Later on the amplitude of the beat may be reduced and the tonus of the ventricle increased.

As with crystalline digitoxin, so also with digalen, the effects of the drug may continue for a time to increase after substituting Ringer's fluid for the drug solution—a phenomenon not noticeable with the less active constituents of the digitalis plant, digitalein and digitonin. With more concentrated solutions of digalen the above sequence of events is more rapid and the effect less readily washed out.

Fig. 4 shows the effect of perfusion with a 1 in 100,000 solution. In this case the frenum cordis was divided; hence the tracings show both the auricular and the ventricular contractions, the former undiminished, the latter reduced by concomitant relaxation of the auricle.

The difference between the records in A and in B was of gradual growth, and the approximation of the heart tracing to the abscissa in the latter appeared, from inspection of the beating heart, to result from increased relaxation during diastole. Towards the end of this perfusion diastolic tonus commenced to increase, but at C was less than at A. Three minutes after C, digalen was again perfused for six to seven minutes, and reduced the frequency of the heart to nineteen per minute. On removal of the digalen the amplitude and the frequency of the beats continued for a while to diminish (the latter to thirteen a minute) and the diastolic tonus to increase, after which amplitude increased and tonus diminished, whilst frequency remained substantially constant (*vide* tracing D). Owing to movement of the apparatus between C and D the tonus in the latter cannot be compared with that in the former tracing.

SUMMARY AND CONCLUSIONS.

In considering the bearing of the above results on the therapeutic applications of digalen to the human subject, it is important to keep in mind the differences between the animals under experiment and the human organism under treatment.

In the former case the drug is producing, for the most part, pressor deviations from the normal state—that is, is working against the resistance of the organism. In the latter case its pressor effects are aided by the natural tendency of the organism towards recovery from depression. Moreover, in the former case the pressor effects are diminished by the anaesthetic. This is exemplified in Table I, where, *caeteris paribus*, the larger effects are seen on the smaller pressures, and the largest of all in Cat 2 after pithing—that is, on the lowest pressures and in the absence of anaesthetic. Hence it may be anticipated that the human subject* in immediate need of digitalis will react to intravenous injections of relatively smaller dose.

The non-production of thrombosis in the small veins of the rabbit seems good evidence that thrombosis would not, with equal care, follow injection into the larger veins of man. It is not, however, fair to conclude that absence of recognizable pain and tenderness from subcutaneous and intramuscular injections in the rabbit implies complete absence of discomfort in man under the same circumstances.

As far as can be judged from the foregoing observations, digalen is an active preparation of digitalis producing characteristic digitalis effects on the circulatory system and on the secretion of urine.

Intravenous, subcutaneous, and intramuscular injections have produced no local trouble.

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* I understand from Dr. Golla that he has, under such circumstances, obtained good results from intravenous injections of 1 c.cm. (= 0.3 mg.) of the preparation.

UNDER the will of the late Mr. Charles Bowles Hare, of Clifton Park, the General Hospital, the Royal Infirmary, and the Eye Hospital, all in Bristol, receive respectively sums of £1,000, £300, and £100.

THE PROTEIN REQUIREMENT; OR, "DO WE EAT TOO MUCH MEAT?"

BY

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VOIT established the rule that the amount of protein required daily was from 1.4 to 1.7 grams per kilo of body weight; or that 119 grams of protein and 2,800 to 3,000 calories of energy were required to meet the demands of the body of a man of average weight when doing light work. Atwater, after many years of work in metabolism, considered that a man—

Without work required 90 grams of protein and 2,700 calories.

With light work required 112 grams of protein and 3,000 calories.

With moderate work required 125 grams of protein and 3,500 calories.

With severe work required 150 grams of protein and 4,500 calories.

Maurel also considers that an adult in health and vigour requires 1.5 grams of protein and 35 to 38 calories of energy per kilo; or 105 grams of protein and 2,450 to 2,660 calories for a man of 154 lb., and 90 grams of protein and 2,100 to 2,280 calories for a woman of 132 lb.

