POSTDIALYTIC CHANGES IN SERUM OSMOLARITY AND IN BLOOD UREA OF 23 PATIENTS

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PATIENTS in chronic renal failure, and to a lesser extent those in acute renal failure, may have a relative decrease in urinary output after treatment with the artificial kidney. It has been suggested that the cause of this postdialytic "oliguria" may be due to a decrease in osmotic load. We know of no study that substantiates or refutes this thesis, and therefore undertook to investigate a possible correlation between postdialytic changes in urinary output and in osmolarity of serum.

Methods and Material

Twenty-three patients in different stages of acute and chronic renal failure were treated with twin-coil disposable artificial kidneys for a total of 64 dialyses. Before and after each dialysis, samples of blood were taken for standard laboratory tests and to determine the osmolarity of the serum. For control purposes, 24 samples of blood were taken from normal blood donors for determinations of osmolarity of the serum. Determinations of concentrations of sodium, chloride, bicarbonate, and urea in the serum, and of hematocrit readings were performed in our hospital laboratory under the supervision of John W. King, M.D., Ph.D., and Willard R. Faulkner, Ph.D.

Osmolarity of serum was determined with the Fiske osmometer, which operates on the physical principle that both the osmotic pressure of a solution and the depression of the freezing point of the solvent are directly proportional to the molecular concentration of the dissolved substance (the total ion and molecular counts in the case of ionized solutions). The osmometer measures the depression of the freezing point, but is calibrated to read in units of osmotic pressure directly in milliosmols per liter. Prior to every determination, the osmometer was standardized with a solution of 300 m-osM. of sodium chloride per liter in water.

Results

After dialysis, with few exceptions, there was a change toward normal of the individual values for osmolarity, sodium, chloride, and bicarbonate in the serum, and in the hematocrit readings. The 64 dialyses are classified into four groups

according to the changes in serum osmolarity after treatment: Group A—serum osmolarity increased in a range of slightly above 0 to 18 m-osM.; Group B—it decreased in a range of slightly less than 0 to -10 m-osM.; Group C—it decreased in a range of -10 to -20 m-osM.; and Group D—it decreased more than 20 m-osM.

Figure 1 is a graph of the changes in serum osmolarity before and after the dialyses. It is evident that the greatest decreases occurred in those patients who had extremely high osmolarities prior to dialysis. During the day of, and on the day after dialysis, decreases in average urinary output occurred in every group. The magnitudes of the decreases were not correlative with changes in osmolarity. Invariably, on the second day after dialysis, urinary output had attained the pre-dialytic volume.
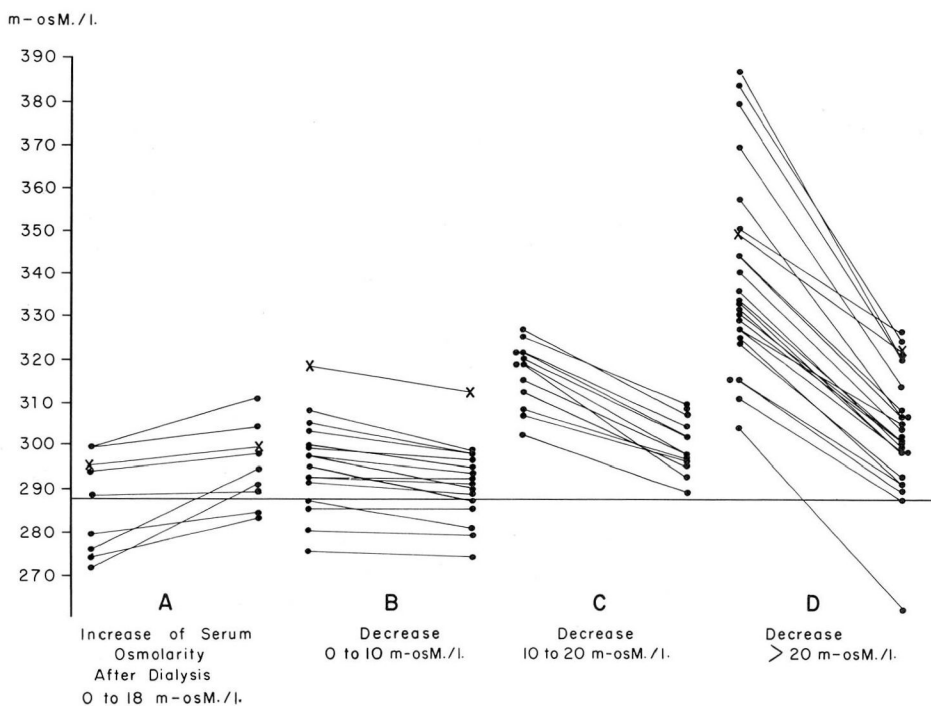

