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AS A TEST FOR
FUNCTIONAL DISORDERS
OF THE LIVER

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THE SALIVA

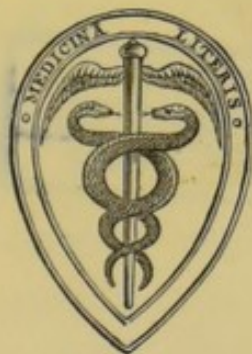
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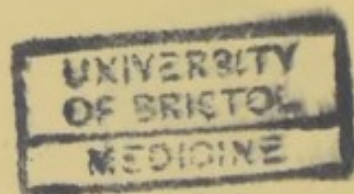
THE SALIVA
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BY
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P R E F A C E

THE substance of the following pages was originally delivered as a lecture at the London Hospital, and was afterwards published in the 'Lancet.' Some further observations are now added that seemed necessary to render more intelligible certain points that, for the sake of brevity, were imperfectly illustrated in the lecture.

It is, I think, probable that the brilliant success that has followed the employment of physical signs in the investigation of disease has a tendency to foster the belief that we are better acquainted with the nature and consequences of various structural changes than is actually the case.

Although the anatomical condition of an organ is most important as regards prognosis, yet the extent of the mischief is no certain guide as to the result of the case, for we constantly see one person sink under the same amount of structural alteration that is readily borne by another. As to treatment, it is rarely that we are guided by the knowledge derived from physical signs, for in most cases we have to direct our remedies

either to the relief of functional disturbances, or to the improvement of the general health of the patient.

What seems now to be needed in order that medicine should rest upon a more certain basis, is to ascertain how far each change in the structure of an organ necessitates a loss or alteration of its functions, and how far such loss can be compensated for by an increased activity of the organ affected, or by the action of other allied structures. I think no one will doubt that if we were armed with such knowledge, our prognosis would be more sure, and our treatment more definite and more certain in its results.

It was with this view that I attempted to ascertain some of the functional disorders to which the liver is subject, thinking that its great importance as a nutritive, as well as an eliminating, organ would repay any labour expended on the inquiry. Unfortunately, in the investigation of this organ we meet with unusual difficulties, for the colouring matters of its secretion are mixed with a number of other excretions before they are eliminated from the system, whilst the biliary salts are absorbed in the upper part of the intestinal canal, and therefore elude our further observation. It was therefore necessary to examine the secretions of other glandular structures, and to note how far alterations in them seemed to coincide with the presence of structural changes in the organ I had selected for the inquiry.

I do not wish to ignore the valuable researches that

have, from time to time, been made into the colouring matters and salts of the urine, which have been by many supposed to be the result of the action of the liver, but I think these can only be regarded as the consequence of its power as an excreting structure, and are no measure of its activity as an organ of nutrition. Of the various processes that take place in the animal body, that by which the food, digested and absorbed in the alimentary canal, is transformed into material fitted for the necessities of life, is perhaps least understood, and as the liver appears to be the organ chiefly concerned in this transformation, its investigation as a nutritive organ must be of great importance.

Whatever may be the opinion of the mere pathologist, few observant practitioners will doubt that most of the constitutional diseases, such as for example phthisis, have for their origin some alteration in the nutritive processes, by which the power of repair, or the resistance of the tissues, is so diminished that the minute organisms, to which so much attention is bestowed at the present day, are permitted to multiply and invade the various structures of the body. If such be the case any test for an alteration, however slight, in the normal performance of the nutritive functions must be of practical value.

Each one must judge for himself how far I have been able to show, in the following pages, that there is a probability that the amount of the sulphocyanide in the saliva is an index to the activity of that part

of the nutritive process which is performed by the liver, but if the consideration of the question should induce others, better fitted than myself for such inquiries, to investigate the relation between alterations of function and structural changes, especially with relation to the organs engaged in nutrition, I shall consider the labour I have bestowed upon this matter as well spent.

THE SALIVA

AS A TEST FOR

FUNCTIONAL DISORDERS OF THE LIVER

WE know perhaps less of the functional diseases of the liver than of those of any other structure in the human body of equal importance. The organ is popularly supposed to be very frequently deranged, and various symptoms of disordered digestion are commonly referred to an increase or diminution in its action ; but, from the changes its secretions undergo before they come beneath our notice, we have no means of proving how far such an opinion is correct.

Many years ago I commenced some inquiries in order to ascertain if any of the secretions afforded a means of testing the manner in which the hepatic functions are performed. For this purpose I first examined the colouring matters of the urine, but was unable to arrive at any definite conclusions, although

there is no doubt in many cases a close connection between the state of the urine and the condition of the liver. As there is often a yellow coating on the tongue in jaundice and other affections of the biliary system, I procured the saliva from persons suffering from jaundice, evaporated it in a water bath, and thus obtained a material of a yellowish-brown colour. But although this seemed to be a modification of the colouring matter of the bile, I found it was only present under certain conditions, so that I was forced to abandon the hope that it could be employed as an ordinary test for the quantity or quality of the hepatic secretion.

You are aware that a bitter taste in the mouth is occasionally complained of by patients suffering from jaundice, and also sometimes by those who are only what is termed "bilious." Acting on the supposition that this was the result of an excretion of the biliary acid by the salivary glands, I examined the saliva of various persons suffering from congestion of the liver and from jaundice, but I failed to discover any evidence of the presence of these salts in the secretion.

Whilst engaged in these inquiries, an elderly medical man consulted me, whose only complaint was an intensely bitter taste in the mouth. He never had suffered from jaundice, and he believed himself in other respects to be in perfect health. He found the taste increased after taking alcohol in any form, but

no treatment he had adopted had relieved him. I received from him a considerable quantity of saliva, and obtained from it the ordinary indications of the presence of biliary salts. On thinking over his case, it seemed to me that if the salivary glands were capable of separating the biliary salts, perhaps some material derived from these might be a normal constituent of their secretion. Then as the bile contains so large a percentage of unoxidised sulphur, and as the saliva also secretes a sulphur salt in the shape of sulphocyanide of potassium, it struck me there might be some connection between the action of these glands. I therefore determined to ascertain, if possible, whether the quantity of this substance varied in different persons, and under what circumstance such variations occurred.

The estimation of the sulphocyanide was, however, a matter of no small difficulty, for it is normally present in so minute a quantity than any attempt to measure it by isolation appeared hopeless. You are aware that the addition of a persalt of iron to saliva gives the blood-red colour of sulphocyanide of iron, and it appeared to me that the simplest way would be to compare the depth of the colour thus produced in the salivas of those suffering from disease with that of persons in a state of health. The saliva of each person examined was therefore collected as it flowed from the mouth for about two minutes, and seven drops of a solution of half a drachm of the perchloride

of iron to one ounce of water were added, and the colour thus obtained was compared with a scale of colours prepared in the following manner.

A quantity of saliva collected from a number of healthy persons was mixed together, and the tint produced by the addition of the perchloride of iron was taken as the normal amount; a portion of the same saliva was then evaporated to one quarter, and another to half, its bulk, and the colours produced in these respectively were assumed to represent four times and twice the normal amount of sulphocyanide; whilst two other portions diluted with water to twice and four times their amount were taken as representing half and a quarter of the normal quantity of the salivary salt. These were then copied in colours by an artist, so that there should be no variation in the tints.

In this way I examined during the course of many years the salivas of numerous persons who consulted me for different maladies, recording also the symptoms of which they complained, and in most cases the results of the treatment adopted. These observations were so numerous (probably many thousands) that I selected for analysis only those in which the amount of the sulphocyanide was much below or much above the normal. I have described these in this lecture as "private cases" whenever I have found it necessary to quote them. In order to check these observations, I requested Dr. Needham, at that time house physician to this hospital, to examine in the same way the

salivas of a number of patients who were under treatment in the wards, and two years afterwards a similar inquiry was carried on by Dr. Bedford Fenwick. The cases thus obtained, numbering between 200 and 300, were analysed together, and I have quoted them as "the earlier hospital cases."

Although the conclusions from both of these sets of cases were generally in accordance with each other, there were numerous discrepancies which could not be explained. I therefore commenced a fresh series, in the following manner:—A solution of sulphocyanide of iron was prepared of definite strength, and was graduated by successive dilutions, so that each was only three quarters of the strength of that above it. These were placed in the small flat bottles used by spectroscopists, each bottle being of equal thickness. I took my own saliva, which agreed in colour with that formerly taken as normal, as the normal standard, and the bottles were labelled + or —, according as they differed from it. Each of the salivas, when examined was mixed with a definite quantity of the tincture of perchloride of iron, filtered through cotton wool, and being placed in a spectroscopic bottle of equal thickness was carefully compared with the graduated strengths of the sulphocyanide of iron.