Chittenden, as the result of experiments, believes that 0.1 to 0.12 gram of metabolizable nitrogen, or 0.625 to 0.75 gram of protein, represents the requirements of the body in the ordinary circumstances of life, and that an allowance of 50 to 60 grams of protein daily, or half the amount usually stated in textbooks, is an ample provision for a man of 60 to 70 kilos.

Numerous investigations undertaken by Voit, Moleschott, Ranke, Foster, Munk, Reider, Paton, Zuntz, Lehmann, Pechsel, Klemperer, Hirschfield, and others, show that when no food is taken for twenty-four hours the amount of nitrogen excreted varies from 7.5 to 12 grams, the variation probably being due to a difference in the amount of stored and circulating protein and glycogen in the organism. But if the starvation is continued the stored protein and glycogen is all consumed in a few days, and after a period of about five days all the nitrogen in the excretions will be derived from the disintegration of tissue proteins. In fasting people the amount of nitrogen excreted by the kidneys from the fifth day of starvation averages about 4.5 grams per day. If we allow a margin of 1 gram for other modes of excretion, for example, the skin and mucous surfaces, we arrive at the conclusion that the amount of protein absolutely essential to prevent the destruction of tissue proteins is $N\ 5.5 \times 6.25 = 34$ grams daily, or about 0.5 gram of protein per kilo of body weight. *The physiological minimum for an adult is therefore 34 grams of protein daily.* But other points have to be considered. The observations of Chittenden, Hirschfield, Klemperer, Siven, Pechsel, and others, have clearly demonstrated that it is possible to maintain life and keep the body in nitrogen equilibrium, and even do a certain amount of work, with a diet having the standard energy value, but containing a very much smaller amount of protein than is usually considered necessary. It remains to be seen how far the protein requirement is influenced by work. It is possible for protein to supply all the energy required by the body, as well as to maintain the body in nutritive and nitrogenous equilibrium. But whether it is necessary or even advantageous for the body to derive part of its energy from protein is another matter. There are people who perforce live almost exclusively on animal food for six or nine months of each year. In such cases the energy of the body is derived from the fatty moiety of the protein molecule or from the carbohydrate complex which exists in many proteins. But what we want to know is whether work increases the demand for protein food. Pflüger advanced the theory that protein is the source of all muscular energy. Against this theory, no longer held, is the fact that no evidence has been adduced which clearly shows there is any change in the condition of the muscle proteins when muscle contracts. Hermann's theory of muscular contraction assumes that there is a change in the muscular proteins similar to what occurs in rigor mortis. But nobody has actually observed the formation

of myosin during the contraction of muscle. We have, however, the evidence afforded by the excretion of nitrogen, for it may safely be asserted that if protein be the source of muscular energy, the exercise of the muscles will materially increase the excretion of nitrogenous waste products. Without quoting the experiments of investigators, it may be stated at once that this is far from being the case. The cleavage of protein is increased by muscular work; but the cleavage is small in proportion to the consumption of non-protein material, and it is not directly connected with the work performed. The total nitrogen of the urine is increased after severe exertion, and is chiefly in the form of urea, creatinin, and preformed ammonia; but there is also an increase in the sulphates and phosphates. Indeed, the conclusion is arrived at that when the body contains no stored proteins muscular exertion increases the output of nitrogen 15 per cent.; but if the body is in good "condition," that is, containing a store of circulating proteins, the output of nitrogen is larger, because such proteins are consumed as a source of heat and energy; but the muscle fibres are not broken down in a greater proportion by the work they perform. In Paton's investigation the excretion of nitrogen was increased both during and after the performance of work, and the metabolism of protein indicated by the increased nitrogen excretion accounted for 35 per cent. of the work done. It was evident, therefore, that one-third of the energy expended in work was derived from the metabolism of nitrogen and two-thirds from non-nitrogenous matter.

