may be fibrous and derived from hypertrophied fringes or villous excrescences such as were present in the case just related. They may be fibrinous from inflammatory exudations of the sac which have been rolled up into pellets in the movements of the part. Finally, they may be due to blood clots decolorized and inspissated in the course of time and moulded by movement. Obviously, the removal of the whole sac would be the best treatment in such cases, as not only would the bodies themselves be taken away but also the diseased tissue, which might reproduce similar ones if they were simply evacuated. So far I have not come upon primary acute infective bursitis in this sac. Nor have I met with tuberculous disease of it, though frequently a tuberculous disease of the knee has involved it secondarily. The possibility of such infections with tubercle must, however, be always kept in mind when the semimembranosus sac is enlarged, and if the swelling resist all of the usual remedies, there is an extra reason for its extirpation in this suspicion. This operation calls for very great care and deliberation on account of the anatomical relations of the bursa. A long skin incision a little to the inside of the mid-line of the popliteal space is quite safe. But in the deeper dissection a very close watch must be kept to avoid the internal popliteal nerve and the artery and its branches. But, by keeping close to the wall of the sac after reaching it (which is usually an easy matter, if it be enlarged) on the inner side of the internal head of the gastrocnemius, it can usually be shelled out of the loose tissue in which it lies without much difficulty. It should be preserved unopened to the last moment, as it is easier if this be done to make out its boundaries and deal with the synovial sac, all of which ought to be removed. Behind the inner condyle, where the sac has a communication with the synovial membrane of the knee-joint, it will, of course, require to be eventually opened. But all the dissection should be finished before the narrow neck of communication is severed. The opening into the knee-joint requires no attention in the way of stitching up, and may be left to itself. If carefully carried out there is little or no immediate bleeding or subsequent oozing, and the wound can be completely closed without any drainage, as was done in the two cases referred to. Flawless primary union followed in both cases. There was some difficulty in the last case in dissecting out the large sac from beneath the gastrocnemius. But as it was thickened and tough it was quite distinguishable from the tissues around, and no damage was done to any structure of importance.

Next in order of frequency of occurrence is enlargement of the bursa under the expanded insertion of the sartorius muscle. Of this swelling I have seen several instances. The tumour has been well defined—oblong in shape and elastic. In the cases in which I have excised it it was about the size of an average sausage, and could be extirpated unbroken. The lining was smooth and looked like ordinary healthy synovial membrane. I have never seen it affected with tubercle primarily, but recently there has been a case in our hospital operated on by one of my colleagues, which showed, I am told, a distinctly tuberculous infection. A specimen which can be found in the museum of University College Medical School shows another variety of enlargement of this bursa. It is flattened, and fibrous, like a prepatellar sac. Apparently it was due to chronic inflammation, or possibly to organized blood clot.

I am not sure that an enlargement of the gracilis bursa has ever come in my way nor of that between the biceps near its insertion and the external lateral ligament. But I have seen and operated on a case where the bursa under the ligamentum patellae was enlarged and painful, and required evacuation. This did not in this case communicate with the knee-joint, as is often the case, but was completely shut off. As well as I can recollect, it was a septic infection of the bursa through the blood, and the fact that it did not communicate with the knee-joint was fortunate.

In this brief sketch of the enlargement of bursal cavities about the knee my wish has been to direct attention not only to recognized swellings which have received more or less study, but also to suggest that in some obscure conditions in this region an explanation may be found in enlargements of synovial tracts which are sometimes forgotten. What these may be due to I have also hinted, and

how they may ultimately seriously affect the knee-joint proper if neglected. In the case of enlargement of some of them I have strong grounds for the belief that they are the origin of those large cystic swellings which have been, I think erroneously, believed to be due to hernial protrusions of the synovial membrane of the knee-joint. As to treatment, we are safest when we regard them as rudimentary joints, and deal with them as such. And as it is now recognized that joints may be dealt with freely by operation with a good prospect of the preservation of their functions, so may these bursal sacs.

SOME PHARMACOLOGICAL EFFECTS OF THE STRONG SULPHUR WATER (HARROGATE).*

SECOND PAPER.

By DAVID BROWN, B.Sc., M.D.LOND.,

HARROGATE.

(Abstract.)

DR. DAVID BROWN, after giving a brief account of the results detailed in the first paper of the series, which was published in the BRITISH MEDICAL JOURNAL of August 20th, 1910, went on to say that those results important for all interested in Spa treatment generally, and in Harrogate in particular, needed further tests for their complete establishment: first in the way of direct verification by repetition, and secondly, from the point of view of obtaining more complete data, ultimately embracing observations on all the excreted substances so far as at present they are known.