In this manner I examined week by week the salivas of 500 patients admitted into my wards, carefully recording the depth of colour at every observation, but not looking at the notes in the hospital case-

books. After all these persons had been discharged, I compared the state of the saliva of each in every week of his residence with his condition at the time his saliva was obtained. The results of these observations form the facts from which I have drawn most of the conclusions I am now about to lay before you, and I have quoted these as the "later hospital cases."

Before commencing our inquiries it is necessary to determine what is the normal amount of sulphocyanide in the saliva of healthy persons. No doubt this must vary considerably according to the circumstances of the individuals examined, but I thought we should obtain the best standard for reference if the observations were conducted upon persons of the same class as our hospital patients. I therefore procured the salivas of forty-three persons, most of the females being hospital nurses, and the males either hospital porters or patients suffering from some trifling local malady, such as gonorrhœa. The following table shows the results of this inquiry :—

TABLE I.—*Showing the Colour of the Saliva of 43 Healthy Persons.*

Colour of saliva.	Males.	Females.	Totals.	
$-1\frac{1}{2}$	1	0	1	} 6
-1	2	2	4	
$-\frac{3}{4}$	1	0	1	
$-\frac{1}{2}$	4	5	9	} 31
$-\frac{1}{4}$	2	0	2	
N	12	4	16	
$+\frac{1}{4}$	1	0	1	} 5
$+\frac{1}{2}$	2	1	3	
$+\frac{3}{4}$	0	0	0	
$+1$	2	0	2	} 5
$+1\frac{1}{2}$	1	1	2	
$+3$	1	0	1	
Totals . . .	29	13	42	

When you examine this table you will observe that the largest number of the salivas presented the depth of colour I before took as the normal standard, but that most of the females were half a degree below it, and thirty-one out of the forty-two were within half a degree below or above that amount, only five being above, and six below. It will be necessary that this should be borne in mind when we afterwards discuss the diseases to which persons apparently healthy, but in whose salivas the sulphocyanide varies greatly from the normal point, are especially liable.

In commencing an analysis of the cases in which the amount of the sulphocyanide in the saliva was deter-

mined, let me first direct your attention to the patients who were admitted suffering from typhoid fever. Thirteen are recorded in the "later hospital cases," all of whom recovered, and in each, as soon as convalescence was established, there was a sudden rise in the amount of the salivary salt, which either increased or was maintained at about the same strength until the patient was dismissed. This is seen in Table II, in which are placed in the first line the average quantities of the sulphocyanide in each week before and after the commencement of convalescence, and in the second the number of cases from which the averages were obtained. The date of convalescence was in each fixed at the day on which the temperature permanently fell at or below the normal point, and you will observe that in the second week before this period the average amount of the salt was only $+ \frac{3}{4}$. But during the febrile condition there is a very scanty secretion of saliva, so that the quantities we were able to obtain were very small, and consequently in a state of great concentration. It is evident, therefore, that the amount of the sulphocyanide daily excreted must have been very minute whilst the fever was going on, but as soon as this began to subside the average rose to $+ 2$, and remained high until the seventh week after the commencement of convalescence. Let me remind you that the figures in this table are averages, for in some instances the quantity rose to $+ 4$, and in one or two cases to seven times the normal amount.

The degree of increase of the salt seems to depend on the length of the febrile stage. In Table III I have included in the first line all those in whom the fever lasted less than twenty-one days, and in the second those whose febrile stage exceeded three weeks in duration. It would appear from these figures that in cases in which the fever has been of short duration the increase of the salivary salt takes place more slowly, but the duration of the convalescence is longer than in those in which the febrile stage has been more prolonged. It is also worthy of remark that the greatest amount of secretion was reached earlier in the latter than in the former, the maximum being in the third week in the second group, and in the fourth week in the first group. The augmented quantity secreted is not the result of an increased supply of food, for, as you are aware, the patients are confined to a liquid diet for two or three weeks after convalescence has been established, and it is also worthy of observation that in Table II the salt is seen to increase before the fever has quite subsided.

If further investigations should confirm these conclusions, we shall have in the quantity of the sulphocyanide during the first week of convalescence a means of ascertaining the probable length of the period during which the patient is likely to regain his former health and strength. If, for example, the saliva should show a colour four or five times that of the normal, we may expect a rapid improvement and a

short period of convalescence, but if the excess of sulphocyanide be only slight, a tedious recovery, perhaps checked by complications or recurrences of the fever, may be looked for. I need not remind you how anxiously the patient is watched both by physicians and friends towards the termination of a tedious case, and how any sign of improvement, however slight, is impatiently awaited. Now, you will observe that the quantity of the sulphocyanide increased to + 2 on the week before the permanent fall of the temperature, so that we may perhaps find in the salivary secretion the earliest indication of approaching recovery. But the question will naturally suggest itself to your minds, As a moist state of the mouth and tongue is usually amongst the earliest signs of improvement, and as we find there is an increase of the sulphocyanide at the cessation of the fever, may not this salt act as a stimulant to the glands and thus produce the augmented secretion of saliva? I think we must answer this in the negative, for neither in typhoid nor in any other disease have I been able to discover any relation between the amount of the sulphocyanide and the quantity of the salivary secretion.

TABLE II.—Showing the number of Typhoid Fever examined, and the average amount of the Sulphocyanide in each week.

	Weeks before Convalescence.		Weeks after Convalescence.						
	2nd	1st	1	2	3	4	5	6	7
Average amount of sulphocyanide . . .	$+\frac{3}{4}$	+ 2	$+2\frac{3}{4}$	$+3\frac{1}{4}$	$+2\frac{3}{4}$	+ 3	+ 3	+ 2	$+2\frac{3}{4}$
Number of cases examined . . .	8	7	10	12	13	10	7	3	1

TABLE III.—Showing the Differences in the weekly quantity of the Sulphocyanide in Typhoid of short and long duration.

	Weeks after Convalescence.						
	1	2	3	4	5	6	7
Within 21 days of fever { Average amount of sulphocyanide Number of cases . . .	+ 1 2	$+2\frac{1}{2}$ 3	$+2\frac{1}{2}$ 4	+ 3 3	$+2\frac{1}{2}$ 4	+ 2 3	$+2\frac{3}{4}$ 1
Beyond 21 days of fever { Average amount of sulphocyanide Number of cases . . .	$+2\cdot90$ 3	$+3\cdot02$ 3	$+3\cdot17$ 3	$+2\cdot71$ 2	$+4\cdot08$ 1	—	—

Let us now ask ourselves what are the changes that occur during the progress of typhoid fever. Every day's observation shows us that there is a rapid loss of flesh and strength; the muscles quickly waste and the fat is absorbed, so that in a case of long duration the patient is reduced almost to the condition of a skeleton. As soon, however, as the fever disappears, nature begins to repair the damaged textures, the muscular structures regain their strength and firmness, the roundness of the limbs returns with the deposition of fat, and day by day the patient increases in weight and strength. Along with this the nutritive organs are stimulated into a state of unusual activity, the appetite becomes keen, and the digestion of the food proceeds with unaccustomed celerity.

What, then, I wish to draw your attention to, is the fact that along with this unusual activity of the organs engaged in nutrition we find an excessive quantity of the salivary salt—a fact sufficient to indicate that, instead of its being a mere accidental result of local decomposition, as some have supposed, the sulphocyanide is in some way dependent upon the action of the digestive or assimilating structures. But, in addition to this, Table III seems to point out that there is probably some relation between the quantity of the sulphocyanide secreted and the degree of activity of these organs, for it will be remarked that in the group in which convalescence was most rapid the amount of the salivary salt was the greatest.

A similar state of the saliva may be occasionally observed when from other causes there is a sudden demand made on the nutritive organs. In some cases of hæmorrhage occurring in persons whose digestive powers are not impaired, the salivary salt will be found in increased quantity, at the same time that the loss of blood is being rapidly replaced. Thus a woman, about thirty years of age, was admitted into the hospital in a very exhausted condition. A few days previously, when she appeared to be in perfect health, she had suddenly fainted, and shortly afterwards had vomited a large quantity of blood, the hæmorrhage being repeated twice in the next few hours. There was no return of the bleeding from the stomach, and that it had arisen from some general cause, and not from ulceration of the stomach, was shown by the presence of hæmorrhages in the retinae, an absence of pain after food and of all other symptoms of disorder of the digestion previous to the attack. Two weeks after the attack the sulphocyanide was $+ 2\frac{1}{2}$, next week $+ 3$, and in the successive weeks $+ 3$, $+ 2\frac{1}{2}$, and $+ 1\frac{3}{4}$, at which latter date it is noted in the case-books that she had quite regained her strength and colour. One month afterwards she was again attacked in the same manner, and was readmitted in a very blanched condition; the amount of the sulphocyanide was remarked to be $+ 2$, and continued at that amount until she regained her colour and left the hospital.