One principle in dietetics, which has not received adequate recognition, may be expressed by saying that the requirement for food varies not only with the condition of activity but with the nutritive plane at which it is desirable to maintain the organism. Out of this arises the question: "What level of nutrition is most advantageous?" The answer to this question is not easy to obtain. It must be sought in metabolism experiments and dietary studies; but it must also be sought in broader observations regarding bodily and mental efficiency, general health, strength, and welfare. Is it possible to answer the question with regard to protein? *The physiological minimum* requirement of protein is 34 grams per diem; it has been shown that, with an ordinary diet on Voit's standard, muscular exertion increases the metabolism from 1.10 to 18.0 per cent., with an average of 15 per cent. From this point of view an allowance of 10 or 15 grams of protein daily would suffice for the performance of muscular work, thereby raising the minimum to 44 or 50 grams of protein daily, providing the energy value of the food is up to normal. I think that, however, is only a partial reply to the question. But we are bound to admit that Professor Chittenden has proved his contention that it is *possible* to maintain life, to prevent destruction of the tissues, and do a certain amount of work with an allowance of 50 to 57 grams protein daily.

Is such a small allowance of protein desirable? It has not only been shown that half the standard allowance of protein will meet the demands of the body for nitrogen, but it has been shown that anything over that amount is added to the amount of circulating proteins in the body and is very soon disintegrated, the urea moiety being quickly excreted. It is claimed also that the additional amount consumed is harmful to the organism by throwing extra work on the kidneys, that it may cause disease of those organs, gout, migraine, and kindred ailments. It may at once be acknowledged that an *excessive* consumption of protein is deleterious to the organism. What we cannot acknowledge without further proof is that people as a rule consume an excess of protein. As a matter of fact, do average individuals regularly consume as much protein as the standard diets of Voit, Atwater, and others prescribe for us? It is exceedingly doubtful whether they do, at any rate in Europe. It is usually considered that we consume one-half of our proteins in the form of animal food and the other half in vegetables. It has, I believe, never been suggested that we should reduce the consumption of vegetable foods, because they are the chief source of carbohydrates or of muscular energy and heat. The matter therefore resolves itself into the question, "Do we eat too much meat?" How can we get an answer to this question? Metabolism experiments are conducted on individuals and not on races of people; even the enormous

work of Atwater and his band of co-workers had reference to individual experiences. There is, however, another method of arriving at the average consumption of animal food by entire races of people—that is, by statistics of the food supply of nations. Thus, for instance, Mulhall states that the amount of animal food consumed *per annum per head of the population* in America is 120 pounds, Great Britain 105, France 74, Germany, Belgium, and Holland 69, Scandinavia 67, Austria 64, Spain 49, Russia 48, and Italy 43 pounds. I do not know from what sources these figures have been derived; but if they approach to anything near the truth it is obvious that in Europe at least the consumption of animal food is not excessive. It means that the average consumption of animal food in Europe does not exceed 1½ pounds per week, which is just half the amount consumed in America. It is presumed that the amount per head means for people of all ages—men, women, and children. Taking 15 as representing the average amount of protein in all animal foods, then the supply of animal protein for Europe is 85 grams per week; and for Great Britain 136 grams per week, or not quite 20 grams per day.

There is another source from which information may be obtained, and that is the returns of the Board of Agriculture. The chief source of animal protein in Great Britain is derived from the beef and mutton consumed. In 1907–1908 the total annual supply of beef amounted to 22.8 million hundredweights, and the total supply of mutton was 10 million hundredweights. The population is in round numbers 45 millions, and therefore the supply of beef and mutton averages 80.75 lb. per head per annum. Assuming the average amount of protein in beef and mutton to be 16.5 per cent., it shows that the supply of protein from these sources was not quite 17 grams per diem. The total number of "home" and imported eggs was 450 millions, and provided 0.19 gram of protein per diem for every person. The imported bacon was 5½ million hundredweights, and assuming the home supply to be the same, it provided 3.4 grams of protein per person daily. Ham also provided 1.09 grams per day. Home and foreign rabbits provided 1.00 gram. The supply of home and foreign cheese provides 7.06 grams daily. So far we have a provision of 29.74 grams of protein daily, and making an allowance for milk, fish, and birds, for which statistics are not at hand, *the total provision of protein from animal sources may be about 35 grams per day.* Surely it cannot be said that the consumption of meat in Great Britain is excessive. And, supposing the supply of protein from animal sources represents one-half the amount consumed, there must be a misconception in the minds of physiologists as to the amount of protein which is consumed by large bodies of people.