Fig. 1. Graph showing changes in serum osmolarity before and after 64 dialyses (the horizontal line represents the average normal serum osmolarity). In the three cases indicated by X at the beginning and X at the end, urea was added to the dialyzing (bath) fluid.

If the decrease in osmolarity of serum is effected mainly by a decrease in blood urea, then a graph of the values would define a straight line; we obtained such a general, but crude, correlation *(Fig. 2)*. A number of cases fall outside the
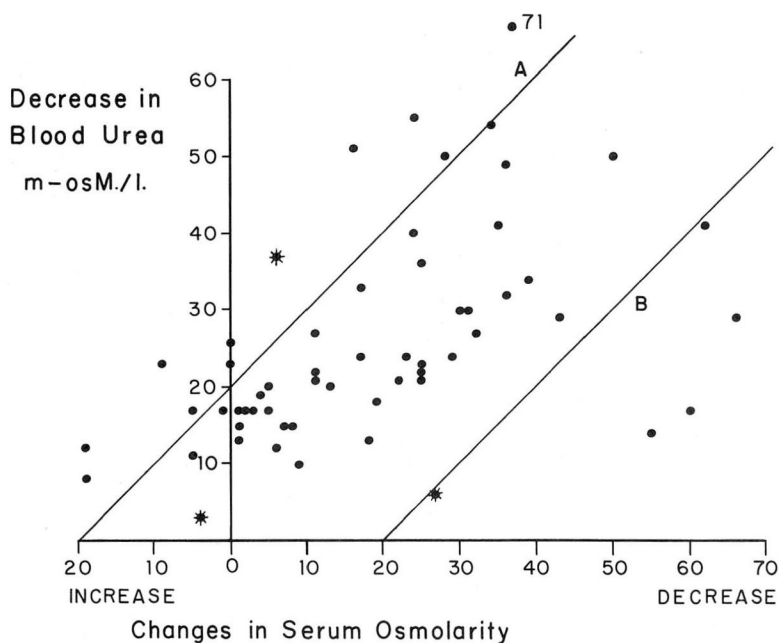

Fig. 2. Graph showing decreases in blood urea and changes in serum osmolarity. There is a crude correlation between change in blood urea and change in osmolarity. The points above line A and below line B are discussed in *Figures 3* and *4*. The three cases in which urea was added to the bath are indicated by asterisks.