The conclusion that seems fairly to follow from these facts is that an unusual amount of the sulphocyanide presents itself in the saliva whenever the necessities of the system call for an increased activity of the nutritive organs ; and this is supported by the circumstance that persons who are unusually stout and well fed ordinarily secrete a saliva having an excess of this salt.

But you will naturally say, Is there not a necessity for an increased action of the assimilating organs in typhoid from the first moment when the patient is smitten with the fever? Certainly there is, but the nutritive organs are incapable of responding to the demand, for they themselves rapidly waste and lose their functional powers. Thus in four cases that had died of typhoid fever I carefully scraped off the whole of the mucous membrane of the stomach and found that the average weight was only 580 grains, whilst the average weight of the gastric mucous membrane in seventeen males who had died of other diseases was 1035 grains, showing that in this malady the stomach loses nearly half its bulk. Nor is there merely a loss of substance ; there is also an impairment of functional activity, for in seven cases I made an artificial gastric juice with the mucous membrane of the stomach, and found that the average amount of coagulated albumen dissolved was only one grain, whilst the amount ordinarily dissolved by the mucous membrane of the stomachs of persons dying from other

disorders was four grains. In two of the typhoid cases the albumen was quite unaffected by the artificial gastric juice, and in one a small quantity only was dissolved. It is therefore probable that in typhoid the general wasting of the body is the result not merely of an increased destruction of tissue, but that it also arises from the inability of the digestive organs to supply sufficient nutriment to compensate for the augmented waste ; and, as we have already seen, along with the diminished activity of these organs there is a decreased quantity of the sulphocyanide in the saliva. As soon, however, as the blood-making organs are restored to activity, the salt reappears in the salivary secretion in an increased amount.

It will be obvious that, if the above conclusions are correct, we ought to find the quantity of sulphocyanide below the normal whenever the digestive organs are unable to supply nutriment sufficient to meet the requirements of the system. Let us, then, test this by the condition of the saliva in maladies attended with a rapid loss of flesh. Perhaps one of the best diseases we can select is pulmonary phthisis. Seventeen cases are recorded in the "later hospital records," of which ten died or were removed from the hospital in a sinking condition, and seven were dismissed much improved. Of those who died, the average amount of sulphocyanide was only -1.27 , and in some no colour at all could be produced by the addition of the solution of iron to the saliva, so that in these we may assume

the secretion of the salt had ceased. In only two of these was the amount above the normal—in one it was $+ \frac{1}{2}$, in the other $+ 1$; but in all the others it was much below the ordinary quantity. In eight of them the weight of the body was regularly recorded; in five there was a diminution of weight, and these exhibited an average of $- 1.15$ of the sulphocyanide.

You must not, however, suppose that a deficiency of the salivary salt is an indication of the existence of tubercular disease; it is only a concomitant of a failure of the general nutrition, for the average of those who improved in the hospital amounted to $+ 1$; only two exhibited a deficiency of the salt, and all the others showed an amount above the normal. In three there was a weekly gain in weight, and in these the quantity of the sulphocyanide was above the normal. The above facts are supported by the "earlier hospital cases," from which it appears that the diminution of the salivary salt increases with the duration of the malady. Thus twenty-six cases of phthisis are recorded, of whom 25 per cent. had a deficiency of the sulphocyanide when examined within six months of the beginning of the illness, whilst 58 per cent. of those between the sixth and twelfth months, and no less than 87 per cent. of those above twelve months' duration, presented the same condition.

This difference in the state of the saliva in phthisis at different periods is not difficult of explanation. In the earlier stages there is usually, as will be after-

wards shown, an increase of the salivary salt, the amount varying with the severity of the case, and the capability of the digestive organs to support nutrition, but as soon as the patient begins to suffer from vomiting, diarrhoea, excessive expectoration, or any other cause tending greatly to reduce his vital powers, the colour sinks below the normal point. Whenever, therefore, we discover this to be the case, we must at once attempt to check any undue discharge, and to increase the general strength by all the means in our power.

A similar deficiency of the salivary salts is usually observed in the later stages of malignant diseases. In almost all of those in which the stomach was the seat of cancer the sulphocyanide became deficient at an early period, and remained so until the termination of the case; thus I find eight cases of this disease recorded, and in all the amount was very small or was entirely absent. When other organs were affected by cancer, the period at which the sulphocyanide sank below the normal varied with the rapidity of the growth, the organ involved, and the more or less rapid inroad made upon the general health of the patient. This fact may perhaps prove useful in the diagnosis between cancer and simple ulcer of the stomach. It is rare to find a deficiency of the sulphocyanide in the latter, for the nutrition usually remains good, and in cases of hæmorrhage, as we have before seen, there is often a sudden increase in the quantity; whereas in

cancer the amount early falls below the normal from the loss of digestive power with which it is accompanied.

But you may ask, Why is there such an early failure in the general nutrition in gastric cancer? The explanation I believe to be that malignant disease of this organ is almost always associated with morbid changes of the peptic glands, and consequently with inability to digest the food. Thus in every case that I have examined microscopically changes of an important nature have been found in the mucous membrane of the stomach, although it often appeared normal to the naked eye, and the parts examined were at a distance from the seat of the tumour. The peptic glands were either closely adherent to each other or were in a state of atrophy, and an infusion of the mucous membrane exerted only a slight power of dissolving coagulated albumen. In addition to these structural changes the patient's strength is sapped by the more or less constant discharge of blood, by frequent vomiting, or by an obstruction to the passage of the food into the intestines.

From the above facts we are bound, I think, to conclude that the sulphocyanide in the saliva is increased in quantity whenever an unusual demand is made upon the nutritive organs by the necessities of the system, and these organs are capable of answering to the call; but that, on the contrary, the amount of the salt is diminished whenever the nutritive organs are unable to meet its requirements. An increased

quantity of the sulphocyanide, therefore, under such conditions, manifests an excess of the income over the expenditure, whilst its diminution points to an excess of the expenditure of the system over its income.

We before found that when, as in convalescence after typhoid fever, an increased activity in the cell-growth of the whole body took place, there was an unusual amount of the sulphocyanide in the saliva, and we attempted to explain this by supposing that the necessity for repairing the previous waste of the tissues stimulated the blood-forming organs into increased activity, the augmented amount of the salivary salt being only an indication of their increased action. But if there is a connection between the necessities of the system and the activity of the blood-making organs, we should expect that an increased local cell-growth would act in the same way as an increased general cell-growth, and would also stimulate the functional activity of the nutritive organs, and that consequently, under such circumstances, the amount of the sulphocyanide would be also augmented. Let us, then, test the truth of this anticipation by the examination of the saliva in persons who were suffering from increased local cell-growth—in other words, from malignant or inflammatory affections.

We have already seen that in cases of cancer of the stomach the salivary salt was below the normal, but in these the local malady had made great inroads upon the general health. Where, however, either

from the position of the tumour or the slowness of its growth, there was no marked cachexia, the sulphocyanide was above the normal. Thus, in a case of sarcomatous tumour of the ribs the amounts registered each week were $+ 2\frac{3}{4}$, $+ 3\frac{1}{4}$, $+ 2\frac{3}{4}$, $+ 3\frac{1}{4}$, $+ 3\frac{1}{4}$, and the patient left the hospital with no loss of weight or strength, although the size of the mass had greatly increased. I have met with the same circumstance in some cases of cancer of the liver, where the disease was in an early stage, and where the growth was rapid, although in some of them jaundice was also present, probably resulting from compression of the smaller bile-ducts. I have already mentioned that the same increase is usually present in the early stages of phthisis, but is replaced by a diminution as the life of the patient draws towards its close.

But you may naturally object that in typhoid the increase of the sulphocyanide was only observed after the cessation of the fever, whilst in cancer and phthisis it takes place in the earlier stages of the disease. This is easily explained when you remember, what was before stated, that in typhoid there is but little digestive power, so that the blood-making functions cannot respond to the demands of the system until after convalescence has set in ; whilst in the local maladies we have been just considering the digestive functions appear, in the earlier stages at least, to be intact.

In most cases of acute inflammation there is a rapid local cell-growth. What, then, is the state of the

saliva under these circumstances? Let us first look at acute pneumonia, of which disease there are nine instances recorded in the "later hospital cases." The average amount of the salivary salt in these was only $+ \cdot 95$; they were examined after convalescence had set in, for unfortunately I have no records of the state of the saliva during the acute stage. The smallness of the increase is what might have been anticipated, for everyone must have observed how little flesh the patient loses in an ordinary attack of acute lobar pneumonia, and how rapidly he regains his strength. This is supported by the fact that the more severe the case was, the greater was the amount of sulphocyanide during convalescence. Thus five were dismissed within three weeks, and their average was $+ \cdot 70$; four required a longer residence to regain their strength, and their average was $+ 1 \cdot 27$. It is not then likely that we shall derive much advantage, either in prognosis or treatment, in an ordinary case of pneumonia, but it would be wise to test the saliva when the convalescence seems to be unusually prolonged.