It is usually considered advisable to allow children under 1 year of age about 2 grams of protein per kilo of body weight. In the discussion which has waged around the protein requirement nobody, so far as I am aware, has attempted to show that 2 grams per kilo is too much for a growing child. The amount of protein required diminishes gradually to the adult period, when it reaches a point where it remains steady for several decades. Voit's standard for adults is 1.4 to 1.7 grams of protein and 40 calories of energy per kilo of body weight. This is the standard which has been seriously impugned. It is a standard which Folin described as the *optimum*, whereas Chittenden shows how *little* we can do with. Until we have much greater experience of the effects of a low protein dietary we should still accept Voit's standard as the optimum. For generations past it has been considered that protein starvation is the cause of much ill health and misery, and this point ought not to be lightly given up by the physician. Protein starvation is not uncommon among poor but respectable people, who for long periods have perforce to live upon a diet in which "tea and bread-and-butter" figure prominently, with an occasional "bloater" or chop as an appetizer. Such a diet, although it may yield enough protein to maintain the nitrogen balance in equilibrium, does not give the consumer strength or endurance or confer immunity to disease.

When middle life is attained the body is less active; the power of the muscular system begins to decline, the involuntary muscles of the heart and other organs gradually diminish in vigour. The metabolism becomes

feebler and slower, and everywhere there are indications of the diminished ability to metabolize the amount of protein according to Voit's standard; and in old age the amount consumed ought to approach somewhat nearer to the physiological minimum. Many persons in old age actually do reduce the amount consumed to the physiological requirements. I could give instances of old people who actually consume no more than 30 grams of protein daily, and, nevertheless, enjoy moderate health, or do not suffer from any appreciable disease.

But as regards children, growing persons, and young adults, the general principles laid down should guide us; and when the cost of animal food is prohibitive a freer use of vegetable proteins—legumes and nuts—should be recommended.

RHEUMATOID ARTHRITIS:

A PERSONAL EXPERIENCE OF THE DISEASE.

BY

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THE writer of this article has suffered from arthritis—a rather doubtful privilege, but one which carries with it opportunities for insight and investigation which are denied to his more normal brethren. Such is my apology for the infliction of this somewhat personal treatise upon those who are interested in the subject.

I propose to describe my own variety of arthritis, and particularly to attempt the elucidation of certain points in the pathology. I do not imagine that all cases of this disease will admit of the same explanation, but I do think that there is a large group which would come under the same heading.

Although a history of joint disease is usual in these cases, it is not the rule to find a family history of arthritis. The case under consideration is an exception to this rule, since one grandmother was crippled for years with "rheumatic gout," and one member of the present generation in my own family has a joint disorder as nearly as possible identical with my own. The parents had no serious joint trouble of any kind, but one of them had a constitution which I consider to be of some importance in considering the pathology of the disease. Some features of this constitution were as follows: A skin which blanched abnormally easily, cold hands and feet, nails which were very much ribbed, a tendency to severe sick headaches, and a digestion which was only kept in order by careful and abstemious living. These were inherited from the old lady with rheumatic gout, but throughout a long life of 80 years no joint symptoms of any importance supervened, and it was not until the present generation that this constitution again provided a suitable nidus for a germ infection which was to lead to arthritis.

In the present generation there have been since childhood the same peculiarities—a skin rather dry and white, fingers which go dead rather easily, and a tendency to typical attacks of migraine. The frequency of the latter has always depended upon the proportion of starchy foods in the diet; at school, where we fed mostly on bread-and-butter and porridge, the sick headaches were frequent; during the holidays they never occurred. It was suggested that this might be due to the fact that the optic axes are almost imperceptibly out of the parallel. Appropriate glasses, however, have been tried with no good result. The indisposition lasts only about four or five hours, and usually ends with vomiting. Since the advent of the arthritis this sickness has always had an astonishing effect; the joint symptoms are much diminished for about twenty-four hours, and the more severe the attack of migraine the more complete is the relief from stiffness.

