

and inconsequential binder so that there may be no pressure atrophy from the Page support.

In approximately 5 per cent of patients, adhesions bind the viscera in their malposition so that operation must be considered. Likewise, incomplete fusion of the right colon with subsequent gross prolapse may finally warrant surgical intervention. It might be wise to emphasize that visceroptosis should always be considered before, and not after, surgical measures.

In our series of 100 patients, eighty-two improved under treatment. Of the remaining eighteen patients, two were afflicted with pulmonary tuberculosis, four with heart disease, three with nephritis, and one with thyroid disease; five had some form of pelvic disorder.

This investigation and survey was considered advisable for the reason that visceroptosis is commonly found and many physicians maintain that it is of no clinical significance. I believe that the therapeutic test disproves this assumption. I would recommend a reexamination of every patient looked on as a chronic complainer, in whose behalf the diagnosis of some form of ptosis had not hitherto been considered.

THE EFFECTS ON HUMAN BEINGS OF A TWELVE MONTHS' EXCLUSIVE MEAT DIET

BASED ON INTENSIVE CLINICAL AND LABORATORY
STUDIES ON TWO ARCTIC EXPLORERS LIVING
UNDER AVERAGE CONDITIONS IN A
NEW YORK CLIMATE *

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The question of minimal and optimal protein requirements has received considerable research attention in recent years. There is now very little disagreement among students of nutrition as to what these requirements are. On the effects of a high protein dietary, however, not only do opinions of authorities differ but the results of carefully controlled experiments show considerable variance. It is a traditional belief that a high protein intake leads to high blood pressure, arteriosclerosis or nephritis. Among physicians it has almost become a dietetic dogma to reduce or eliminate entirely the intake of meat whenever diets are prescribed. Unless proper interpretation is given to certain present-day investigations on protein metabolism, including the results of the experiment reviewed in this paper, there is danger that the dietetic pendulum will swing too far in the opposite direction.

The Eskimos have lived on a high protein dietary as far back as records go. Thomas, who recently made a careful study of their health status, found very little evidence to indicate that hypertension or nephritis was more prevalent among Eskimos than among low protein feeders. Several years ago it was my privilege to make an exhaustive clinical survey of Vilhjalmur Stefansson, the arctic explorer who had lived for seven years on an exclusive meat diet. The result of this study indicated that such a dietary had left no physical or clinically proved stigmas, and that while Stefansson was living on nothing but meat and fish (including fat) his health was at its maximum.

* This work was done under the direction of a committee of scientists under the chairmanship of Dr. Raymond Pearl of Johns Hopkins University, from contributions made by the American Institute of Meat Packers.

The data presented quite naturally gave a jolt to our accepted ideas of protein metabolism. Some of the critics maintained that the arctic cold was responsible for this high protein and fat tolerance; others that it was due to vigorous exercise in the open air. As a matter of fact, summer heat comparable to our own was experienced for a part of each year in the arctic circle and, since practically a tropical temperature exists in the houses and beneath the fur clothing, this explanation was untenable. Exercise likewise was not a factor, since the exclusive meat diet worked just as well during months of sedentary existence.

In order to answer some of the queries which Stefansson's experience provoked and to throw additional light on the effects of an exclusive meat diet, Stefansson and Andersen (who spent three years with him in the arctic) consented to go on an exclusive meat diet for a year and to be intensively studied from every clinical angle.

The studies which this paper capitulates have just been completed. Monographs¹ detailing the results of these investigations, including basal metabolism, chemical analysis of the blood and urine and fecal bacteriology, are appearing under the names of the respective investigators.

DETAILS OF INVESTIGATION

This research extended over a period of twelve consecutive months and was divided in point of time, location and experimental subjects as follows:

1. STEFANSSON.—The studies on Stefansson at the Russell Sage Institute of Pathology at Bellevue started, Feb. 13, 1928. From that date to February 26 he came to the hospital for all meals but he did not stay at the hospital continuously until February 26. After the completion of preliminary studies he was placed on an exclusive meat diet on February 28, and for two months intensive metabolic and laboratory studies were made on him. Then, for a period of ten months he was at large attending to his affairs but reported once each month for clinical and laboratory check ups. The concluding meat diet studies lasted one week. Dietary control was supervised in his home and he reported to the hospital for metabolism and blood studies. He was under observation for two weeks following the completion of the meat diet. His meat diet experiment ended March 8, 1929.