Bronchitis, when uncomplicated with heart and kidney disease, seems to have no effect on the production of the salivary salt, for in seven cases which were examined from week to week the average did not exceed the normal.

In acute pleurisy there is a considerable cell-growth, and consequently we find a marked difference in the amount of the sulphocyanide from that in bronchitis.

There were thirteen observed in the "later hospital cases," four of which presented only the physical signs of "dry pleurisy;" in seven there was exudation of fluid, and most of these were treated by aspiration. In the cases of dry pleurisy the average of the salivary salt was $+ 1.09$; in those accompanied by effusion it reached $+ 1.45$. A similar result is afforded by the "earlier hospital cases;" for of nine cases, four were examined within one week of the commencement of the illness, and three of them presented an excess of the sulphocyanide, while in one it was normal; three were examined between the second and third week, of whom two had an excess and one was subnormal; after the third week two were examined, and both were below the normal. It is therefore evident that the amount of the salivary salt is greatest where there is most local cell-growth, and it often falls below the normal in the stage of absorption. There were two cases of empyema in the "later hospital cases;" both were treated by drainage, and the examinations of their salivas were very interesting. The weekly amount of the salivary salt was in one $+ 2\frac{1}{2}$, in the other $+ 3\frac{1}{2}$; but in each at the twelfth week of the illness it fell suddenly—in the one to $-\frac{1}{2}$, in the other to $-\frac{1}{4}$, and in each it remained in amounts varying from -1 to $+\frac{1}{2}$ till the termination of the illness.

Observation teaches us that a local cell-growth, whether malignant, tubercular, or merely inflammatory, will often continue for a length of time without

perceptibly reducing the strength of the patient, the undue loss of material being supplied by an increased action of the nutritive organs ; but that when a certain point is reached the general health rapidly deteriorates. This point then—probably that at which the expenditure exceeds the income of the body—seems then to be accurately marked by the sudden diminution in the quantity of the sulphocyanide.

Two cases of “granular kidney” were admitted suffering from uræmic convulsions ; both improved under treatment, and the amount of the salivary salt increased in proportion to the improvement. One had, on his admission, $+1$, which increased to $+3$, at which figure it still stood on his leaving the hospital at the end of eight weeks. The second had only $-\frac{1}{4}$ at first, but it had risen to $+2\frac{3}{4}$ on the fifth week of treatment. In another case it was normal on admission and remained so the next week, but ten days afterwards he died with uræmic symptoms, no other observation being recorded in the meanwhile.

In chronic tubular nephritis, there must be a large demand upon the nutritive organs to supply the waste caused by the abundant cell-growth and the drain of albumen from the diseased organs. Consequently I have generally found that in the early stage the amount of sulphocyanide was above the normal, and remained so until the patient's strength began to fail. In one case of this kind it was $+1\frac{1}{2}$ on admission, but it rose to $+2\frac{1}{2}$ the next week, and remained high until he

left the hospital much improved. Two cases died ; in one the quantity was at first normal, but it sank next week to -2 , and remained at this point until death ; in the other it was at first $+1\frac{1}{4}$, but it had fallen to $-\frac{1}{4}$ on the last observation recorded before his death.

We have before seen that in two cases of empyema the amount of the salivary salt remained for some weeks above, but that it then suddenly sank below the normal, and the same circumstance usually occurs in cases of long-standing inflammation, of tubercle, cancer, or any other disorder that depresses the vital powers. But how can we explain the sudden change that thus takes place? I think the most probable hypothesis is that the nutritive organs are at first stimulated to unusual activity in order to supply the materials for increased growth, and that we then find the sulphocyanide in excess ; but that this augmented functional activity is after a time succeeded by a corresponding depression in their action, in accordance with the law that an excessive exercise of any organ is followed by a diminution of its functional power, and that when this occurs the patient exhibits the proof of it in his loss of strength, flesh, and colour, the exact point at which this takes place being marked by the sudden diminution in the sulphocyanide.

We have before seen that an increased growth of structure, whether local or general, must be accompanied by a sufficient power of digestion, in order that the sulphocyanide should present itself in increased

amount; it will be therefore necessary to inquire into the state of the salivary salt in various diseases of the digestive apparatus, when there is no demand made upon them for unusual exertion.

In the earlier stages of stricture of the œsophagus and of the pylorus the amount of the salivary salt is generally either normal or above the usual quantity, so long as sufficient food can be taken to maintain the nutrition of the body; but as soon as this ceases to be the case the quantity sinks below the normal. In cancer of the stomach, as I have before mentioned, the amount soon becomes subnormal.

In gastric catarrh it is usually above the normal, probably because this condition is so often associated with acute congestion of the liver. In atonic dyspepsia, on the contrary, the amount is ordinarily subnormal; in fact, this is by far the most frequent cause of a deficiency of the sulphocyanide, for 39 out of 111 "private cases," in which the amount was below the average, were instances of this disorder. They were all very severe cases, the appetite being bad in all; in many the sensation of hunger was totally absent, or was replaced by a loathing of all food. It is probable that feebleness of the stomach is also a common cause of a deficiency of sulphocyanide in various chronic maladies, for in 84 persons presenting a deficiency of the salivary salt the appetite was stated to be bad in 55, moderate in 12, and good in only 17 of the whole number.

Vomiting is a common accompaniment of a deficient amount of the sulphocyanide, but this was only observed where the rejection of the contents of the stomach was frequent and complete. It is not the case in the so-called "hysterical vomiting," and the condition of the saliva might possibly be of value in the diagnosis of this latter condition. In phthisis vomiting assists in enfeebling the patient, and also in producing the small amount of the salivary salt we have before seen is common in the later stages of that disorder. But it is only fair to remind you that in vomiting there is generally an increased flow of saliva, and we may therefore doubt whether the deficiency of the sulphocyanide may not be due, in certain cases of gastric disease, to exhaustion of the salivary glands, arising from their undue action. This objection is, however, disposed of by the fact that in some of the cases where the vomiting was relieved by the regular washing out of the organ, there was no increase thereby produced in the quantity of the salivary salt.

An occasional attack of diarrhoea or the exhibition of a purgative does not seem to affect the quantity of the sulphocyanide; but if dysentery or diarrhoea has been continued long enough to diminish the general nutrition, it then falls below the normal amount. Thus 23 per cent. of the "private cases," who presented a decrease of the salivary salt were suffering from one or other of these conditions. It is of course possible, if the saliva be examined only after the cessation of

the dysentery, that you may find an excess instead of a deficiency of the sulphocyanide, as an unusual demand may have been made on the digestive organs in order to repair the loss occasioned by the undue waste. Thus, a patient was admitted on Oct. 27th, 1883, with a sharp attack of dysentery which had commenced on that day; the discharge of blood and mucus entirely ceased on the 31st, and the saliva then was +4. It remained at the same point two weeks longer, when it fell to $+2\frac{1}{4}$, and finally in the sixth week to +1, when he was discharged cured.

From a consideration of the effects of long-standing diarrhœa, we might have conjectured that any cause that prevented the absorption of the digested food from the intestines would be followed by a change in the saliva. I had not, however, thought of this. I was therefore much surprised to discover a marked alteration produced by the tapping of persons suffering from ascites arising from cirrhosis. The saliva of a man affected with this complaint, whose abdomen was tensely distended with fluid, was examined on May 11th, and found to be $-3\cdot$; on the 14th he was tapped, and three days afterwards the sulphocyanide had risen to $+2\frac{1}{2}$; on the 28th it had again fallen to $-1\cdot$, but on that day 470 ounces of fluid were removed by aspiration; and on the 31st it had risen to $+2\frac{1}{4}$, after which date it gradually declined each week to +2, $+1\frac{1}{2}$, and N., subsequently to which there are no records. In a second case the sulphocyanide was only

—3 on November 15th ; on the 20th tapping was performed, and on the same day it rose to $+\frac{1}{2}$; on December 28th it was only $-1\cdot$, when aspiration was again practised, but the patient sank a few days afterwards. Three cases of this kind are recorded, each being tapped twice ; the average quantity of the sulphocyanide was $-1\cdot8$ just before and $+1\cdot04$ shortly after the operations. This is not due simply to the removal of an obstruction from the general circulation ; for no alteration in the amount of the salivary salt was observed after aspiration of the pleura, nor did it occur where the distension was only moderate, as you will see in a man suffering from ascites dependent on cirrhosis at present in the wards. In this latter case the fluid had been collecting for three years, and although there was a considerable quantity of liquid in the peritoneum, there was no great amount of internal pressure. He was tapped at his own request, and the saliva was not below the normal point before the performance of the operation.