The points taken for confirmation were:

1. The reality of the diuresis and its amount.
2. The rise in the excretion of total nitrogen in the urine.
3. The rise in excretion of body tissue (or endogenous) uric acid during treatment.
4. The rise in excretion of uric acid arising from the food (exogenous) as shown by the ingestion of measured amounts of pure hypoxanthin in regularly repeated doses.
5. The rise in excretion of body tissue (or endogenous) kreatinin as an index of muscle metabolism.

The new points observed were the following:

6. The fate of the sulphur water as regards the urinary and bowel excretions, and the ascertainment of any relationship, direct or inverse, between the amounts of the two excretions.
7. To ascertain if any change occurred in the excretion of phosphates as an index of tissue change.
8. To ascertain whether any change in the amount of indican (indoxyl sulphuric acid) took place as a result of the course of sulphur water.
9. To examine the blood pressure at frequent intervals and to register any variations in the same.
10. To ascertain whether the amount of potassium sulphocyanate in the saliva altered during the course of sulphur water.

The most exact biochemical methods of analysis were used, and the personal equation was eliminated as far as possible by observing the rule of awaiting the termination of the whole of the experiments before attempting to calculate, even in the roughest way, any of the data obtained in the laboratory.

The subject, the same as that of Case I of the previous paper, took the following diet on each of twenty-one successive days:

- 14½ oz. bread (white).
- 25 oz. milk.
- Five eggs.
- 8 oz. rice pudding.
- 8 oz. macaroni cheese.
- 2½ oz. butter.
- 20 oz. distilled water (aerated).

On the morning of the twelfth day of the experiment, between 8 and 9 a.m., 580 grams (20 oz.) of the strong sulphur water was taken, and this was repeated each day up to the nineteenth day. On the twentieth and twenty-first days 18 oz. were taken, and on the twenty-second, 16 oz.

All the doses of sulphur water were taken fasting.

On the eighteenth, nineteenth, twentieth, and twenty-first days a dose of 0.3 gram of hypoxanthin was taken after 5 o'clock in the afternoon.

On the twenty-first, 10 oz. extra of distilled (aerated) water were taken to relieve thirst. On the twenty-second and twenty-third days the diet consisted of

- Milk, 40 oz.
- Bread, 14 oz.
- Aerated distilled water (unlimited in quantity).

* The paper was read before the Section of Balneology and Climatology of the Royal Society of Medicine.

The points observed and shown on the accompanying diagrams were then taken.

CHART A.—Illustrating Points 1 and 6. Urine (in c.cm.) and Faeces (in grams).

1. The average amount of water passed in the eleven days of the presulphur stage was 970 c.cm. (3½ fluid ounces roughly correspond to 100 c.cm.). During the first nine days of the sulphur period the amount averaged 1,374 c.cm., a daily excess over the first period of 404 c.cm., or 42 per cent. Previous cases showed a diuresis varying from 25 to 110 per cent. The high percentage refers to a case of recurrent gout.

6. Faeces.—The weight of faeces from days 7 to 11 averaged 94 grams; from days 12 to 20, 324 grams, a daily excess of 230 grams, or 245 per cent.

The 580 grams of sulphur water taken daily were completely represented in the urinary and faecal excretions thus:

Excess urine	...	...	404 grams.
Excess faeces	...	...	230 "

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Sulphur water taken ... 580 grams.

This leaves an excess of 56 grams per day, and roughly amounts to 500 grams, or rather more than 1 lb. weight of excess excretion in nine days.

The experiment, then, shows the existence of a definite and positive diuresis, in addition to the increase of bowel action. It is also noteworthy that the amounts of urine and faeces do not vary *inversely*, but that the days of the greatest bowel action were in general those of maximum diuresis.

During the first eleven days the weight of the subject, observed at frequent intervals, was reduced from 10 st. 8½ lb.

CHART B.—Total Nitrogen (in grams).

to 10 st. 8½ lb. During the remaining twelve days the weight was reduced to 10 st. 5 lb. Of this amount of weight (equivalent to 1,500 grams) about 500 grams are accounted for by the excess of urine and faeces excreted

during the first nine days of the sulphur water period, and probably the profuse sweating on the nights of the twenty-first and second (twenty-four hour periods) account for at least an equal amount. This leaves something like 500 grams (1 lb.) unaccounted for, a loss covered by the normal day-to-day variations in body weight.

Chart B shows an average rise of 8 per cent. in the total nitrogen during the sulphur-water period—that is, from 14.8 to 16.0 grams per diem (the highest rise in previous experiments was 10 per cent.).