Dietary Notes.—After preliminary studies on a mixed diet Stefansson was put on an exclusive lean meat diet for the purpose of studying the effects of an excessively high protein, minimal fat dietary. Stefansson predicted that he would be ill in a few days, judging by his past experience in the arctic, and such proved to be the case. Although this experiment was planned for but four days, in the evening of the second day he became nauseated and developed some of the discomfort, lethargy and weakness of the knees which he experienced on an enforced lean meat diet in the North. The next day all the symptoms became intensified and diarrhea developed. This part of the experiment was, of course, stopped and by adding fat in tasteful quantities he fully recovered within two days. He lost

1. Two short articles on the metabolic results have already been published: McClellan, W. S.; Spencer, H. J.; Falk, E. A., and Du Bois, E. F.: *Clinical Calorimetry*. XLIII: A Comparison of the Thresholds of Ketosis in Diabetes, Epilepsy and Obesity, *J. Biol. Chem.* **80**: 639 (Dec.) 1928. McClellan, W. S., and Toscani, Vincent: *Clinical Calorimetry*. XLIV: Changes in the Rate of Excretion of Acetone Bodies During the Twenty-Four Hours, *ibid.* **80**: 653 (Dec.) 1928. Lieb, C. W., and Tolstoi, Edward: Effects of an Exclusive Meat Diet on Chemical Constituents of the Blood: *Proc. Soc. Exper. Biol. & Med.* **26**: 324-325, 1929. The following articles are in the course of preparation: McClellan, W. S., and Rupp, V. R.: Note on the Efficiency of Absorption from the Intestinal Tract with Meat Diets. Rupp, V. R.; Toscani, Vincent; and McClellan, W. S.: Nitrogen, Calcium and Phosphorus Balances of Two Men on an All Meat Diet. Rupp, V. R.: Analyses of Meat, Nitrogen, Fat, Calcium and Phosphorus. The reports of the basal metabolism of the specific dynamic action of foods will be made by Drs. McClellan, Spencer and Falk. Certain phases of the blood chemistry and the response to the injection of dextrose will be published by Dr. Edward Tolstoi. Dr. John C. Torrey and Dr. C. W. Lieb will report on the studies of the intestinal flora.

2 Kg. in the first ten days. Following the acute enteritis just described he developed a stubborn constipation coincident with a craving for special foods, particularly calves' brains (10 per cent ether soluble substance) and bacon. He ate heartily of this combination for several meals, but this overcompensatory diet resulted in two days of nausea and severe diarrhea. By adjustment of the lean-fat ratio a normal gastro-intestinal state returned, and no other diet complications developed during the year's experiment.

2. ANDERSEN.—Preliminary studies were made on Andersen from Jan. 6, 1928, when he entered the hospital, up to January 25. He then left the hospital for eight months, reporting at monthly intervals for clinical and laboratory surveys. Concluding meat diet observations lasted three weeks in the hospital and he was under observation for two months following the conclusion of the meat regimen.

Dietary Notes.—Andersen did not suffer such digestive upsets as Stefansson, mainly because no all-lean meat (high protein) observations were made on him. Andersen lost weight steadily while on the mixed diet from the day he entered the hospital (60 Kg.) and continued to lose during the first week he was on the exclusive meat diet (57.8 Kg.). He then began to gain weight steadily and within sixty days after the start of the experiment his weight was 60.5 Kg., thus exceeding his initial weight by 0.5 Kg. His weight fluctuated slightly during the interhospitalization period, being 58.4 Kg. at the beginning of the concluding calorimetric studies. Andersen ended his continuous meat diet, Jan. 24, 1929. From then to January 31, inclusive, he was placed on a high fat diet with moderate protein. From February 1 to February 7, inclusive, he was on the same diet plus 35 Gm. of carbohydrate in the form of thrice cooked cabbage. From February 8 to February 14 he was on the regular exclusive meat diet. During these periods he was studied intensively from the clinical, laboratory and calorimetric standpoint.

February 13; he developed a slight cold. He had a dextrose tolerance test on February 15 after which he was supposed to go on his general mixed diet. In the evening of this day he developed a chill, with rise of temperature. The next day he developed signs of a lobar pneumonia of the right lower lobe with a temperature of 104 F. and a rusty sputum. This proved to be type II pneumonia. Dr. Felton's concentrated polyvalent pneumonia serum was then intensively given with an immediate drop in temperature, which reached normal within a few days. Andersen made an uneventful convalescence. Aside from signs of acute intoxication on the fourth day of the disease he showed very little of the toxic symptoms of other patients in the hospital at this time with type II infections. While Andersen was in the hospital there were many cases of type II pneumonia in the wards and his was possibly a case of cross-infection. When one considers that approximately 50 per cent of these patients died, it is noteworthy that he survived. It may be of interest to know that Andersen, during his seven years' residence in Florida, has had a low resistance to head colds, having a succession of them each winter. He had only one cold during the past year and that was caught during an epidemic of grip in the hospital seventy days after he started on the meat diet. He had a very mild attack and only through the insistence of his physician did he go to bed, where he remained but two days. His physician caught the grip at the same time and was confined to bed ten days with a very severe attack. Though this clinical incident does not prove anything, it is at least an interesting fact that, in two subjects contracting grip at the same time and apparently from the same source, the resistance of the one on the exclusive meat diet should apparently exceed that of the subject on the mixed diet.

