

each type of depletion be treated separately. Discussion of electrolytes other than NaCl is also avoided in this paper, although it is understood that simple NaCl therapy is frequently incomplete electrolyte therapy.

SUMMARY

It is suggested that the loose term "dehydration" be substituted by its physiologic components: "primary water depletion," "primary salt depletion," and "mixed water and salt depletion." The physiologic basis for this recommendation is presented as well as the reasons for using urine salt (measured as chloride) concentration and urine volume instead of plasma chloride concentration as a guide to the diagnosis and treatment of these various types of dehydration. An experimental study of volunteer subjects is presented in support of this recommendation.

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DISCUSSION.—DR. I. S. RAVDIN, Philadelphia: These studies represent the type of work which is necessary to provide a clearer knowledge of the fluid and electrolyte requirements of surgical patients. In adopting Marriott's classification which divides dehydration into two conditions that differ in cause in physiologic and chemical effects,

and in the treatment needed, they have provided a more rational concept of the problem of dehydration and they have further strengthened our thinking by calling these conditions "primary water depletion" and "primary salt depletion." Anyone who has attempted to study the shifts in fluids and electrolytes in man, in health and in disease, knows that most of the methods now being utilized provide meagre data on what is happening in the body as a whole, and in the specific compartments which go to make up the whole. The part which the normal kidneys play in their effort to maintain isotonicity of the plasma and interstitial fluids was stressed some years ago by James Gamble and his associates. It should be recognized that urinary analyses such as Dr. Evans and Dr. Van Slyke are making are particularly useful when the kidneys are normal. The conditions initiating primary water and/or salt depletion, however, frequently result in a variable degree of renal injury, as Dr. Campbell and Dr. Collier and their associates have shown. Under such conditions, the authors have rightly pointed out that the urine may not correctly indicate the internal conditions of salt and water content. In the seriously ill surgical patient, abnormalities in glomerular infiltration, tubular secretion and absorption, exist all too frequently. It is in these patients that the excretion of an apparently normal urinary volume may be associated with marked abnormality in base, chloride and other electrolyte excretions. Under such circumstances it may be far better to be very cautious in the administration of large amounts of fluid or salts, as Dr. Collier pointed out in his discussion. This is especially true in nephrosclerosis or in kidneys subjected to periods of anoxia. It may be better to keep the patient in a state of mild hypochloremia than to risk the untoward effects of the burden which the opposite state may impose on the patient.

There remains much to be learned about the function of the kidneys in health and in disease, of the effect of the different renal components on various salts and especially such salts as potassium salts and calcium salts. In certain conditions there is generalized renal impairment, but tubular and glomerular dysfunction are not necessarily impaired to the same degree. The entire picture may be further complicated by abnormalities in plasma protein; for in severe hypoproteinemia there is apt to be specific sodium retention. Studies of the type reported in the last two papers facilitate greatly our thinking upon the problems of renal and will, we hope, provide a more rational basis for parenteral fluid and salt therapy in surgical patients.

DR. JOHN H. GIBBON, JR., Philadelphia: I think Dr. Collier's warning that patients with anuria should be kept on the "dry side," merely replacing insensible water loss, is a very important one. Kolff of Holland, who developed an apparatus for the dialysis of blood outside the body, is in hearty agreement with this point of view. These patients will often recover provided they are not drowned by excessive amounts of intravenous fluid and provided the acid base equilibrium is maintained. I think the observation on the great loss of salt and water which occurs during the period of diuresis, is very interesting.

Drs. Evans and Van Slyke are to be congratulated on a beautiful piece of work in carrying out experiments on normal human subjects and presenting us with a very practical test for determining what we all want to know at the bedside, i.e., whether we should give a patient salt solution, or glucose and distilled water, intravenously.

DR. KENNETH N. CAMPBELL, Ann Arbor: This paper brought out extremely important factors which Dr. Van Slyke did not have time to emphasize. The first of these is the fallacy of basing therapy on a laboratory value. May I give very concrete examples: I speak particularly of laboratory values for plasma chloride. If we take the normal plasma volume at 3000 cc., and order a plasma protein determination from the laboratory that comes back some 7 Gr. per cent, that would give us a total circulating protein in our plasma of some 210 Gm. Now, if perchance that individual did not have a normal plasma volume, let us say he had been subjected to dehydration or to plasma loss from some other cause, we might receive back from

the laboratory a plasma protein value of eight grams per cent at a time when the plasma volume was not 3000 cc. but 2000 cc. With simple arithmetic that will tell you that we now have only 160 Gm. of total circulating protein and not 210. Our laboratory value is higher, it is better than the example I gave you previously, and may lead one very erroneously into assuming that that patient has a normal total circulating protein. Similar changes may occur obviously in determinations of chlorides.

We are very happy to hear of the experimental work that Drs. Evans and Van Slyke have reported concerning the interpretation of plasma chloride values. They have simplified it to its utmost on a rational basis.

I will finish by saying something about volume for volume replacement which we have heard so much about in the past. If one institutes gastric or intestinal drainage and replaces volume for volume the secretions obtained with the solutions we now have available, and we call those normal physiologic solutions—when they are not either normal nor physiologic—you may be replacing approximately twice the amount of salt that you are withdrawing from your intestinal or gastric drainage.

DR. E. I. EVANS, Richmond, Va. (closing): We should like first to thank Dr. Ravdin for his comment. I should like then to say that I was much impressed by the remarks made by our President this morning about teaching surgery to medical students. I refer to this now because of what we have learned by placing in the hands of the medical student this simple bedside urine chloride technic, so that they may follow their patients day by day and learn thereby the fundamentals of fluid balance and salt therapy. We get almost every week requests from new groups of students on the ward for these little laboratory bedside kits so that they can run urine chlorides on their own patients. It is gratifying for a teacher to learn how easy it is to get a little idea across once a year or so.

Third, I am happy that Dr. Lockwood brought up the important point potassium deserves in his reference to Dr. Darrow's work. It is rather interesting in observing cycles of surgical research how often different groups become interested in the same type of thing at about the same time. We are following with interest what Dr. Lockwood's group is doing. We have come to similar conclusions and have learned a great deal from Dr. Darrow's presentations.

It is well here to call attention to the extreme danger of giving adrenal cortical hormone to those surgical patients who are suffering from hypochloremic alkalosis. We have learned that one cannot correct this alkalosis by administration of salt or Ringer solutions if at the same time one is administering even small amounts of adrenal cortical hormone.

About the "dry" side. We agree, Dr. Campbell, with everything you say, but I cannot sit down without emphasizing again, be "dry" on the side of sodium chloride or water, but don't be "dry" on the side of whole blood when it is needed.