limiting lines of A and B, indicating that in these cases there is no correlation between serum osmolarity and the change in blood urea. The points above line A represent a decrease in blood urea but only a relatively small decrease in serum osmolarity. When in these cases the decrease in blood urea was plotted against the combined increase of the concentrations of serum sodium, serum chloride, and serum bicarbonate, it was evident indeed that a large increase in this sum had occurred up to 40 mEq. per liter *(Fig. 3)*. Similarly, a relatively small reduction in blood urea associated with a large decrease in serum osmolarity (points under B in *Fig. 2*) may be explained by a decrease in the sum of the concentrations of sodium, chloride, and bicarbonate in the serum; decreases in the sums were as much as 28 mEq. per liter *(Fig. 4)*. One case did not conform to this relationship.
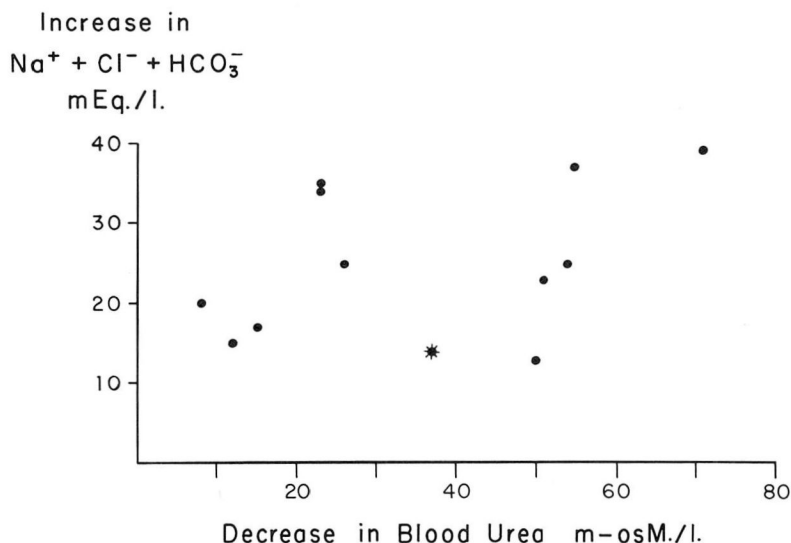
Increase in
Na$^+$ + Cl$^-$ + HCO$_3^-$
m Eq./l.

Fig. 3. Graph showing increases in the sums of serum sodium, chloride, and bicarbonate in the cases in which there were large decreases in blood urea but relatively small decreases in serum osmolarity. The asterisk indicates that urea was added to the bath.

Decrease of
Blood Urea

m−osM./l.

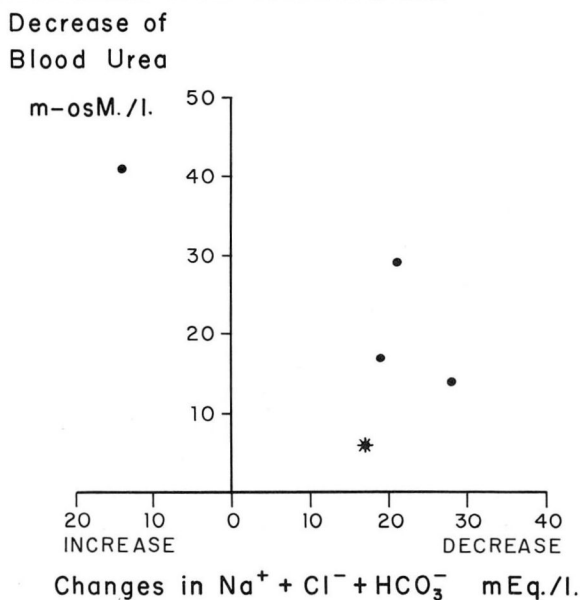Changes in Na$^+$ + Cl$^-$ + HCO$_3^-$ m Eq./l.

Fig. 4. Graph showing decreases in the sums of serum sodium, chloride, and bicarbonate in four cases in which there were relatively small decreases in blood urea with large decreases in serum osmolarity. The asterisk indicates that urea was added to the bath.

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Summary

Osmolarity of serum was determined in samples of blood from 23 patients before and after 64 dialyses. Dialysis may result in large, small, or minimal decreases in serum osmolarity, and even an increase. Most frequently there was a decrease in serum osmolarity, generally correlative with a decrease in blood urea. Discrepancies in the correlation between decrease in serum osmolarity and decrease in blood urea can usually be explained by increases in the sums of serum sodium, serum chloride, and serum bicarbonate concentrations in the opposite direction.