively.

Key words Proteinuria · Protein urine/creatinine ratio · Morning urine · Body surface area

Introduction

The quantity of urine protein (Up) in a 24-h urine sample is an important index in the field of kidney disease. However, to determine Up, it is important that all of the urine for 24h is accurately collected. In the outpatient clinic, it would be very helpful if random urine could be used to estimate Up. Several reports have described methods for estimating Up using the random-urine protein/creatinine (P/Cr) ratio since a method for roughly estimating Up with random-urine P/Cr was reported in 1983. Several regression formulas for estimating Up from random urine P/Cr have also been described. These formulas were obtained using urine samples from individual facilities. However, there is a large variation in the regression coefficients among facilities, which makes it difficult to obtain consistent values for Up with the formulas that have been reported thus far. In this study, to quantitatively estimate Up from random urine samples, we used a receiver operating characteristic (ROC) analysis, instead of a qualitative analysis with a regression formula. We verified the correlation between morning-urine P/Cr and Up/BSA. The cutoff value of morning-urine P/Cr using an ROC analysis is useful for estimating the value of Up/ body surface area (BSA).
Patients and methods

Patients

Thirty-four children (16 boys, 18 girls) who were being treated at the Miyazaki Prefectural Miyazaki Hospital Department of Pediatrics (hospital A), who had been diagnosed as having various types of kidney diseases, were the subjects. They ranged in age from 2 to 18 years, with an average age of 9.5 ± 4.4 years. The details of the diagnoses are shown in Table 1. None of the subjects showed abnormal renal function. The diagnoses were confirmed by pathological examination. Because the dispersion of Up/BSA was extremely large, samples in which Up/BSA exceeded 5 were excluded. None of the subjects was receiving diuretic drugs that may have affected Cr excretion. The duration of sampling and the number of samples are shown in Table 1.

Urine samples were also obtained from patients at Kagoshima University Hospital Department of Pediatrics (hospital B; Table 1) and Kagoshima City Hospital Department of Pediatrics (hospital C; Table 1) by the same method as that described below. The cutoff value obtained from the samples at hospital A by ROC analysis was used to analyze the samples from both of the other facilities. Informed consent was obtained from each patient’s guardian after permission had been received from the Director at each hospital.

Urine collection

Morning-urine samples (n = 309) and 24-h urine samples (n = 309) were collected from all subjects. The 24-h urine samples were collected from 10 a.m. to 10 a.m. the following day. The minimum necessary amounts of morning and daytime urine were used for chemical analyses. Early-morning primary urine was considered to be morning urine. Daytime urine was considered to be random urine obtained between 10 a.m. and 4 p.m. Thirty-one samples from eight patients were used to compare early morning and daytime urine without a bias due to urine collection.

Biochemical analysis

Protein in urine (mg/dl) was measured by the pyrogallol red method. The Cr urine value (mg/dl) was measured by an enzymatic method. The BSA was calculated from the body height and weight obtained during hospitalization.

Statistics

The relationship of random-urine P/Cr to Up and Up/BSA was analyzed using a regression model. An ROC analysis was used to determine the value of morning-urine P/Cr, which was estimated for Up/BSA greater than 0.5 (Up/BSA 0.5) or greater than 1.0 (Up/BSA 1.0). Statistical analyses were performed using StatView-J 5.0 (SAS Institute, Cary, NC, USA) and STATA (Stata, College Station, TX, USA).

Results

There was a statistically significant positive correlation between morning-urine P/Cr and Up from samples at hospital A (Fig. 1a). Morning-urine P/Cr was correlated more strongly with Up/BSA than with Up (Fig. 1b). As shown in Fig. 2, morning-urine P/Cr was significantly correlated with Up/BSA, and this correlation was stronger than that between daytime-urine P/Cr and Up/BSA.

ROC curves for morning-urine P/Cr and Up/BSA 0.5 and 1.0 are shown in Fig. 3. Using the ROC analysis, the cutoff value of morning-urine P/Cr for estimating Up/BSA 0.5 was calculated as shown in Table 2. In this analysis, the most appropriate cutoff value for estimating Up/BSA 0.5 was ≤1.0 (efficiency, 88.0%; sensitivity, 85.8%; specificity, 90.1%; area under ROC curve, 0.9223). A similar analysis