Plasma Electrolyte Concentrations in Ambulatory Cardiac Patients

By Neal S. Bricker, M.D., and Laurence G. Wesson, Jr., M.D.

The authors find that electrolyte concentrations of the plasma of the more severely ill cardiac patients attending two outpatient clinics are statistically indistinguishable from controls. They note, however, a slight tendency to metabolic alkalosis and occasionally a mild hyponatremia. No instance of "low salt syndrome" was found.

The existence of abnormal concentrations of plasma electrolytes in many patients with chronic congestive heart failure has long been recognized. In particular the plasma sodium concentration is frequently depressed and the plasma bicarbonate concentration either elevated or depressed with the chloride moving reciprocally to the bicarbonate. Two papers1,2 have shown that these abnormalities are virtually absent in untreated, hospitalized patients.* By implication, treatment is the factor, additional to complications attendant upon impaired cardiac function, which results in hyponatremia and acidosis or alkalosis. The effect of acidifying salts tending to produce metabolic acidosis appears evident, and, if we accept, hypothetically, a tendency of mercurial diuretics to promote the excretion of a bicarbonate-free chloride-rich urine, then the production of metabolic alkalosis by mercurials is understandable. The correlation between hyponatremia and measures designed to effect sodium depletion appears to be close, although the physiologic mechanisms involved in the production of the hyponatremia have not yet been elucidated.

It is the aim of the present paper to delineate further the group of patients with congestive heart failure within which these plasma electrolyte abnormalities occur. Previous studies have dealt with hospitalized patients. Hospitalized patients are heavily weighted, statistically, in two directions: they represent the most severely ill; and they are the most intensively treated. The patients upon whom studies are presented in this paper were drawn entirely from outpatient clinics. All were capable of limited ambulation. Electrolyte abnormalities occurred but they were few and relatively small. From this we conclude that the severity of heart disease consistent with nonhospitalization, when combined with the intensity of edema control measures attainable in an outpatient clinic, is insufficient to produce electrolyte abnormalities of the degree observed frequently in hospitalized patients. The details of this study are recorded below.

Material and Methods

Patients were selected from two hospital outpatient cardiac clinics between February and June, inclusive, 1952.† The group is not representative of the clinic population, since the more seriously ill and more intensively treated were preferentially selected. A cardiovascular history and physical examination was taken on each patient as a basis for cardiac classification. The principle cardiac diagnoses were arteriosclerotic heart disease in 55 per cent, rheumatic heart disease in 23 per cent, hypertensive heart disease in 13 per cent, with 9 per cent miscellaneous. In addition, each patient was questioned for dietary salt intake and for the occurrence of symptoms of the "low salt syndrome." A single, heparinized venous specimen was drawn for determination of plasma sodium, potassium, chloride, bicarbonate and creatinine. On a few patients, two

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* These papers may conveniently be consulted, for careful reviews of the literature on this subject.
Table 1.—Statistical Data on 91 Ambulatory Cardiac Patients Grouped According to Intensity and Principal Method of Edema Control. (See Text for Detailed Description)

<table>
<thead>
<tr>
<th>Group</th>
<th>Cardiac Classification*</th>
<th>Men</th>
<th>Women</th>
<th>Age</th>
<th>Plasma Concentration†</th>
<th>Creatinine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per cent</td>
<td></td>
<td></td>
<td></td>
<td>Sodium</td>
<td>Potassium</td>
</tr>
<tr>
<td>Control</td>
<td>IIB—37</td>
<td>28</td>
<td>14</td>
<td>61</td>
<td>141 ± 4</td>
<td>4.3 ± 0.2</td>
</tr>
<tr>
<td></td>
<td>IIC, D—40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low salt</td>
<td>IIB—25</td>
<td>11</td>
<td>4</td>
<td>63</td>
<td>139 ± 4</td>
<td>4.4 ± 0.3</td>
</tr>
<tr>
<td></td>
<td>IIC, D—63</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercurial</td>
<td>IIC, D—90</td>
<td>9</td>
<td>0</td>
<td>63</td>
<td>143 ± 5</td>
<td>4.3 ± 0.4</td>
</tr>
<tr>
<td>Low salt-mercurial</td>
<td>IIC, D—100</td>
<td>12</td>
<td>13</td>
<td>60</td>
<td>142 ± 5</td>
<td>4.4 ± 0.4</td>
</tr>
</tbody>
</table>

* Miscellaneous classifications are omitted.
† Means and standard deviations for all determinations within each group.

