tection against the development of ulceration than does vagotomy. Antrumectomy and vagotomy combined appear to give the dog a considerable measure of protection against the development of ulceration. This method of producing peptic ulceration in the dog may have certain advantages over the standard methods that will render it useful for further experimental study of the ulcer problem.

Summary. 1. A method for production of experimental peptic ulcer in dogs is presented. Its advantages are reliability, simplicity of post-operative care, rapidity of ulcer development, and survival of animals in good nutritional condition, thus allowing prolonged study in protected animals. The ulcers are produced without extraneous stimulation. 2. Four groups of animals were studied. The effect of vagotomy alone, antrumectomy alone, and vagotomy combined with antrumectomy are evaluated as to incidence of ulcer and period of survival (an indication of the time required for development of ulcer).

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Cation Adsorption by Alginic Acid in Humans.* (19405)

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The removal of exogenous sodium from the intestinal tract and prevention of its absorption into the body by means of cation exchange resins has offered a new therapeutic approach to the management of the edematous state. In clinical practice, however, the use of these agents has been attended by several undesirable effects(1), including unpalatibility, anorexia, fullness, vomiting, constipation and the potential hazard of sodium depletion and acidosis. The search for substances with similar clinical promise, but without the limitations and disadvantages of the resins has led to the investigation of alginic acid. It is the purpose of this report to describe initial experiences and record laboratory data on the cation adsorbing ability of this agent in humans.

Alginic acid† is a water-insoluble amorphous solid with marked hydrophilic properties which is widely used in the food and pharmaceutical industry as a stabilizing, emulsifying and thickening agent. Chemically the substance is a polymer of anhydro-B-D-mannuronic acid. It is extracted from giant kelp (*Macrocystis pyrifera*) and is closely related to cellulose and pectic acid. Each anhydromannuronic acid residue contains one free carboxyl group which is responsible for its theoretical cation adsorption capacity of 5.7 meq. per g. *In vitro* studies(2) have shown that sodium adsorption by alginic acid is primarily dependent on hydrogen ion concentration of the medium. In unbuffered solutions of sodium chloride, alginic acid combined with less than 1 meq. sodium/g and this was not appreciably influenced by changes in sodium concentration. During the adsorption process liberation of hydrogen ion lowered the pH of the medium from neutrality to approximately 3. However, when equilibrated with sodium ion in solutions buffered to approximately physiological pH of 7.6 the sodium adsorption per gram of alginic acid rose to 4.2 meq. These *in vitro* studies suggested that alginic acid had cation adsorption capacities similar to synthetic resins. Feeding experiments in ani-

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mals indicated the non-toxicity of alginic acid derivatives(3).

Material and methods. Three patients were selected for this study whose clinical condition warranted sodium restriction. Patient C.K. was a 56-year-old white male with severe cirrhosis of the liver and ascites. Patient N.P. was a 50-year-old white male with hypertensive cardiovascular disease, class III C (N. Y. Heart Association classification). Patient C.N. was a 59-year-old white male with arteriosclerotic heart disease and chronic left heart failure, class IV, D. A fourth patient was selected as a control. This patient, N.Z. was a 35-year-old white male with no illness other than a Meniere's syndrome. Full cooperation of the patients was secured and detailed studies were carried out under controlled conditions in a special unit of the Medical Service. Following a 7-day control period during which time each patient received a diet calculated to contain approximately 500 mg of sodium per day, this dietary regimen was complemented by the addition of 15 g of alginic acid 3 times daily for 7 days. In 3 of these patients this experiment was repeated utilizing a diet containing approximately 1500 mg of sodium per day. Total 24-hour urine volumes were measured daily, aliquots were taken and sodium and potassium analysis of the pooled specimens was carried out every 3 or 4 days with a Perkin-Elmer flame photometer. Similarly, all stool specimens were pooled every 3 or 4 days and sodium and potassium determinations were done according to the procedure of Eisenmenger(4). Most of the determinations were performed in duplicate and occasional cross checks were made on the same specimen by means of two different flame photometers with different sets of standards. The greatest difference in any 2 determinations was less than 5%. Other observations included daily body weights, and plasma electrolytes and electrocardiograms taken at weekly intervals. The patients were examined daily for presence of edema and their subjective reaction to the medication was noted.