The intimate way in which the migraine depended upon the diet, and the dramatic rapidity with which the joint symptoms diminished after one of these attacks, at first led me to suppose that the stiffness was directly due to a species of food poisoning. Subsequent investigations, I think, now clearly show that the effect of the diet is indirect. Both cases of arthritis in the present generation have a chronic congestion and catarrh of the nasal mucous membrane, and one is troubled at times with hay fever. I believe that this vasomotor imperfection is due to the same cause which induces the other constitutional

peculiarities. The latter have for the most part existed since childhood, whereas the joint symptoms are a comparatively recent addition. I regard the alimentary deficiency, therefore, as a predisposing cause only; the actual determining cause appears to be a staphylococcal infection of the nasal mucous membrane. This will be dealt with more fully later.

The following brief account of the symptoms will serve to convey a notion of the general course of the illness. The onset was extremely slow and gradual; the first symptom was rheumatism in the right shoulder, which lasted for twenty-four hours and then disappeared; after a month the same thing occurred again; at the end of another two months a curious stiff feeling was noticed in the soles of the feet on first getting out of bed in the morning; this at first disappeared after standing for a minute or two, but it gradually lasted a longer and longer period every morning until, at the end of eighteen months, it continued throughout the day. In the same insidious way the hands were attacked. On awaking one morning there was an unaccountable stiffness in all the proximal interphalangeal joints of both hands; after flexing and extending once or twice they recovered their usual suppleness; like the feet, they were affected for a longer and longer period each morning, until, when two years had elapsed, all the joints were typically spindled. Similarly the wrists, ankles, knees, elbows, shoulders, hips, jaw, back, and neck were gradually attacked. As a rule, there appeared to be merely a pulpy thickening of the synovial membrane, but in some cases they contained fluid. Certain tendon sheaths were affected in the same way, and especially those beneath the internal and external malleoli and round the wrists. Another prominent feature has been tenderness in the fibrous origin of muscles from certain bony points, such as the tuber ischii, anterior superior iliac spine, os calcis, and clavicle; also there have been tender fibrous nodules in various tedinous structures. In addition to this slow advance of the disease, from time to time attacks of acute pain and swelling have arisen and as suddenly disappeared, after lasting only forty-eight or seventy-two hours; the carpal and tarsal joints have been the ones usually attacked in this way.

Of those collateral symptoms which are usually looked upon as being part of the disease, the following were constantly present: General lassitude, increased pulse-rate, cramps and fibrillary twitching of muscles, ridging and brittleness of nails, enlargement of the axillary glands, unnatural whiteness of the skin over the affected joints, glossiness of the skin at the root of the nails, and pigmented patches about the skin. The following common symptoms were absent: sweating, neuralgia, and sensations of pins and needles. A few rather unusual symptoms were present: a very dry and itchy skin, occasional urticaria, and a very decided increase of the joint pains in warm weather.

It is usual to find a warm sunny climate recommended in the treatment of arthritis. Acting on this advice, I spent a year in South Africa, and was sadly disappointed to find that the joint pains rapidly got worse in the delightfully sunny though temperate climate of the Cape peninsula; the same results awaited me in the Karroo, where the rainfall is next to nothing, and bright sunny days are almost perpetual. A holiday in Switzerland and a year as ship's surgeon travelling backwards and forwards to South Africa, resulted in the same experience; hot weather invariably caused an increase of joint pains, and cold weather always came as a relief. The ideal climate is a constant temperature of about 55° F., with a little dampness in the air such as one gets towards the end of October in England. Failing this, decidedly cold weather is infinitely preferable to great heat.

Answers which I have received from many arthritis patients make me rather sceptical as to the advantages of warm weather on account of the loss of vigour which heat entails.

In some cases I believe there is a reason why a hot climate actually increases the joint swellings; if the nasal mucous membrane is the site of a chronic germ infection the engorgement of that part which a hot atmosphere induces both causes a more vigorous inflammatory reaction and also carries more toxins into the general circulation. This is borne out by the way in which the heat produces its bad effect; after a spell of cool weather