Stefansson, while traveling through the Middle West this winter, contracted a very mild and short attack of grip in a community where the grip was very severe and the mortality great. Of like interest in connection with the subject of resistance and diet is the experience of Stefansson during his explorations in the Far North. Having contracted a severe case of typhoid in the arctic in a region remote from medical help and

where he was forced by circumstances to eat nothing but canned food, his case was given up as practically hopeless. Stefansson, however, while in the third week of his typhoid, demanded that he be taken by sleigh to a hospital 140 miles distant. En route he ate nothing but raw fish. He reached the hospital in two weeks fully recovered from his typhoid and with a gain of 20 pounds (9 Kg.) in weight.

These citations are not made for the purpose of proving the resistance-promoting merits of an exclusive meat diet but merely as interesting clinical observations in a field of knowledge demanding exhaustive research and a judicious appraisal of facts and theories.

CLINICAL SUMMARY

Weight.—Stefansson lost 2.5 Kg. during his year on the exclusive meat diet. Some of this loss he considered excessive weight. Andersen lost 3 Kg. up to his attack of pneumonia.

Caloric Intake.—Stefansson averaged about 2,650 calories a day, 2,100 calories consisting of fat and 550 of protein. Andersen averaged about 2,620 calories a day, 2,110 calories consisting of fat and 510 of protein. Carbohydrate in the meat varied between 20 and 50 calories a day.

Blood Pressure.—Stefansson maintained a blood pressure of 105 systolic and 70 diastolic during the entire course of his diet. Andersen's blood pressure was 140 systolic and 80 diastolic at the beginning of the diet and 120 systolic and 80 diastolic on the completion of the year's diet.

Vitality.—In neither subject was there a decrease in physical vigor. Both led sedentary lives throughout the experiment. No subjective nor objective signs or symptoms of a decrease in physical vigor was observed. The same holds true of their mental vigor.

Heat Tolerance.—Andersen affirms that he endured last summer's heat, if anything, better than during former years.

Appearance.—Both men appeared ruddier at the end of the experiment than at the beginning.

Hair.—Andersen noted that his hair stopped falling out shortly after the meat diet was started and that the progressive loss has been checked up to date.

Teeth.—In neither case has there been any deterioration of the teeth. The dentist who has watched these two subjects throughout the experiment noted a greatly increased deposition of tartar on Stefansson's teeth while on the meat diet than formerly. This is interesting in view of the low calcium content of meat. There was also a notable absence of pyorrhea in both subjects.

Bowels.—Andersen's bowels have remained normal throughout the diet regimen and required practically no catharsis. Stefansson, who has had a tendency to constipation while living in civilized communities, found no increase in this tendency while on the meat diet. An interesting point in this connection is that in both these men the stools were nonodorous and there was no evidence of gaseous distention or flatus at any time. The stools were somewhat below average size and usually formed.

Pulse, Temperature and Sleep.—There was no variation from the normal and usual.

COMMENT ON DIET

Of interest in this dietary regimen was the apparent absence of monotony; the subjects rarely craved for other food than meat products. What little calcium

they had was obtained from eating the ends of ribs and gristle, averaging about 0.1 Gm. a day. The average water which they drank contained 0.01 Gm. of calcium per liter. Most of the meat eaten was cold storage meat. For a period of two months in the early part of their regimen they had freshly killed meat. During the remainder of the experiment their meat was ordinary, refrigerated, butchers' meat. The meat was usually boiled or stewed, the inside being left rare. Raw bone marrow was eaten as dessert at times early in the experiment but never during the last six months of it. Very little salt was added to the food by Andersen. No eggs were taken by Andersen during the year. Stefansson sometimes used them on journeys when meat was not available. Neither milk nor its products were used. Coffee and black tea and water were the sole beverages and, of course, unsweetened. About 1,500 to 1,800 cc. of fluid was consumed a day. Usually four meals were taken by Stefansson but three by Andersen each day. The food was always relished and complete satiety resulted after eating. No headaches or digestive symptoms, other than those noted as the result of eating lean meat, were experienced. Both these men were ideal experimental subjects and science owes much to them for their whole-hearted cooperation in enduring so patiently the numerous annoyances incident to the complicated and frequent tests made on them. They were psychologically fit for the experiment since, having had years of experience in living on this diet, they had no mental hazards as to its course or outcome.