On the other hand, the sulphocyanide may be below the normal in ascites arising from other causes, not from the pressure of the fluid, but from imperfect nutrition, and in this case the tapping does not alter the amount. For example, a man suffering from cancerous tumours of the abdomen was admitted, whose peritoneum contained a considerable quantity of fluid. On Nov. 14th the saliva was normal ; tapping was employed the same day in the hope of relieving

his pain, and on Nov. 21st the quantity of sulphocyanide was $-\frac{1}{2}$; on Nov. 28th it was $-\frac{1}{2}$, and he was aspirated on Dec. 1st; on Dec. 6th it had sunk to -3° , and he died from exhaustion on Dec. 8th.

From the above facts I think we may fairly conclude that when the amount of the salivary salt falls much below the normal in persons suffering from ascites arising from cirrhosis, tapping is indicated; and that where there is a rapid increase in the sulphocyanide after the operation, it is probable that the former condition had resulted from pressure on the portal vessels, and not from causes immediately impairing the digestive organs.

On commencing these inquiries I suspected that the presence of the sulphocyanide in the saliva would be found to depend on a decomposition of the biliary salts, and that an increased amount would be therefore observed in all cases of jaundice arising from obstruction. On the contrary, in one instance of jaundice, arising from duodenal catarrh in the "later hospital cases" the salt was -2 in the first week of the illness; in the next, in which the yellowness of the skin was much diminished, and the colour of the stools improved, it rose to -1 ; and in the third, when the patient was dismissed, it amounted to $+2$. In a second case it was -2 on admission; three days afterwards it was normal; on the tenth day, when the patient had greatly improved, it was $+1$; and he was dismissed cured on the nineteenth day. Taking

the "earlier hospital cases," where the variations of the sulphocyanide were less minutely recorded, I find that of twenty-three affected with jaundice the salivary salt was deficient in eighteen, and in some of them not a trace of colour could be obtained by the addition of the perchloride of iron. In two the quantity was normal, but one of these had so far recovered as to have been placed on full diet, and in the other post-mortem examination proved the jaundice to have resulted from the rupture of a hydatid cyst into the ducts of the liver, the opening of the common duct being only partially obstructed, and bile being present in the duodenum. In three cases the quantity was above the normal, and in one of these there was cancer of the liver; the histories of the others could not be obtained.

From the above observations it would seem probable that in order that the salt should appear in the saliva the bile must be able to enter the duodenum, and this seems to be supported by the fact that in two cases admitted into the hospital, where large quantities of bile were expectorated, probably from perforation of the lungs by hydatid cysts of the liver, scarcely any colour could be produced in the saliva by the addition of the solution of iron. Supporting the same conclusion is the circumstance that in some cases of jaundice the depth of the colour varies with the amount of the salivary salt. Thus a lady had suffered for three weeks from jaundice arising apparently from hyper-

trophic cirrhosis; the skin and urine were deeply tinged, the stools white, and the saliva free from sulphocyanide. She was treated by perchloride of mercury, and in three weeks the stools became partially coloured, and a slight tinge was produced in her saliva by the addition of iron. In two weeks afterwards, diarrhœa occurred, the stools being deeply stained with bile, and although the skin and urine remained yellow, the saliva contained an abundance of the salt. Again, a gentleman had been for three months deeply jaundiced, the saliva being $-2\cdot$. In two months afterwards the jaundice had greatly lessened, the stools were brown coloured, and the saliva was $+2$. Two or three weeks afterwards he had a severe attack of pain in the abdomen, with an increase of jaundice, and the sulphocyanide again became deficient. When I last saw him he was much better, and the salivary salt was again $+2\cdot$.

In jaundice the deficiency of the sulphocyanide is, unless cancer be present, usually greatest at the commencement of the case, for I found in the "earlier hospital cases" there was, on the average, twice the quantity in the saliva of those examined five weeks after the onset of the disease of that present in those who came under observation in the first week of their illness. This rule, however, does not hold good for the temporary cases following severe pain of the abdomen, and usually referred to the passage of a gall-stone. In two instances of this kind the saliva was normal,

even at the commencement, and the jaundice passed away in a few days.

It is unwise to lay down positive rules when the observations are so few, but as far as my experience goes, *in the commencement of jaundice*, an absence of the sulphocyanide is unimportant ; in cases where the obstruction of the common duct has arisen from the passage of a calculus, the salt usually soon reappears in the saliva and precedes the disappearance of the yellowness of the skin ; where the complaint has originated from an obstruction of the small hepatic ducts only, as in heart disease, the amount of the salivary salt is often normal, or it may be above the normal where the jaundice is associated with a rapidly growing tumour of the liver or some other organ, and where a considerable quantity of bile finds its way into the intestinal canal.

When the jaundice has persisted for some length of time, the saliva may be normal when the disease depends on a hydatid tumour, heart disease, or other cause producing only local obstruction ; but where, as is so often the case, no colour is produced by the addition of a persalt of iron, we may look for a fatal termination from complete closure of the common duct.

I am sorry I am unable to give much information respecting the saliva in cases of jaundice not arising from obstruction. I have only examined one case of acute yellow atrophy of the liver. A woman was

admitted with jaundice of two or three weeks' duration, and there were no symptoms indicative of this fatal disorder. On examination of the saliva, the ordinary colour produced by the addition of the perchloride of iron was absent, but it had a brownish tinge, and I remarked to the students present that in all probability, although the case was an obscure one, it would prove dangerous or tedious. Delirium set in suddenly, the space of the hepatic dulness rapidly diminished, and she died in two or three days. I have been informed by Mr. Hurry Fenwick that he has remarked a brown colour in the saliva on the addition of iron in cases of pyæmia, but I have not myself verified the observation. It is, however, worth while to bear this in mind, as various modifications of the sulphocyanide may perhaps be discovered in different diseases. If we should find that the ordinary salivary salt is always absent in cases of acute yellow atrophy of the liver, it may enable us to suspect the presence of this formidable malady where there are no other indications of it.

In every case of lead colic the sulphocyanide was either absent, or present in diminished quantity, until the urgent symptoms subsided, after which an excess was usually observed. Let me quote to you one or two instances from the "later hospital cases." A man, aged twenty-four, was admitted into the wards with lead colic of six days' standing on July 13th, and his saliva was noted as - 2. The bowels were freely moved by medicine, the pain and vomiting were

relieved, and on the 17th it was $+1\cdot$. A man, aged thirty-six, was admitted with lead colic of two days' duration on July 16th; on July 19th the pain of the abdomen was less and the bowels had acted, but he complained of pain in the epigastrium, and the saliva was $-1\cdot$; on July 26th he had no abdominal pain, and the saliva had risen to $+1\frac{1}{2}$; on Aug. 2nd he was still free from pain, and the saliva was $+2\cdot$. A man was admitted on Oct. 1st with lead colic; on Oct. 4th the saliva was $-\frac{1}{2}$, and on Oct. 11th, when the pain had quite left him, it had risen to $+2$. The cause of this diminution in lead colic is, however, susceptible of explanation on the supposition that, as the saliva is usually thick and tenacious, the lead may act directly as an astringent upon the salivary glands. I therefore stimulated the secretion by the application of tincture of pyrethrum to the tongue, but, although the quantity of the fluid was increased, there still remained a deficiency of colour on the addition of perchloride of iron. I therefore came to the conclusion that the alteration in the amount of the sulphocyanide was not due to a mere local cause.

But however we may explain the diminution of the salivary salt in lead colic, the fact may be of great use in diagnosis. We see occasionally symptoms of peritonitis, of gastric ulcer, and other abdominal disorders in persons who have a blue line around their teeth, and in such instances it may be difficult to determine whether the symptoms are due to the absorption of

lead or not. The state of the saliva will often settle the point, and thus indicate the treatment that should be undertaken for the patient's relief.

In all cases where the symptoms and physical signs have pointed to acute congestion of the liver arising from the abuse of alcohol, overfeeding, or indolence, I have remarked the amount of the salivary salt to be above the normal amount.

Chronic congestion of any organ usually lessens its functional activity, and it is not until the congestion is removed that the normal powers of secretion are resumed. We observe this constantly in heart disease, where the amount of the urinary secretion gradually diminishes along with the increase of the backward pressure upon the venous circulation, but it again becomes free as soon as the renal congestion is relieved. As our inquiries have hitherto pointed to a close connection between the activity of the nutritive organs and the amount of the sulphocyanide, I was anxious to ascertain the state of the saliva in cases of diseased heart. For this purpose I separated those suffering from disease of the aortic valves from those affected with mitral mischief, for, as you are aware, pressure upon the venous system is only occasionally experienced in the former, but almost always occurs in the latter class of cases.

