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Accuracy of Urinary Urea Nitrogen for Predicting Total Urinary Nitrogen in Thermally Injured Patients*

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ABSTRACT. Estimations of total urinary nitrogen from measured urinary urea nitrogen are commonly used in calculating nitrogen balance. Recently published studies suggest the urinary urea nitrogen/total urinary nitrogen relationship is inconstant and total urinary nitrogen must be directly measured in burned patients. This study addresses the relationship of urinary urea nitrogen to total urinary nitrogen after thermal injury. Two hundred random 24-hour urine collections obtained from 45 thermally injured patients (mean burn size 59 ± 28%, mean age 40.5 ± 17.2 years) between 1 and 354 days postburn were analyzed for total urinary nitrogen and urinary urea nitrogen. Regression analysis relating total urinary nitrogen to estimated total urinary nitrogen (urinary urea nitrogen × 1.25) revealed a linear relationship (r = .936, p < .001). The mean urinary urea nitrogen/total urinary nitrogen ratio was 0.77 ± 0.10 and was not significantly correlated with percent burn, age, or postburn day. Mean nitrogen balance calculated from measured urinary urea nitrogen in these patients was −5.7 g, and that calculated from measured total urinary nitrogen was −6.3 g. This difference, although statistically significant, is of little consequence for clinical use. Contrary to recent reports, we found the urinary urea nitrogen to be sufficiently predictive of total urinary nitrogen for practical application, and do not consider routine total urinary nitrogen measurements necessary for the nutritional care of thermally injured patients. (*Journal of Parenteral and Enteral Nutrition* 17:414–416, 1993)

The hypermetabolic response that follows burn injury is characterized by alterations in protein, carbohydrate, and fat metabolism. A constant feature of this catabolic state is increased protein degradation and urinary nitrogen loss. The multifactorial character of this metabolic response complicates nutrition assessment. Neither nutrition assessment indices such as serum protein levels1 nor anthropometric measures are reliable indices in burned patients. Nitrogen balance, reflecting the difference between nitrogen intake and output, is generally accepted as an appropriate basis for monitoring the nutritional status of such patients.

Estimations of total urinary nitrogen (TUN) made on the basis of measured urinary urea nitrogen (UUN) are widely used in calculating nitrogen balance in critically ill patients. TUN includes purine and amino acid nitrogen as well as urea; in the absence of injury, UUN accounts for 80% to 90% of TUN.2 In thermally injured patients, a correction factor of 25% (UUN × 1.25) is frequently used to estimate TUN from UUN.

The development of pyrochemoluminescence as an alternative to the Kjeldahl method has made clinical determination of TUN more practical.[7] On the basis of studies of the UUN/TUN ratio, some investigators have recently advocated replacing the estimation of TUN from UUN with direct measurement of TUN in postoperative and critically ill patients.[4,5] Loder et al[4] found a close relationship between UUN and TUN in preoperative patients but greater variation after surgery or stress. Konstantinides et al[5] found that mean UUN as a percentage of TUN fell within the expected range of 80 ± 12%, but observed a wide variance (12% to 112%) in the relationship and concluded that estimation of TUN from UUN is unacceptable for nitrogen balance studies after general surgery or trauma.

Certain studies in adult burn patients have suggested measured UUN does not accurately reflect TUN after burn injury and TUN should be directly measured, rather than calculated from UUN.[6,7] Konstantinides et al,[6] in a study of thermally injured patients, found that UUN represented approximately 65% rather than 80% of directly measured TUN, suggesting a need for direct TUN measurement.

The purpose of the present study was to determine whether UUN is sufficiently predictive of TUN in thermally injured patients, and to assess the clinical practicality of UUN and TUN measurements for nitrogen balance calculations.