Fig. 1. Frequency distribution of plasma sodium, bicarbonate and creatinine concentrations in ambulatory cardiac patients. The patients are divided into four groups according to the predominant type of treatment. See text for details.

or three additional specimens were drawn on return visits to the clinic.

Patients were classified in four groups according to the amount of dietary salt restriction and the frequency of mercurial (Mercurydrin) injections. Group I (control) received a mercurial injection once weekly or less often, and salt restriction was limited to dispensing with salt at the table. Group II (low salt) received a mercurial as in group I, but salt restriction was more intensive. Salt was omitted from cooking and the diet emphasized low-salt or salt-free foods. Group III (mercurial) received 2 cc. injections of Mercurydrin intramuscularly twice weekly or oftener, but salt restriction was no more intensive than in group I. Group IV (mercurial-low salt) restricted dietary salt as in group II and received mercurial injections as in group III. A few patients in all groups were taking 2 or 3 Gm. of ammonium chloride daily, but the effect of this dose was not evident in their chloride or bicarbonate values. Additional data on these four groups is summarized in table 1.

Sodium and potassium were determined on a Barclay flame photometer, using an internal lithium standard; bicarbonate, as the carbon dioxide content of air-equilibrated plasma, by the method of Van Slyke and Neill; chloride by the method of Van Slyke and Hiller; creatinine by the method of Bonsnes and Tauskey.

Observations

The mean values of the plasma sodium, potassium, chloride, bicarbonate and creatinine for each group are given in table 1. In none of the groups do these values differ significantly from those of the controls. The proportionate distribution of plasma sodium, bicarbonate and creatinine values within each group is illustrated in figure 1. Although the “treatment” groups are far too small to give smooth distribution curves, it is evident that they differ from the control in the following respects. Plasma bicarbonate is frequently elevated, but no more frequently in the mercurial groups than in the low salt group. An elevated plasma
creatinine, suggesting a depressed rate of renal glomerular filtration, was observed frequently in the groups receiving mercurial diuretics. No correlation could be observed, however, between plasma creatinine and the presence or degree of edema. One patient in the mercurial-low salt group was hyponatremic. On two successive clinic visits, her plasma sodium was 130 and 127 mEq. per liter; she had marked edema of the legs and her plasma creatinine was 2.1 mg. per 100 ml. However, she had no symptoms consistent with a "low salt syndrome."

Many patients reported leg cramps and occasionally nausea following the injections of the mercurial diuretics, but these reports could not be correlated with any abnormality of plasma electrolyte or creatinine.

Plasma chloride showed a slightly greater incidence of low values in the "treatment" groups compared with the controls. The distribution of plasma potassium values was the same in all groups.

Conclusions

It is concluded that electrolyte abnormalities occur in ambulatory, nonhospitalized cardiac patients but that such abnormalities are probably less frequent and less marked than among hospitalized patients. The data give no information regarding the relationship of treatment to electrolyte disturbances since all patients with congestive heart failure of more than a few months' duration were receiving therapy.

**SUMARIO ESPAÑOL**

Los autores encuentran que las concentraciones de electrolitos en los pacientes cardíacos más enfermos en dos clínicas para pacientes ambulatorios son estadísticamente idénticas a las de controles. Notaron sin embargo una lige a tendencia a alcalosis metabólica y ocasionalmente una leve hiponatremia. Ningún caso del sindrome de deficiencia de sal se encontró.

**REFERENCES**


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