In six cases then of aortic regurgitation the average amount of sulphocyanide was only $+ \cdot 43$, and the following table shows that there was very little change

when they were examined each week during the period of their residence in the hospital.

TABLE IV.—*Showing the state of the Saliva each week in Cases of Aortic Regurgitation.*

	Number of weeks in hospital.				
	1	2	3	4	5
Average amount of sulpho- cyanide	+·50	+·12	+1·25	+·66	+1·2
Number of cases examined .	2	4	1	3	2

Now, although in the above figures you will observe the amount is greater in the fifth than in the first week after admission, there is no evidence of a regular increase; for in the second week it is smaller than in the first, and in the fourth it is very little above what was remarked in the first. We may conclude, then, that if the quantity of the salivary salt is an index to the activity of the digestive powers, these suffer but little in regurgitation through the aortic orifice.

Now let us examine cases of dilatation of the heart and of mitral disease in both of which pressure upon the venous system is sooner or later developed. Here the difference is most striking, as there were eight cases in which either the patients died or were removed by their friends in a dying condition, and of these five

presented on their admission to the hospital an average of $-.95$. In two cases it was on admission above the normal amount, but in each, as time went on, there was a gradual decrease in the salivary salt. Thus in one it was at first $+2\frac{1}{2}$, next week $+1\frac{1}{2}$, after which no further examination is recorded; in another it was at first $+2\frac{3}{4}$, then it fell successively to $+2$ and $+\frac{1}{4}$, which was quickly followed by death. On the contrary, wherever there was a steady improvement there was a weekly augmentation in the quantity of the sulphocyanide. To illustrate this I have added the following table.

TABLE V.—*Showing the weekly amount of Sulphocyanide in the Cases of Mitral Disease that improved in the Hospital.*

	Weeks in hospital.						
	1	2	3	4	5	6	7
Average of sulphocyanide .	$+.47$	$+1.1$	$+.66$	$+1.7$	$+2.2$	$+2.9$	$+2.75$
Number of cases examined .	12	12	12	10	5	5	1

If you look at this table, you will remark that, although there is a decrease in the third as compared with the second week, the rise week by week in all

the periods was, excepting this, gradual, marking, we may suppose, the diminution in the pressure on the venous system, and the gradual improvement in the functions of the digestive organs. But you will naturally ask, How is it that heart cases during convalescence should show such an increase of the salivary salt? It is, I suspect, because during the illness the general nutrition has suffered, and the system calls, as after typhoid, for an augmented quantity of new material, and consequently the digestive apparatus is stimulated to unusual activity. But in heart disease we should remember that the respiratory functions are as much or more disturbed than the digestive. May not the variations in the saliva, then, be due to the pulmonary congestion, and not to that of the liver? I think this is not the case, because in the later stages of phthisis we found the salivary salt was always much below the normal point, although difficulty of breathing is a marked feature in that stage of the disease.

But, however we may explain these facts, there is no doubt, if their accuracy should be confirmed by future researches, that the condition of the saliva places in our hands a valuable aid in the prognosis and treatment of diseases of the heart. Indeed the importance of a proper performance of the functions of the nutritive organs in cases of disease of the heart seems to me to be strangely overlooked. A physician will carefully listen from day to day to any murmur that may be present, he will examine the respiratory

functions and the urinary secretion, but will show no anxiety as to the condition of the digestive organs. You will constantly see patients of this class recover to a certain point ; they are relieved in the breathing, and freed from dropsy, and yet they are unable to regain their former strength, and after a time there is a recurrence of their previous ailments, the circulation becomes again embarrassed, and death ensues. Now, I believe the reason why the improvement in such cases does not continue is because the nutritive structures have been so long congested that they are unable to resume their functions, and the heart and other organs of the body are therefore incapable of maintaining their nutrition. It is under such circumstances that I trust the frequent and careful testing of the saliva will be useful, for where there is a gradual increase in the amount of the sulphocyanide we may hope that the pressure on the venous system is diminishing and the digestive organs are regaining their functions ; whilst when the quantity sinks week by week, in spite of our efforts to improve them, we can only look forward to a decay of the vital functions and to a fatal termination of the case.

I have found that the quantity of the salivary salt occasionally differs to a considerable extent from the normal in those who seem to be in good health, and it therefore becomes a matter of interest to inquire whether persons who present this condition are more prone to disease than others, and if so, to what mala-

dies they are especially liable. At an early period of these inquiries I was struck with the unusual quantity of the sulphocyanide secreted by persons suffering from acute rheumatism, and this fact was confirmed by both the gentlemen who kindly assisted me. Of thirty-six cases of this disease recorded in the "earlier hospital cases," all but one, whose saliva was normal, showed a marked excess of sulphocyanide, the amount varying from eight times to twice the ordinary quantity. As I before explained to you, the depth of the colour in the earlier observations was not so carefully estimated as afterwards, so I shall now confine myself to the results obtained by the later and more accurate inquiries. Fifty-five were recorded in the "later hospital cases," which are grouped in the following table according to their stay in the hospital, but these include a considerable number of subacute and gonorrhœal cases in which the quantity of the salivary salt is usually small, and consequently the average quantities are much less than you might expect from the former statement.

TABLE VI.—*Showing the amount of Sulphocyanide in Cases of Rheumatic Fever grouped according to their duration in the Hospital.*

	Period of residence in hospital.			
	7 days.	7 to 28 days.	28 to 56 days.	Above 56 days.
Average depth of colour .	+ .33	+ .94	+ .17	+ 2.62
Number of cases examined .	3	26	22	4

You will see by the above figures that there was a gradual rise in the amount of the sulphocyanide in proportion to the length of time required to afford permanent relief to the patients. Those included in the first column were either relapsed or doubtful cases of rheumatic fever, but I thought it was more fair to include everyone who was admitted with the diagnosis of acute rheumatism, even if the correctness of the diagnosis was doubtful. I need not tell you that acute rheumatism does not run a regular course; it consists of a succession of febrile attacks attended with articular inflammations, and, as the most protracted cases presented the largest quantity of the salivary salt, it is evident that an excess of the sulphocyanide was present in those who experienced the most frequent recurrences of the complaint.

But the state of the saliva affords also a measure of

the severity of the attacks—that is, of the number of joints that are simultaneously affected,—for when many joints are implicated the patients are obliged to apply to the hospital earlier than those in whom only one joint is painful, or where the pain is so slight that they can continue at their employment. In the following table the cases are grouped together according to the length of time the pains had been experienced before their admission.

TABLE VII.—*Showing the Cases of Rheumatic Fever grouped according to the duration of the illness before admission into the Hospital.*

	Duration of pains before admission.		
	Under 7 days.	7 to 21 days.	Above 21 days.
Average depth of colour . . .	+ 1·65	+ 1·31	+ 1·18
Number of cases examined . . .	22	24	8

It may, of course, be objected that other causes besides the severity of the attack influence the early application of the patients for hospital treatment, but that this is the chief reason seems to be borne out by the experience of Dr. Hilton Fagge at Guy's Hospital; for he remarks: "A point which comes out clearly from the last column is that a comparatively long

duration of the disease after admission is by no means peculiar to patients admitted at a very early period of the illness. On the other hand, it may be noticed that the cases which subsided most rapidly whilst in the hospital had already been running on for three weeks ; and I am not sure that this is a mere accident, for on tabulating ten other cases which have since occurred at Guy's, and in which rapid recovery has taken place without treatment (or under treatment which I believe to be ineffectual), I find the average duration of the disease before admission was 13·7 days.”*

But you may say that, as it has been already stated that in all inflammatory disorders there is an increase of the salivary salt from the demand made upon the organs engaged in nutrition, why may not this be the reason of the excess in acute rheumatism ? For the simple reason that there is no difference in the saliva to be remarked during the period when the joints are affected and the intervals when they are free from inflammation ; and also because, even when the attacks have subsided, and the patients are able to leave the hospital, the excess of the salivary salt has still been observable. To show this I have constructed the following table. (See Table VIII.)

* ‘The Principles and Practice of Medicine,’ by Dr. Hilton Fagge, vol. ii, p. 538.