Chart C relates to body tissue (endogenous) uric acid; measured as nitrogen:

		Uric Acid.
Average days, 1 to 11	...	0.110 grams, or 0.330 gram.
" 12 to 17	...	0.130 " or 0.390 "
		Increase, 18 per cent.

CHART C.—Uric Acid in Milligrams of Nitrogen.

This chart shows also the excess excretion of uric acid following the ingestion of hypoxanthin as detailed above. It had occurred to me that the exhibition of single doses of pure hypoxanthin (as in the earlier experiments) might have given an exaggerated result as regards the increased excretion (80 per cent.) of uric acid of food origin during the course of sulphur water, seeing that the persons experimented on had previously been for a considerable period on a non-purin diet. It was hoped to check these results by the method of repeated administration of moderate doses of pure purin (hypoxanthin).

The chart shows an average excess excretion of uric acid due to the doses of hypoxanthin during the six days (18 to 23) of 0.058 gram of uric acid nitrogen—equals 0.175 uric acid—a total in the whole period of 1.05 grams of uric acid. This corresponds to about 80 per cent. of the ingested hypoxanthin, a result almost identical with that obtained from the administration of single doses of hypoxanthin during the administration of sulphur water.

Thus the ordinary oxidation of purin bodies to uric acid is practically doubled during the taking of sulphur water.

Chart D, relating to the endogenous kreatinin, shows that the average (days one to eleven) was 2.47 grams

a day. There was no noticeable fall as a result of restriction to a non-purin diet. During the first nine days of administration of sulphur water the average excretion rose to a point over 3 grams a day, a total increase of 13 per cent. The proportion of kreatinin to total nitrogen increased from 18 to 19 per cent. in the two periods. A measured amount of walking exercise (3 miles) was taken daily, and the subject of the experiment did from twelve to thirteen hours' laboratory work a day.

CHART D.—Kreatinin (in grams).

Chart E shows the excretion of phosphates taken on the fourth and eleventh days of the experiment. There was an average excretion of 3.2 grams. During the first nine days of ingestion of sulphur water the average excretion of phosphates was 3.5 grams, an increase of 10 per cent. The fall in phosphates after alteration of the diet is somewhat noteworthy. It nearly coincided with the rise in temperature to be detailed later on.

CHART E.—Phosphates (in grams).

The method used for estimating indican (indoxyl sulphuric acid) was the most exact yet devised—that of Dr. Oerum (Copenhagen).¹ The total amount on four of the last five days of the pre-sulphur water period amounted to 5 mg. a day. During the first nine days of treatment by sulphur water the average was nearly 10 mg. a day, an increase of 87 per cent. This result was totally unexpected, and requires confirmation. It seemed probable, from *a priori* reasoning, that the action of sulphur water would decrease the absorption of any of the derivatives of the aromatic nucleus of protein—that is of tryptophane. Experiments in which tryptophane is fed by the mouth to normal subjects do not apparently lead to any increase in the excretion of the aromatic bodies in the urine. Direct injection of this body, however, into the lower portion of the small intestine leads to an immediate increase of the aromatic sulphates of the urine.

Now sulphur water hurries on the contents of the stomach and upper small intestine, and probably brings to the bacteria of the lower intestine a larger proportion of tryptophane containing proteid than would reach this part of the intestine under more normal conditions. The action of calomel in increasing the excretion of bodies of the indoxyl group has probably a similar explanation.

The blood pressure was very kindly taken for me by Dr. Edgecombe of Harrogate, time, place, and conditions

being as nearly uniform as possible. The lower part of the fractions refers to systolic pressure, the enumerators to the diastolic pressures. An atmospheric manometer was used.

Fifth day	...	...	...	132
Sixth day	...	...	...	130
Eighth day	...	...	...	130
Eleventh day	...	...	...	127
Twelfth day	...	...	...	130
Thirteenth day	...	...	...	130
Fifteenth day	...	...	...	130
Eighteenth day	...	...	...	128
Twentieth day	...	...	...	138