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MATERIALS AND METHODS

Forty-five thermally injured patients admitted to this burn facility between June 19 1 and September 1992 had random 24-hour urine collections (n = 200) analyzed for UUN and TUN as part of routine nutrition assessment. Adult patients in the intensive care unit with indwelling urinary catheters were included in this study. Patients with hepatic or renal dysfunction were excluded. The demographic characteristics of these patients are summarized in Table I. Samples were obtained between 1 and 354 days after injury. UUN was analyzed by a coupled urease procedure (IL Monarch, Lexington, MA) and TUN by chemoluminescence (Antek Instruments, Houston, TX).

Estimated nitrogen intake included all intravenous, enteral, and oral sources, weighed and measured to the nearest milliliter and/or gram. Nitrogen loss by way of wound exudation was estimated according to a formula derived by Waxman et al[8] on the basis of the percent of open wound. In calculating nitrogen balances on the basis of UUN, predicted TUN was estimated by multiplying UUN by 1.25 to account for the nonurea component of urinary nitrogen. Fecal nitrogen loss was estimated as 2 g/d in all patients.

Regression analysis was used to evaluate the relationship between TUN and predicted TUN, and to evaluate the relationship between the UUN/TUN ratio and burn size, age, and postburn day. A paired *t* test was used to evaluate the difference between nitrogen balance calculated from UUN and that calculated from TUN.

RESULTS

The UUN and TUN results are summarized in Table II (n = 200). Regression analysis relating TUN to predicted TUN (UUN × 1.25) revealed a linear relationship (r = .936, $p < .001$) (Fig.1). The mean difference between measured TUN and predicted TUN was 0.68 ± 2.4 g. The mean UUN/TUN ratio was 0.77 ± 0.10 and was not significantly correlated with percent burn, age, or postburn day.

A regression analysis relating nitrogen balance calculated from UUN to that calculated from TUN revealed a strong linear relationship (r = 980, $p < .001$) (Fig. 2). The mean nitrogen balance calculated from UUN was

TABLE I
Patient demographics (n = 45)

Age (y)	40 ± 17
Sex (male/female)	39/6
Body surface area (m^2)	1.89 ± 0.22
Burn size (% body surface)	59 ± 28
Mortality (lived/died)	33/12

TABLE II
Urinary results (n = 200)

TUN excretion (g/d)	15.2 ± 6.8
UUN excretion (g/d)	11.6 ± 5.1
Calculated N balance (TUN)	–6.3 ± 12.6
Calculated N balance (TUN)	–5.7 ± 12.2
Postburn day of study	1–354
UUN/TUN ratio	0.77 ± 0.10

TUN, total urinary nitrogen; UUN, urinary urea nitrogen; N, nitrogen.

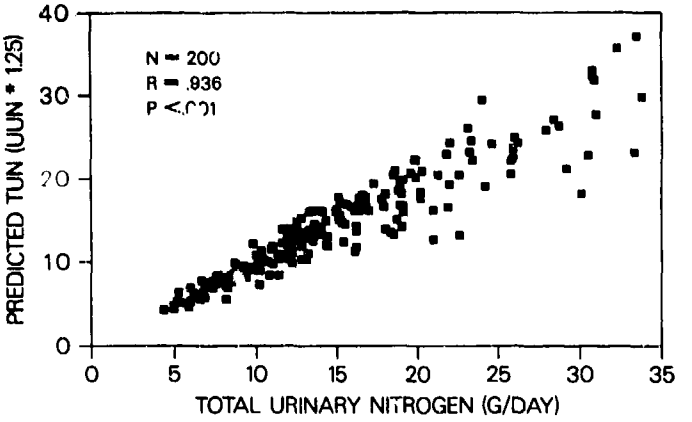

FIG. 1. Relationship of TUN to predicted TUN (UUN × 1.25).