TABLE VIII.—*Showing the Depth of Colour in each Week of Residence in Hospital of Cases of Rheumatic Fever.*

	Weeks in hospital.											
	1	2	3	4	5	6	7	8	9	10	11	12
Dismissed } Average colour	+·33	—	—	—	—	—	—	—	—	—	—	—
within } Number of cases	3	—	—	—	—	—	—	—	—	—	—	—
Dismissed } Average colour	+·9	+·9	+·9	+1·75	—	—	—	—	—	—	—	—
8 to 29 } Number of cases	20	20	13	2	—	—	—	—	—	—	—	—
Dismissed } Average colour	+1·8	+1·72	+1·5	+1·25	+1·5	+2·1	+1·45	+1·75	—	—	—	—
29 to 56 } Number of cases	14	20	16	15	13	7	5	1	—	—	—	—
Dismissed } Average colour	+2	+1·87	+2·25	+1·87	+3·12	+2·81	+2·62	+3·16	+2·75	+2·25	+2·	+2·
above } Number of cases	2	2	2	2	2	4	4	3	3	2	1	1

You will remark that in each group the depth of colour was nearly the same in the week when the patients were dismissed as when they were admitted, so that, notwithstanding the pains were relieved, the excess of the sulphocyanide remained. It is also worthy of observation that no effect appears to have been produced upon the saliva by the treatment. Nevertheless, after the patients left the hospital the excess of the sulphocyanide seems to have disappeared. Thus, four patients were readmitted on account of a return of pains in the limbs; one on his first admission presented a colour of $+3\frac{1}{4}$, which fell to $+2$, and he was readmitted with $+1\frac{3}{4}$; another had a colour of $+3\frac{1}{4}$, which had fallen to $+2\frac{3}{4}$ when discharged, but when readmitted it was only $+1\frac{1}{2}$; another on his first admission presented a colour of $+2\cdot$; it was $+2\frac{1}{4}$ when he left the hospital, but it was $-\frac{3}{4}$ when readmitted; a fourth returned one month after leaving the wards with a colour of $-3\cdot$. In all of these the pains on readmission were slight, there was scarcely any rise of temperature, and they were quickly again discharged cured.

But there is another objection that has probably occurred to your minds. May not the excess of the sulphocyanide in acute rheumatism and in all the febrile diseases hitherto examined be due to the increased temperature of the body, and be therefore merely an indication of the augmentation of the destructive processes by the fever, or of the inspissation of the

saliva accompanying it? Table IX has been prepared to test the truth of this objection, and was formed by calculating the average evening temperature of each case during its residence in the hospital; the whole of the cases being then grouped according to the temperatures thus obtained.

TABLE IX.—*Showing the Cases of Rheumatic Fever grouped according to their average Evening Temperatures.*

	No. of observa- tions.	Average depth of colour.
Average evening temperature below 98° . . .	6	+ 1.16
„ „ between 98° and 99°	93	+ 2.25
„ „ „ 99° and 100°	42	+ 1.92
„ „ „ 100° and 101°	22	+ 1.5
„ „ above 101° . . .	11	+ 1.43

It will be remarked that the highest quantity of the sulphocyanide was in the cases in which the average temperature was 98° to 99°, and that it lessened as the average amount of heat increased, so that there is no connection between the quantity of the salivary salt and the increased retrograde processes that are believed to occur in fever. In acute rheumatism the

saliva is always abundant, so that there is no reason to suppose the augmentation in the amount of the sulphocyanide is the result of an inspissation of the secretion.

It may be said, Is not the temperature a measure of the intensity of the disease, and ought not, therefore, the elevation of the thermometer to correspond with an augmentation of the sulphocyanide? But the *average* evening temperature does not represent the severity of the illness, for the highest temperature in each case usually occurs during the first four days after the patient's admission, and in short cases, where there is no recurrence of the fever, the patients are quickly dismissed, and consequently the average temperature is high. But where there is a frequent succession of attacks, attended with a moderate rise of temperature, the patients remain long in the hospital, and the average height of the thermometer is not much above the normal. Now, it is in these protracted cases that the sulphocyanide is in the greatest excess, and consequently the saliva furnishes us with a most valuable indication in respect to the prognosis of the disease.

You are aware that the condition of the system producing acute rheumatism has been a fertile subject for discussion, and that numerous attempts have been made to discover it, both by chemical analysis and by experiments on animals. Now, it will naturally occur to you to ask whether we may not have hit upon the

cause of the disease in the excess of the sulphocyanide present in the saliva of such cases ; may not the excess of this represent some sulphur compound that sets up the articular inflammations by its presence in the circulation ? I fear that we are unable to answer this question in the affirmative ; for, as we have before seen, the salivary salt is augmented in various other conditions that are unattended with inflammation of the joints. Besides, if the cause of the rheumatic fever were dependent on the presence of this salt in the system, we should expect to find it in greater quantity when the disease was hereditary than when it occurred in a single member of a family alone. To ascertain if such is the case I have added the following table.

TABLE X.—*Showing the average amount of sulphocyanide in persons hereditarily predisposed to Rheumatic Fever.*

	Average amount of sulpho- cyanide.	No. of cases.
History of parents liable to rheumatic fever .	+ 1·4	16
History of other members of family than parents liable to rheumatic fever	+ 1·05	10
Persons who had no history of rheumatic fever .	+ 1·4	31

You will see by the above table that a hereditary predisposition has no effect in increasing the amount of the salivary salt, or consequently the severity of the attacks, for the average amount is the same in those whose parents had suffered from the complaint, and in those from whom no history of hereditary predisposition could be obtained. It is also curious that previous attacks do not seem to increase the quantity of the sulphocyanide, for of twenty-four who had a history of former attacks the average was $+ 1.4$, whilst in twenty-eight who were suffering for the first time it was $+ 1.3$.

If these facts should be confirmed by subsequent experience, the practitioner will find in the condition of the saliva a guide that ought never to be neglected in any case of acute rheumatism. Inasmuch as the duration of the disease seems to be prolonged in proportion to the amount of the salivary salt, a great excess of this will enable him to foresee a tedious case and a frequent recurrence of the articular inflammations, whilst when the quantity is only a little above the normal, he may anticipate rapid relief from his treatment and a speedy recovery. In every case in which the sulphocyanide is in excess, it will be necessary, however well the patient may be, to keep him for a length of time on low diet, and guard him carefully from cold and every other circumstance likely to provoke a recurrence of the complaint.

It is probable that those who have habitually a large

amount of the sulphocyanide in the saliva are more liable to local rheumatism than other persons; for amongst the "private cases" 40 per cent. of those who had an excess had suffered from pains of the limbs or joints. This is not, however, so constantly the case as in acute rheumatism, for I have met with cases of lumbago and rheumatic arthritis in which the amount was below the normal.

The occurrence of chorea in rheumatic subjects has long been recognised, and has given rise to much speculation as to the connexion between diseases so very dissimilar. I felt anxious, therefore, to ascertain whether the examination of the saliva would throw any light upon this question. I find nine cases of chorea are recorded in the "later hospital cases," and of these, at the first observation, six presented an amount of sulphocyanide below the normal, some as low as -3 ; two were normal; and only one was above the normal—viz. $+ \frac{1}{4}$. I have examined several others since the above cases were dismissed, and have always found the salivary salt below the normal at the commencement of the disease.

One of the above-quoted cases developed acute rheumatism, which affected both ankles, but lasted only one week, the evening temperature being 102° and 103° . The saliva for three weeks before the rheumatism occurred had risen to $+2$, $+ \frac{3}{4}$, and $+ \frac{1}{2}$, being $+1$ during the articular affection. Two other cases had a systolic mitral murmur, and in both

the salivary salt was in excess; one was admitted with $+\frac{1}{4}$, but next week it rose to $+2\frac{1}{4}$, $+2$, and $+2\frac{1}{4}$; the other, on first observation, showed $-\frac{1}{4}$, but next week it was $+2\frac{3}{4}$, then in the two following weeks $+3$ and $+2\frac{1}{2}$. None of those whose saliva remained below the normal had either rheumatism or mitral murmur.

It is worthy of remark that the chorea in those in whom the excess presented itself yielded rapidly to treatment, whilst where it continued below the normal the complaint was very obstinate. Thus the two presenting an excess were dismissed on an average in thirty-seven days, whilst the three with a deficiency remained on the average seventy-seven days under treatment. It is strange that in chorea, unlike the diseases we have hitherto examined, there is always a tendency to great variation in the quantity of the sulphocyanide from week to week, very few of the cases showing the same quantity in any two successive observations. I have observed the same variation in the weekly amounts of sulphocyanide in some cases of hysteria, and suspect it may arise from an irregular action of the nervous centres.

It is always unsafe to draw general conclusions from small numbers of facts, but, if future inquiries should confirm these above stated, it would appear that there is no necessary connection between chorea and rheumatism, but that the latter is apt to arise whenever the imperfect nutrition which accompanies chorea is

suddenly replaced by an excessive amount of vitalised nutriment. A long-continued subnormal amount of sulphocyanide seems to be associated with a long duration of the nervous disturbance, and indicates that the treatment adopted is likely to be ineffectual. In one such case I lately omitted the arsenic the patient was taking, and substituted cod-liver oil and hypophosphite of soda. In a few days the salivary salt increased, and the patient so rapidly improved that she was soon discharged.