Results. Plasma electrolytes and serial electrocardiograms showed no appreciable changes during the entire experimental period. All four patients tolerated the alginic acid well when taken stirred up in water. However, during the first 2 days of medication, complaints of a transient, slightly unpleasant taste were noted, as well as occasional brief sensations of fullness. In no instance did anorexia, nausea or vomiting occur. A mild but effective laxative action of the drug was observed in all patients. The data on sodium and potassium excretion in feces and urine for each control and medication period, as well as stool weights and urine volumes are presented in Table I. All data are recorded as daily averages calculated on the basis of seven-day pooled specimens.

Discussion. The data presented clearly indicate that in every instance except one, the daily average excretion of fecal sodium increased with alginic acid medication. The fecal potassium excretion increased in every instance during the administration of alginic acid. These increases in fecal sodium and potassium excretion occurred even in those cases in which total sodium excretion dropped during the alginic acid period as contrasted with the control period. It would thus seem probable that this increased fecal excretion of sodium and potassium was due to the alginic acid medication.

The discrepancy noted in those cases in which the total sodium excretion dropped on alginic acid in comparison with the control period may be attributed to variations in dietary sodium intake. Although the diets were carefully calculated from accepted standard tables(5), a random sample diet calculated to contain 10 meq. of sodium proved on actual analysis to contain 48 meq. of sodium.

Statistical analysis shows the increase in daily fecal sodium and potassium excretion to be significant (p smaller than 0.05 for Na, and smaller than 0.01 for K). Although daily stool weights increased in every instance on alginic acid medication, these increases were not found to be statistically significant.

The body weights showed only minor variation throughout the period of study except in patient C.K., who had a marked diuresis, which was at least partially attributable to the

TABLE I.

Patient	Diet Na	Urine vol, ml/day O	Urine vol, ml/day A	Urine Na, meq/day O	Urine Na, meq/day A	Urine K, meq/day O	Urine K, meq/day A	Feces wt, g/day O	Feces wt, g/day A	Fecal Na, meq/day O	Fecal Na, meq/day A	Fecal K, meq/day O	Fecal K, meq/day A
K.	500	638	1077	29.5	22.6	37.5	37.9	81	151	1.5	5.4	7.4	14.9
	1500	1071	1424	21.6	57.7	46.1	50.3	102	164	2.2	10.2	5	14.6
P.	500	2307	2332	87.1	48.7	82.1	51.8	166	161	4.9	2.2	21.7	27.4
	1500	2560	2237	96.3	88.5	101.1	87.7	151	248	2.2	9.2	19.5	36
N.	500	1489	2017	89.8	48.4	102.6	65.9	76	135	1.9	2.9	7.9	21.8
Z.*	500	2074	2252	53.2	24.7	74	45.5	119	185	3	6.1	10.6	12.7
	1500	1727	2050	69.1	38.2	72.7	50.9	233	349	6.7	15.8	26.3	43.4

* Z (control patient).
O = control period; A = alginic acid period.

fact that his regular mercurial medication was temporarily increased. Despite this, his fecal excretion of sodium significantly increased. The large increase in urinary sodium excretion in this instance was felt to be associated with the marked diuresis of this cirrhotic patient.

The results of this study indicate that the adsorption of sodium by alginic acid is approximately one-fifth to one-sixth of the values reported for cation exchange resins in clinical use(6). The reasons for the discrepancy between the *in vitro* cation adsorption capacity of alginic acid and the results reported here are not clear. It may be that partial digestion of alginic acid occurs, as has been reported in animals(3), or that an insoluble calcium alginate is formed in the stomach.

In view of the definite sodium adsorbing capacity of alginic acid, although admittedly small in comparison with cation exchange resins, and because of its favorable tolerance by patients and lack of marked undesirable side effects, it is felt that further trial and clinical investigation may be warranted. Possible chemical modification of alginic acid to increase its *in vivo* adsorption capacity may be worthy of study.

Conclusions. 1. Alginic acid is well tolerated in humans when ingested in quantities of 45 g per day and is mildly laxative. 2. Alginic acid increases fecal sodium and potassium excretion in humans to the extent of approximately one-fifth to one-sixth that of the cation exchange resins in clinical use.

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Vitamin E in Pituitary Gland Function of Fowls. (19406)

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The necessity of vit. E for proper function of the anterior pituitary gland has been a controversial problem for a number of years. Verzar(1), in early studies, stated that vit. E acted like anterior hypophyseal hormone in

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