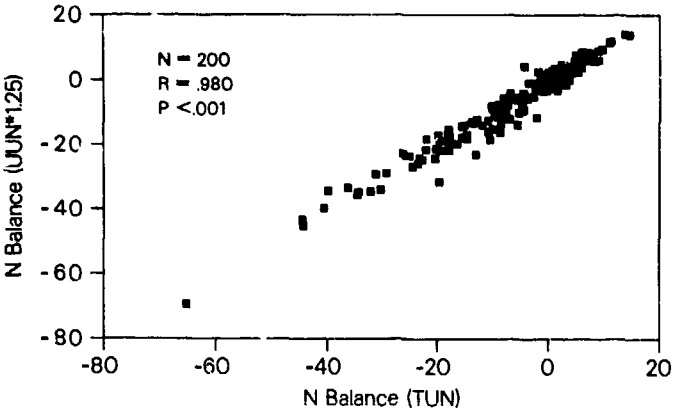

FIG. 2. Relationship of nitrogen balance calculated from TUN to that calculated from UUN.

–5.7 ± 12.2 g, and that calculated from measured TUN was –6.3 ± 12.6 g. This difference was statistically significant ($p < .001$, paired *t* test).

DISCUSSION

The limitations inherent in estimations of nitrogen balance must be considered in interpreting this study. All such studies are susceptible to errors in collection, in measurement, and in estimation of dietary nitrogen. In addition, high protein intake and/or high blood urea nitrogen may result in misleading analyses of nitrogen balance. Stool losses of nitrogen do vary, especially in patients with diarrhea, but are rarely measured. Burned patients sustain additional nitrogen losses through their open wounds; these, too, are usually estimated and not measured, because collection of wound exudate is often impractical.

Despite these limitations, nitrogen balance studies are widely accepted as a "gold standard" for nutrition assessment in thermally injured patients. Although not an exact indicator of nutritional adequacy, they offer a general guideline for nutrition support when used in conjunction with other variables such as weight and the relationship between caloric intake and measured or estimated caloric requirement. Although the mean nitrogen balances calculated from UUN and TUN in these patients differed statistically, the mean difference

TABLE III
Patient data (>7 g discrepancy in N balance)

Patient	Age (y)	Sex	% Burn	BSA (m^2)	Postburn day	N balance	
						UUN	TUN
1	31	Male	25.75	1.90	5	-19.6	-31.6
2	58	Male	28	2.12	18	-5.4	-13.8
3	53	Male	47	1.97	8	-13.0	-23.2
4	58	Male	60	1.8C	33	-8.6	-16.3
5	27	Female	85	1.65	14	-2.1	-11.6
6	40	Male	92	2.16	44	-10.4	-18.5

N, nitrogen; BSA, body surface area; UUN, urinary area nitrogen; TUN, total urinary nitrogen.

of 0.6 g is clinically irrelevant and did not alter nutrition therapy in these patients.

Occasional outliers were observed in these 200 determinations. Six nitrogen balance studies showed a difference of more than 7 g between calculations made on the basis of UUN and those made on the basis of TUN, the balance being more negative with TUN. These differences, which occurred in six different patients, all of whom survived, are summarized in Table III. In these patients, differences between 0 and 7 g were observed in the week before and the week after the studies listed in Table III, suggesting possible measurement error in the week in question.

Estimations of TUN made on the basis of UUN occasionally differ widely from direct measurements of TUN. This is anticipated, because both measurements are susceptible to error, and does not mandate direct measurement of TUN. The differences observed in this study between nitrogen balance calculations made on the basis of UUN and those made on the basis of directly measured TUN were statistically significant, but were too small to justify alteration of any nutrition support regimen and are therefore considered clinically irrelevant. Contrary to recently published reports, the results of this study do not justify routine measurement of TUN for postburn nitrogen balance studies. Although recent technology has made direct TUN analysis less expensive, less hazardous, and less time consuming than previous procedures, it is still more expensive and less accessible than UUN analysis, which is available in most clinical settings. UUN results are available almost immediately as compared with direct TUN results, which may take longer to obtain. Accessibility, lower cost, and satisfactory accuracy make UUN a more practical approach to the nutrition assessment and treatment of burned patients.

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