We might appropriately conclude this report with a comment of Graydon Hume: "The serious and relentless nature of optic atrophy associated with the late stages of syphilitic infection, justifies one in attacking the disease by a route which has added risks."

---

CALCIUM AND POTASSIUM CHLORIDES IN THE TREATMENT OF ARTERIAL HYPERTENSION

W. L. T. ADDISON, B.A., M.D., AND H. G. CLARK, M.B.

Toronto

In the issue of the Journal of the Canadian Medical Association for November, 1924, W. L. T. Addison reported the results obtained by calcium chloride therapy in fourteen cases of arterial hypertension. Since that time further clinical work has been done in the out-door department of the Toronto General Hospital.

After our cases had been thoroughly examined and given the usual dietary treatment by the out-door clinic for a month's time, they were turned over to the clinic for cases of arterial hypertension, and depending upon their weight, were given from ninety to 180 grains of calcium chloride per diem, in the following prescription:

<table>
<thead>
<tr>
<th>Prescription</th>
<th>Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcii Chloridi</td>
<td>5 ii</td>
</tr>
<tr>
<td>Tinctura Cardamomi Comp.</td>
<td>5 i</td>
</tr>
<tr>
<td>Syrupi Simplicis ad</td>
<td>5 viii</td>
</tr>
<tr>
<td>Misce et Signa</td>
<td>Two to four drachms in water three times daily after meals</td>
</tr>
</tbody>
</table>

Blood pressure readings were taken weekly. If at the end of a month's time no fall in pressure occurred, potassium chloride was substituted for calcium chloride in the same doses. When a fall in pressure occurred and was maintained, a clinical test was made to see if the salt were the active agent or not. All treatment was stopped for one or two weeks; any rise in pressure was noted and afterward the treatment was continued again. Many of our cases were so tested many times.

Results Obtained.—These reports deal with forty-five consecutive cases of hypertension, some from the clinic of the hospital and some from the private practices of the writers and of Dr. H. B. Lane who assisted in the work. Three cases reported were in-door hospital cases, in none of which were positive results obtained. Hospital cases as a rule are in a much more advanced stage of kidney, arterial, and cardiac degeneration than are those seen in general practice. We did not expect and did not get as striking results in the former as in the latter for that reason. All cases had an initial systolic pressure of 170 mm. of mercury or over. Some ranged as high as 262. The diastolic pressures ranged from eighty-four to 152. The ages were from twenty-eight to ninety-one. Individuals in whom both kidneys were apparently normally functioning and cases in all stages of kidney destruction up to those diagnosed as end-stage interstitial nephritis were encountered. Only those cases were considered as reacting in whom the salt given reduced the systolic pressure thirty or more mm. and maintained it there, and kept the diastolic pressure twelve or more mm. lower than the initial reading. Of the forty-five cases twenty-six or 57.7 per cent. reacted with calcium chloride (Chart 1), and six or thirteen per cent. with potassium chloride, making in all 70 per cent. As explained above only those cases in which there was no result with the calcium salt were given potassium chloride (Chart 2). Not only was the blood pressure reduced but the patients felt decidedly better. As found by Blum and his co-workers, edematous cases lost their edema. The effect of the salt was considerably better during the summer than in the winter. Five patients whose pressure remained satisfactorily low during the warm weather of 1924,
promptly showed a rise in systolic and diastolic pressure with the advent of cold weather in November, and in one case with a fatal result. Conversely the warmer weather during April of this year has begun to produce marked improvement in these and other patients. The effect of cold is probably a protecting vaso-constriction, an action antagonistic to that of the salts on the blood pressure and, as seen, one more or less over-riding them.

The main objections to the giving of calcium chloride are the gastrointestinal upsets. The taste of the salt is very unpleasant, and difficult or impossible to disguise. Various gastric symptoms may be produced such as belching of gas, or in patients with sensitive stomachs even vomiting. To follow the dose with a glass of milk or buttermilk will considerably relieve this distress. In warm weather diuresis is promptly set up, but in so far as we know this does no harm to the kidneys. Bowlers and Walters discuss the examination of sections of dogs' kidneys after the animals had received repeated intravenous injections of calcium chloride. No evidence of damage was found. The calcium chloride produces, however, an inorganic acidosis, which, though not greatly dangerous, must be seriously considered. On no account should a patient take these salts without the guidance or direction of his physician. One passing observation may be detailed: a patient, age eighteen, with normal blood pressure and kidneys, was given 145 grains of calcium chloride per day for another condition, and he developed a distinct cyanosis on any dose over sixty grains. This, however, was the only case showing such symptoms.