The diets on which these two experimental subjects have been for the past year have not been particularly high protein diets, being but 30 or 40 per cent above the average protein intake. Their protein intake amounted to between 100 and 140 Gm. a day. The remaining calories were derived from fat which was equal to about three fourths or four fifths of their caloric intake. Andersen showed little evidence of an adaptation to the utilization of the higher percentages of fat. Stefansson appeared to develop an increased utilization to the high percentages of fat. The highest ketosis noted was in Andersen, the subject who weighed least. Stefansson, who is a better nourished type, tolerated the fat better than Andersen.

MISCELLANEOUS DATA

Metabolism.—The basal metabolism of these subjects showed a uniform variation between minus 10 and minus 20 per cent by the Aub-Du Bois standards. There was a slight rise in metabolic rate of 5 per cent during the first month. It is therefore noted that meat diets do not produce any striking elevation of metabolism.

Weights.—Andersen weighed 60 Kg. at the start. At the end of one month he weighed 58.5 Kg.; at the end of the second month he weighed 60.5 Kg.; at the end of the year's meat diet, 58 Kg.; after recovery from pneumonia 57 Kg., and at this writing, three weeks after recovery from pneumonia, he has regained his original weight.

Stefansson's original weight was 72.5 Kg. At the end of the first month it was 68 Kg.; at the end of the second month it was 69, and at the end of the year's meat diet 69.4 Kg. From April, 1928, to March, 1929, there was no change in weight. Stefansson's concluding weight after the calorimeter studies had been completed was 69.7 Kg.

Effects on Kidneys.—1. No albumin, casts or blood was found at any time during the course of the experiment.

2. A red test on Andersen showed 55 per cent excretion at the beginning of the experiment; 62 per cent after recovery from pneumonia after completion of a year's meat diet. (The red test was not carried out on Stefansson.)

3. Urea clearance showed 100 per cent plus.

These tests would indicate an ability on the part of the kidneys to hyperfunction while on a meat diet.

4. Roentgen examination of the kidneys before and at the conclusion of the meat diet did not show any change in size.

Mineral Metabolism.—As Aub's work indicated that an acid diet increases calcium excretion and calcium drainage, one would suspect that subjects on a meat diet, which is an acid diet and is likewise low in calcium, would in a year show a calcium deficiency. The increased amount of tartar on Stefansson's teeth and the lack of evidence of lowered blood calcium offers an interesting field for speculation. There was no decreased density in roentgenograms of the hands at the end of the experiment when compared with the hand of a man on a general diet.

Chemical Analysis of the Blood.—The chemical composition of the blood was little affected except for a slight increase in uric acid and a temporary lipemia. The latter occurred only after unusual amounts of fat were taken. Nonprotein nitrogen, urea, uric acid, creatinine, sodium chloride, sugar, carbon dioxide combining power, serum calcium, plasma protein albumin (plasma), globulins, total protein (plasma) albumin:globulin ratio, and cholesterol were studied before the meat diet and after an exclusive meat diet for twelve months, and no noteworthy changes were discovered. Of interest was the fact that the dextrose tolerance test, consisting of the ingestion of 100 Gm. of dextrose, developed in Andersen a typical diabetic curve resulting in the spilling of sugar for the two following days.

Observations on Intestinal Flora (by Dr. John C. Torrey.)—No blood appeared in the fecal specimens and rarely any mucus, the latter occurring once in the case of Andersen and twice in that of Stefansson. The stool reactions were generally definitely acid—between p_H 6.0 and 6.8—with an inoffensive, slightly acid odor.

The whole meat diet in both subjects caused a simplification of the intestinal flora with a marked reduction both in types and in total numbers of bacteria. The acidophilus, enterococcus and streptococcus types were practically eliminated. The *B. coli* group increased greatly numerically at first but later decreased and for a time in one subject (Andersen) were largely replaced by *B. proteus*. Hemolytic *B. coli* increased in both during the first one to three weeks, then disappeared. No increase in virulence of colon strains occurred. *B. welchii* at the start was present in both subjects in higher counts than usual for normals, and during the first period a great increase occurred. Later the count fluctuated but was generally high. There were very few putrefactive spore-bearing anaerobes at any time. The diet did not appear to introduce them or encourage their growth.

This meat diet did not cause the development of a putrefactive flora in Stefansson and in Andersen only so far as the late appearance of *B. proteus* (noted first after about one year on the diet).

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