Av. 130

Av. 130

Thus whatever may be the exact significance of the slightly lowered diastolic pressure, the alteration of the systolic pressure due to sulphur water is virtually negligible in a healthy person fed on a strictly measured non-purin-containing diet. A solitary exception afforded by an observation of the twentieth day can, I think, be satisfactorily explained as the result of the ingestion of repeated doses of hypoxanthin. On the nineteenth day of the experiment the subject suffered from depression and considerable headache, and on the twentieth his temperature was 100.2° at 2 p.m.; he sweated profusely during the following night. On the following day at 2 p.m. his temperature was 102.6°, rising the same evening to 103°. On the morning of the twenty-second day of the experiment the temperature at 8 a.m. was 99.6°, and at 11 a.m. was subnormal. His skin had an icteric tinge, and he complained of considerable lumbar pain. There was no albumen in the urine, and on the twenty-fifth day the lumbar pain had completely disappeared, to be replaced by a feeling of considerable stiffness in the flexor muscles of the lower parts of the thighs. The urine on the twentieth and twenty-first days of the experiment showed enormous deposits of uric acid crystals, amounting on the twenty-first day to 0.3 gram. The feverish attack was not followed by any marked debility. This, I take it, is the clinical picture of a true uric acid storm, and was the cause of the increased blood pressure of the twentieth day.

The late Dr. Samuel Fenwick many years ago pointed out that in certain conditions in which the function of the liver was abnormally performed there was a lessening amounting in some cases to almost entire absence of sulpho-cyanate in the saliva.² As gout was one of the conditions in which this lessening occurred, I instituted a colorimetric method to show the influence, if any, of sulphur water on the excretion of this body in the saliva. A rise was noted during the first eleven days of the experiment, but sulphur water had no obvious effect upon the quantity of sulpho-cyanate excreted in a given time, although the amount of saliva excreted in the test time (five minutes) was rather lessened during the sulphur water period.

CONCLUSIONS.

The action of sulphur water may at present be best summarized as one of increased oxidation and tissue change. That it influences general metabolism profoundly is shown by

1. The increased total nitrogenous output (8 per cent.).
2. The increase in the excretion of the phosphates (10 per cent.) on a strictly regulated diet identical from day to day in every particular.

Further, the increase in excretion of endogenous kreatinin (13 per cent.) proves its effect on the whole musculature of the body—and on the hepatic functions.

The large increase in the excretion of body tissue (endogenous) uric acid (18 per cent.) proves its powerful influence in increasing the rate of metabolism of the nuclein-containing elements of the body.

Further, the increase in the total solids of the urine also definitely points in the same direction (see Paper No. 1).

Finally, the fact that hypoxanthin is recoverable from the urine as uric acid to a percentage almost double that of the normal and in two-thirds of the normal time, is very plain evidence of the greater extent and increased rate of oxidation going on in the body generally, and in the liver in particular. In the present state of knowledge this action can only be explained as due to the enormous

stimulation of the xanthin oxidase of the liver. Incidentally I may remark that the body becomes capable of dealing with increased quantities of these materials—a point of some interest with regard to diet in gout.

Now, as to whether these points have any direct bearing on the classes of cases most likely to receive benefit at Harrogate, I must leave to the criticism and judgement of others, but I may bring to recollection some of the main points of recent research with regard to gout and arthritic troubles.

Brugsch and Schittenhelm have shown (1) that gouty patients kept on a non-purin diet and dosed with measured amounts of hypoxanthin excrete the hypoxanthin as uric acid both more slowly (five to six days) and in smaller percentages than is normal. (2) They assert that the administration of hypoxanthin in gouty patients may provoke an attack of acute gout.

Dr. Gowland Hopkins some years ago showed that the total uric acid output is lower in gout than is normal, and later Dr. Mallory³ has shown in a small series of cases that this is true whether the uric acid is of endogenous or exogenous origin. In Mallory's cases only 8 per cent. of hypoxanthin is recoverable as uric acid.

The results of my inquiries into the action of sulphur water in approximately normal subjects tend to show that in all these points sulphur water exerts a profound influence.

A very prominent characteristic in some cases of gout—the diminution in the amount of urine passed (it is often well under 20 oz. in the twenty-four hours)—is very rapidly relieved by treatment with this water, the diuresis amounting to well over 100 per cent. In such cases also the specific gravity of the urine does not vary inversely as the amount passed; on the contrary, the specific gravity is often highest at the height of the diuresis, the increase of the total solids being relatively enormous.

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BALNEOLOGICAL TREATMENT OF DISEASE.

By W. RINGROSE GORE, M.B.,

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SPEAKING generally, there are two classes of cases that resort to spas for treatment—first, those that are not suffering from any definite disease, but from the results of living at high pressure, either in acquiring or expending wealth, who obtain, through the freedom from worry, regular hours, and plain food which form part of the regular régime of a spa, a restoration to their usual health. The other class are those that come for the relief of some definite disease.