**Chemistry of Calcium Chloride.**—The action of calcium chloride is mainly attributable to the chlorine ion. Of eighteen cases in which the blood calcium was estimated, only one showed a reduction below the usual 10 mgm. per 100 cc. of blood. According to Haldane 90 per cent. of the calcium ingested is excreted in the faeces as calcium carbonate and calcium phosphate and the balance by the kidneys. The Cl ion is then free to substitute the CO₂ in the blood stream in accordance with the equation: CaCl₂ + 2 Na HCO₃ = Ca CO₃ + 2 NaCl + CO₂ + H₂O. Haldane gives the urinary excretions roughly as follows in percentage of normal: ammonia 500 per cent., phos-

**Chart 1, Showing Effect of CaCl₂ on Hypertension**

A case showing marked susceptibility to CaCl₂ after a month's treatment.

S.—Treatment discontinued.

T.—Treatment re-started.

The very low figures could be obtained in twenty-four hours in warm weather.

**Chart 2, Showing the Effect of KCl on Hypertension**

A typical chart showing no result with CaCl₂ but a good result with KCl.

A.—CaCl₂ started.

B.—KCl started.

C.—KCl discontinued.

D.—KCl restarted.

phate 200 per cent., chlorine 200 per cent., sodium 250 per cent. The alkali reserve is appreciably diminished and the blood calcium slightly raised. The action of ammonium chloride is essentially similar to that of calcium chloride. The ammonia is absorbed with the chlorine, but is destroyed by the liver and helps to form urea, thus freeing the chlorine which unites with the blood alkali: 2 NH₄ Cl + 2 Na HCO₃ = CON₂ H₄ + 2 Na Cl + 3 H₂O + CO₂. Ammonium chloride has been tried in our cases but it is even more nauseating than calcium chloride.

The use of potassium chloride was suggested by the results obtained by Blum in the treatment of oedema. It produces a diuresis without the malaise and without the accompanying acidosis of the calcium salt. It will often promptly reduce a blood pressure when calcium chlorid-fails.
The heavy increase of ammonia excretion is worthy of special note in view of Dr. Major's work on the production of arterial hypertension by guanidine. This heavy excretion in the form of chlorides and phosphates leaves less ammonia to take part in the production of urea. When one considers the molecule of guanidine as a supersaturated ammonium salt of carbon dioxide, it is evident that in the buffering of an ammonia and carbonate mixture with carbon dioxide in excess, guanidine could hardly exist. It is probable that this buffering of carbon dioxide and ammonia is much more sensitive and rapid than has been supposed, and has been overlooked in the buffering of the blood salts.

Summary

1. Calcium and potassium chlorides will produce a decided fall in blood pressure in a large percentage of cases of hypertension with a coincident improvement of the patient's symptoms.

2. Edema will improve and disappear under their action.

3. The treatment must be persisted in for three or four weeks to get results.

4. The only serious objection is the possibility of producing symptoms of an inorganic acidosis.

We wish to thank Dr. G. S. Young of the Toronto General Hospital for his assistance and advice in the work of this paper, and to state that the late Dr. Strathy had been a prime mover in the investigation.

BIBLIOGRAPHY

(8) Haldane, Lancet, 1924, i, 537.

PERIPHERAL NERVE INJURIES*

Fred. H. Mackay, M.D.

Montreal

Probably no one epoch in recent medical history has seen more change in our conception of disease than that of the period of the World War. Many of the more radical changes of recent years may be attributed, directly or indirectly, to the influence of this period. While this is generally true throughout the whole field of medicine, it is especially so in our understanding of the subject now under discussion. Only upon such rich experience and vast opportunity as was presented during those years of war, could the possibilities underlying the scientific treatment of injuries of the peripheral nerves be even partially disclosed.

Meeting to-day, almost seven years after the final enactment of that period, enriched by long observation of these cases and enabled, we hope, to review our results with a more matured judgment, we may ask ourselves the following pertinent questions:

First. Is treatment of injured peripheral nerves worth while, and have our original hopes in this field been attained?

Second. If so, what factors operate in certain cases to prevent or obscure this attainment?

My answer to the first question is that I have seen complete regeneration follow suture of almost every peripheral nerve to the extremities, ranging from such large and long nerves as the two popliteals to such a fine and short one as the circumflex. There can be no doubt as to the efficacy and completeness of peripheral nerve regeneration, and yet in the most promising of cases we may meet with disappointment, a fact which suggests to us the consideration of our second question. Part, at least, of the answer to this question will be attempted in the body of this paper. In so short a summary as this must necessarily be,

*Read at Eighth Annual Convention of the Association of Officers of the Medical Services of Canada, Ottawa, April 15, 1925.