EXTRACELLULAR VOLUME AND EXCHANGEABLE SODIUM IN CHRONIC HYPERTENSIVE RENAL DISEASE

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It has been observed that even severe hypertension can be controlled in patients with end stage kidney disease by hemodialyses and removal of sodium and water (1, 2). In non-dialized ambulatory patients with renal insufficiency and hypertension satisfactory control of blood pressure is often accomplished by restricting dietary sodium. It is the purpose of the present study to investigate the role of the extracellular fluid volume (ECV) and the amount of exchangeable sodium (Na\textsubscript{e}) in the control of blood pressure in such patients, and to determine whether reduction of these parameters below normal is necessary to attain blood pressure control.

METHODS

The volume of distribution of radioactive Br\textsuperscript{82} was used to represent ECV and radioactive Na\textsuperscript{24} was used for the determination of Na\textsubscript{e}. 15 \mu c of Br\textsuperscript{82} and 40 \mu c of Na\textsuperscript{24} were administered simultaneously in an intravenous injection. Radioactivity was measured in plasma samples after 24 hours, and correction was made for urinary excretion. For counting the two isotopes were separated easily and completely with an anion exchange resin. The results of ECV and Na\textsubscript{e} were expressed in relation to lean body mass (LBM) as estimated by the method of Edwards and Whyte (3). Their formula incorporated measurements of body weight (BW), height (h) and the thickness of double folds of skin and subcutaneous fat (SFT = skinfold thickness):

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LBM = BW \cdot 0.87 - \frac{SFT \cdot h^2}{1000} \cdot 0.09 + 3.04
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RESULTS

ECV and Na\textsubscript{e} were first determined in a group of healthy control subjects, 4 men and 6 women, 23 to 45 years old, with weights between 40 and 87 kg. There was a very close correlation of ECV and Na\textsubscript{e} to LBM, as shown in Figure 1a and 1b. The regression lines were fitted to the experimental data by the method of least squares, the outer diagonal lines enclose the 95% confidence limits which in these studies was used as the normal range.

Next a group of 8 ambulatory patients with chronic renal disease was studied. It consisted of 4 men and 4 women, 28 to 60 years old. Kidney function was markedly decreased in all with creatinine clearances ranging from 4 to 25 ml./min. Before treatment 7 of them had had hypertension with blood pressure values of 180-220/110-130 mm. Hg. They were mainly treated by restricting sodium intake to 0.5 to 2 g./day (with the exception of the patient without hypertension who was salt wasting and needed salt supplements). In addition, 2 patients were receiving minimal doses of Guanethidine, 10 mg. every other day and 10 mg. every day. With this regimen blood pressure was well controlled with values in the range of 145-170/95-100 mm. Hg. At this time ECV and Na\textsubscript{e} with but one exception were within or above the normal range (Figure 2a and 2b). Thus satisfactory control of blood pressure was attained without reducing ECV and Na\textsubscript{e} below normal.

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The second group that was studied included patients with end stage kidney disease. It consisted of 4 men and 2 women, 25 to 45 years old whose renal function was severely damaged, with creatinine clearances ranging from 0 to 2 ml./min. All patients were maintained on periodic dialysis once or twice a week and on this treatment were able to lead a fairly normal life and to work. They were eating a diet containing 0.5 to 2 g. of sodium/day and no patient received any drug treatment. Prior to each dialysis their blood pressure was usually moderately elevated with values of 150-185/100-115 mm. Hg. and ECV and Na\textsubscript{e} were generally increased despite the lack of clinical evidence of fluid retention. With dialysis fluid removal and weight loss occurred and ECV and Na\textsubscript{e} decreased to normal but not below (Figure 3a and 3b). At this time, i.e. after dialysis blood pressure was found to be essentially normal, the values ranging from 120 to 140/75 to 90 mm. Hg., except for one patient with a blood pressure of 150/110 mm. Hg.

CONCLUSION

It was possible to control blood pressure adequately in the patients with hypertensive chronic renal disease described in this study. This goal was achieved by dietary sodium restriction or sodium and volume removal by dialysis. One question raised by this experience was whether in this process ECV and Na\textsubscript{e} had to be depleted. Measurements of ECV and Na\textsubscript{e} presented in this paper support the fact that blood pressure control was attained without reducing these parameters below normal.

REFERENCES

Figure 1a and 1b. The relation of ECV (in liters) and Na\textsubscript{e} (in milliequivalents) to LBM in 10 normal control subjects. The center lines are expressed mathematically in the regression equations, the outer diagonal lines enclose the 95% confidence limits and represent the normal range.

Figure 2a and 2b. ECV and Na\textsubscript{e} in non-dialyzed patients with chronic kidney disease. The normal range is defined by the 2 diagonal lines.
Figure 3a and 3b. ECV and Na\textsubscript{e} in patients with chronic kidney disease on dialysis before and after treatment. The 2 enclosed circles not connected by arrows represent patients studied only after dialysis.