We know that practically all disease is bacterial in origin, that inflammation may be defined as the tissue reaction to bacterial invasion, and that those chronic inflammatory diseases that form the majority of the cases that resort to spas for treatment are microbial; yet it has not been properly appreciated that the methods of treatment in use in the majority of spas are those most suited for the treatment of chronic bacterial disease, especially when it affects the digestive tract.

I will assume as a working hypothesis that such diseases as gout, rheumatism, rheumatoid arthritis, colitis, the various forms of neuritis, glycosuria, arterio-sclerosis, dyspepsias, and most skin diseases, have a toxic basis probably intestinal in origin.

The study of the varying pathogenicity of the intestinal bacteria shows that the bacteria which may be harmless inhabitants of the various secretions of the alimentary canal become at once pathogenic on a change in their environment—that is in this instance a change in the character of the secretion. The virulence of bacteria may depend upon the medium in which they grow. For example, a change in the nasal secretion due to the reflex effects of chill causes an increased growth of those bacteria normally present in the upper air passages, which at once become pathogenic, producing a common cold. A similar sequence of events takes place, I believe, in the upper digestive tract; owing to gastro-duodenal catarrh brought on by errors in diet, a change takes place in the normal gastro-intestinal secretions, and a bacterial growth takes

place in the upper intestinal tract which should in health be sterile, leading to the absorption of more virulent toxins. That this increased bacterial growth really does take place is known from the indol reaction in the urine.

The normal secretions of the body cavities inhibit the growth of those bacteria that are usually present in these situations, but if the character of the secretion is altered, this inhibitory power is lost, and a bacterial growth takes place, producing a catarrhal condition which leads to the production and absorption of bacterial toxins, and is the cause of most of the chronic diseases that come to spas for treatment.

Direct antiseptic treatment of this condition is useless; vaccines are occasionally useful, but the scientific treatment is to restore to the secretions that inhibitory power over the growth of bacteria which they have lost. This is what spa treatment really does. The most common form of spa treatment is the early morning drink; the most popular spas are those in which a fairly large quantity of water is drunk before breakfast when the stomach is empty. The most effective of these waters are not highly mineralized, and depend upon the quantity of fluid drunk for their therapeutical effects; at some of the spas, such as Contrexéville, six or eight pints may be consumed during the early morning walk.

That water drunk when the stomach is empty passes directly into the intestine has been well shown in recent x-ray work; consequently, any water then drunk acts as a gastro-intestinal douche, and by its purely mechanical action limits bacterial growth in the upper intestinal tract and helps to restore a catarrhal mucous membrane to a normal condition. A normal saline douch is the best way of restoring an infected mucous membrane to a normal condition, and this spa treatment is a long continued saline douche to the upper intestinal canal, for patients at these spas spend one or two hours sipping what is practically a normal saline solution.

It is the length of time required that makes this form of treatment difficult in private practice; it is very easy to spend an hour sipping hot water, walking about with genial companions who are all doing the same thing; quite a different matter in the seclusion of one's own home to spend an hour drinking and wait another half-hour for breakfast.

Intestinal catarrh with increased bacterial growth of the upper intestinal tract, which should in health be sterile, is quickly relieved by this saline douche; the contents of the intestine are mechanically washed downward, general peristalsis of the intestine is started by the direct stimulation of the salt in solution, which induces a more healthy secretion from the intestinal glands and removes the catarrhal condition that exists, as the same method of normal saline douching does in the case of other catarrhal mucous membranes. That this is the actual process can be proved by the indol test. The presence of indol in the urine is evidence of abnormal putrefactive changes in the upper intestinal canal associated with intestinal catarrh.

The effect of an intestinal douche on a case of intestinal catarrh showing the indican reaction is almost immediate. The indican is at once reduced in amount and gradually disappears, showing that the catarrhal condition has been cured and that the jejunum has again become sterile.

The study of the intestinal bacteria is still in a backward state, and, while we theoretically ascribe many diseases to increased or altered growth of this group of microbes, we are not yet able to place each disease. Gout, rheumatism, rheumatoid arthritis, colitis, glycosuria, some cases of eczema, different forms of neuritis, arterio-sclerosis, are a group of diseases which have a certain ill-defined connexion with each other, perhaps best shown in their hereditary relationships. They are, it is now generally believed, toxæmias of bacterial origin, they all have some digestive abnormality, they are all relieved by gastro-duodenal lavage.

The other effect of spa treatment is the protection of the body cell from the effect of toxic substances circulating in the blood by their dilution and by increasing the rapidity of their elimination; the water drunk is rapidly absorbed as it passes through the intestines and is eliminated through various secreting organs, increasing their activity, and especially causing a greatly increased action of the kidneys.