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Kidney Function Tests in Chronic Renal Disease

Serum Urea Nitrogen, Creatinine, and Creatine Clearance

Roy B. Patton, M.D., and Donald Remp, Ph.D.*

Quantitative measurement of kidney function in patients with chronic renal disease is necessary in order to evaluate the effect of therapy and to offer a prognosis. This brief report discusses and compares three common laboratory tests of renal function. The three are: 1) serum urea nitrogen (commonly called blood urea nitrogen or BUN), 2) serum creatinine and 3) creatinine clearance ($C_{cr}$).

The first of these, blood urea nitrogen, is the most frequently requested chemical test for estimating kidney function. Urea is quite soluble in water and is present in all body fluids. Its concentration is slightly higher in plasma than in red cells because the content of water as compared to solids is greater in plasma than in red cells. Normal plasma or serum urea content ranges from 17 to 54 mg per 100 ml. This is equivalent to serum urea nitrogen content of 8 to 25 mg per 100 ml and will be recognized by clinical physicians as the normal range of "blood urea nitrogen." One part of this term "blood urea nitrogen" is erroneous and another part outmoded. The specimen in which urea is most commonly determined today is serum or plasma, not blood. Thus, the B in BUN is in error, and for it should be substituted S for serum. The outmoded part of the term BUN is N for nitrogen. Currently no logic or rationale supports expressing urea content in terms of its nitrogen. Formerly physiologists and biochemists were preoccupied with nitrogen as a biologic substance and with nitrogen balance studies. This emphasis on nitrogen plus some features of urea methodology of that time led to the custom of expressing urea concentration in terms of its nitrogen. Now the term BUN, although partly erroneous and outmoded,

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is firmly fixed in medical minds in the United States and probably cannot be eradicated. In Europe, however, urea concentration is sensibly expressed as urea and not as urea nitrogen. This can lead to misunderstanding and confusion unless the difference is recognized. The molecular weight of urea is 60, of which nitrogen accounts for 28. Therefore, a urea concentration of 60 mg per 100 ml equals a urea nitrogen concentration of 28 mg per 100 ml. To convert, multiply urea nitrogen concentration by 2.14 to obtain equivalent urea concentration, and multiply urea concentration by .47 to obtain equivalent urea nitrogen concentration.

Of the three tests under discussion serum urea nitrogen (SUN) is much more often liable to variation from nonrenal causes than are serum creatinine and creatinine clearance. Elevations of SUN are caused by factors that reduce urine flow, such as dehydration, sodium depletion, and urinary tract obstruction, and by gastrointestinal hemorrhage. Values may be low but are rarely abnormal in liver failure and in pregnancy.

Plasma creatinine concentration is very slightly affected by the factors that can cause gross changes in the urea concentration. Serum creatinine may not be elevated in patients with acute renal disease, but it is elevated when kidney disease is chronic. Conversely, in patients with elevated serum creatinine the cause is almost certainly due to kidney disease.

Endogenous creatinine clearance (C_{cr}) is a simple clearance test that tells more about renal function in chronic renal disease than either the serum creatinine or SUN. Failing kidneys do not cause a rise in blood urea until renal capacity is reduced to 25-30% of normal. In some patients serum creatinine is normal when the creatinine clearance is reduced to 50% or less of normal. Conversely, marked elevation of serum creatinine or urea nitrogen is not always associated with severely reduced renal function although, again, the serum creatinine more closely parallels kidney functional capacity than does SUN. C_{cr} provides more reliable prognostic information than do the other two tests. Patients with clearance rates of 10% or less of normal usually survive for six months or less.

Measurement of C_{cr} requires a 12- or preferably 24-hour collection of urine and a venipuncture for determination of serum creatinine. Urinary creatinine concentration is measured and urine volume is obtained. Clearance is calculated from the following formula:

\[ C_{cr} = \frac{U}{S} \cdot V \]

in which \( C_{cr} = \) creatinine clearance in ml/min

\[ U = \text{urine creatinine in mg/100 ml} \]

\[ S = \text{serum creatinine in mg/100 ml} \]

\[ V = \text{urine volume in ml/min} \]
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The normal range at Henry Ford Hospital is 100-140 ml/min. Clearance rate in terms of ml/min should be converted by reference to a nomogram to ml/min per 1.73 square meters body surface, since volume of plasma cleared depends on the size of the individual. When expressed in terms of body surface a frequently quoted normal range is 80-120 ml/min per 1.73 square meters.

Of the three tests discussed creatinine clearance gives the most precise and reliable information about renal function. This test also provides a rough prognostic guide. Serum creatinine elevations are almost always due to kidney disease whereas serum urea nitrogen may be elevated by any of several nonrenal factors. In patients with chronic renal disease, serial measurements of serum creatinine or serum urea nitrogen do not reliably provide useful prognostic information.

REFERENCES