Cases of gout usually exhibit an increase of the salivary salt, but not to such a marked extent as those liable to acute rheumatism. In seventeen that were observed in the "private cases" the amount was above the normal, and none of them at any time presented a deficiency. When, however, gout has been complicated with phthisis or kidney disease, I have met with a subnormal quantity; so that the state of the saliva is clearly not the result of the articular inflammation, but is only an accompaniment of that over-action of the nutritive organs which most practical physicians are in the habit of recognising as predisposing to the complaint.

The sulphocyanide is usually in excess in the saliva of persons who suffer from eczema, since this is often associated with gout; but such is not invariably the case, as the disease also presents itself in persons who are in an imperfect state of nutrition, and under these circumstances the salivary salt is below the normal.

I have never seen a severe case of urticaria in which the sulphocyanide was not in excess, and the severity and obstinacy of the malady may be generally measured by the amount of colour produced by the addition of iron to the saliva. As an illustration let me quote to you the case of a gentleman aged thirty-one. He was stout, and was affected with this troublesome complaint to such an extent that he was in the habit of amusing his friends by writing on his arm beneath the table with a match or pencil, and then exhibiting the letters marked in bright and elevated lines upon his skin. His saliva was + 3, but after six weeks' treatment it was reduced to + $\frac{1}{2}$; bilious headache, to which he had been formerly subject at least every week, disappeared, and he lost many pounds in weight.

Headache was one of the most common subjects of complaint to which those having an excess were liable, and the so-called "bilious headaches" constituted 25 per cent. of the whole number of the "private cases" where this condition of the saliva was present. Persons suffering in this way usually belonged to families of which other members had been victims to gout or rheumatism; the attacks of headache were periodical, and were often followed by a temporary improvement in health. Cases of this kind were almost always relieved by the administration of the bromide of potash combined with liquor potassæ, the bowels being at the same time carefully regulated by aperients. One

tenth of those presenting a deficiency of sulphocyanide also complained of "bilious headaches," but there was usually no gouty history, no relief was afforded by the attack, and the pain seemed to be of a purely neuralgic character. Under such circumstances the attacks were aggravated by the treatment before mentioned, but they diminished in frequency and severity after the employment of tonics.

You will meet with cases in which it is impossible to say from the description of the patient whether the headache arises from disorder of the digestive organs or from neuralgia alone, and I have often used the saliva as a test, and directed the treatment accordingly, and rarely have I found the indications incorrect.

A great excess of the sulphocyanide, when it occurs in elderly persons, is often indicative of a dangerous condition of health, and may be for some time unaccompanied by apparent disease of any important organ of the body. Afterwards, however, changes in the vascular system usually declare themselves, and the patients eventually die of apoplexy or become the subjects of disease of the heart or kidneys. As an instance of this, a gentleman, aged fifty-nine, first complained in 1877 of irritability of the bladder, the urine being very acid, but neither albuminous nor saccharine. This soon passed away, and in the following year he suffered from shooting pains of his arms and shoulders, although he had never had gout or

rheumatism previously. In 1881 he had bronchitis, and his saliva was then recorded to have contained a great excess of sulphocyanide. In the same year he suffered from intense mental depression and dyspepsia, the saliva still presenting a great excess. Towards the end of the year it was + 4, and a diastolic murmur was first noticed over the aortic valves. This was followed by a slight paralytic attack. The loss of power soon passed away, the saliva rose quickly to + 8, and he complained of general weakness and depression. In 1882 the saliva was + 6, there was no paralysis, the diastolic murmur was still audible, but the urine proved to be slightly albuminous. He remained in this condition for a few months, when he was carried off by a sudden apoplectic seizure.

Cases like the above are by no means uncommon, and are subjects of great anxiety to the physician on account of the indefinite nature of the symptoms from which the patient suffers. They are generally said to arise from "suppressed gout," but I suspect that atheroma of the arterial system takes place from the abnormal nutrition, and produces changes in the blood supply of various important organs. I know of no test for such a state but the excess of the sulphocyanide, which I have found almost always to be present under such circumstances.

A deficiency of the sulphocyanide is much less common in persons enjoying a moderate share of health than the opposite conditions. It chiefly shows

itself in females, and especially in those who are thin and feeble in muscular power. They seem to be liable to neuralgic affections, and as these also often arise from gout, rheumatism, or malaria, in which the sulphocyanide is in excess, an examination of the saliva will often throw light on the nature of a case otherwise hopelessly obscure.

We may now ask whether the foregoing facts, and the conclusions we have derived from them, throw any light upon the uses of the sulphocyanide in the saliva. Does this substance perform any beneficial purpose in the mouth or throat, or is it only an excretion, removed on account of some deleterious effects it might produce upon the system? I think we may assume that the sulphocyanide must be of some use in assisting the functions of the upper part of the digestive tract, for we can scarcely suppose that any deleterious substance would be excreted in a part where there is a certainty of its being rapidly resorbed into the system.

But it will be necessary that we should examine one or two suggestions that have been made by physiologists to account for the presence of the salt in the saliva. It has been stated that it is the result of decomposition set up by the presence of decayed teeth, and that it is not therefore a normal constituent of the secretion, but is merely a pathological product. In order to test how far such an opinion was founded upon facts, careful inquiries were made into the state

of the teeth in eighty-seven cases in the hospital, and with the following results. The teeth were quite perfect in 18 per cent. of those whose saliva contained a normal or excessive amount of sulphocyanide, and in only 14 per cent. of those in whom it was deficient. One or two teeth were carious in 47 per cent. in the former and in 44 per cent. of the latter; whilst many were decayed in 42 per cent. of those in whose saliva the sulphocyanide was below, and in 35 per cent. of those in whom it was normal or excessive. It is evident, therefore, as the salt presents itself in excessive quantities where there is no decay of the teeth, and is as often deficient as superabundant where many are carious, the opinion before mentioned must be incorrect.

Others have attributed the presence of the sulphocyanide to the smoking of tobacco, and the habits of 213 patients in the hospital were investigated as to this point. As the greater number had been confined to their beds in wards in which smoking was not allowed, only a few of them had latterly enjoyed the opportunity of using tobacco. On analysing these cases it appeared that, of those whose saliva contained an excess of sulphocyanide, 6 per cent. had only latterly smoked; of those presenting a normal quantity, only 2 per cent.; whilst of those in whom there was a deficiency, 8 per cent. had latterly consumed tobacco, and one represented himself as an excessive smoker. It is therefore evident that no material

influence is exerted by the use of tobacco, although my own impression before analysing these cases was that the salt is usually present in greater quantity in the saliva of those who smoke than of those who abstain from tobacco.

If, then, physiologists are at a loss to account for the presence of the salivary salt, let us see if our inquiries will enable us to indicate any organ with whose action it seems to be connected. It is clear the quantity secreted is not dependent upon the functional activity of the salivary glands alone, for we have seen that it varies with different disorders of the digestion, such as jaundice and ascites, in which we have no reason to suppose there is any special connection with the salivary secretion.

But if we turn to the facts we have ascertained, we see there must be a close relation between the activity of the digestive tract and the amount of the sulphocyanide. When, for example, a person is recovering from fever and is rapidly gaining flesh and strength, the quantity of the sulphocyanide is vastly increased, whilst it sinks below the normal, or entirely disappears where, as in the later stages of phthisis or cancer, the nutritive organs are incapable of compensating for the waste of the tissues.

At first sight we might suppose it was the result of some chemical change connected with the gastric digestion, for its diminution in cancer of the stomach, stricture of the œsophagus or pylorus, atonic dys-

pepsia, and even frequent vomiting, seems to point in this direction. But, on the other hand, this view will not explain its deficiency in cases of cirrhosis attended with ascites, or its sudden increase directly the pressure has been removed from the portal vessels by tapping, nor does it show why the quantity should be so often below the normal amount in jaundice.

But the liver is an organ as necessary to nutrition as the stomach, and it probably performs a most important part in producing those alterations the food undergoes before it is fitted to contribute to the support of life. Every point we have hitherto ascertained seems to me to point to the sulphocyanide as depending upon the action of the hepatic cells for its origin. Thus we have seen that any circumstance preventing the digestion or absorption of the food, such as severe vomiting, feeble digestion, stricture of the œsophagus and pylorus, is accompanied by a diminution in the amount of the salivary salt, and physiologists inform us that a full supply of albuminous food is necessary for a free secretion of bile, and for this purpose the conditions both for its digestion and absorption must be favorable. Again, we before found that chronic diarrhœa and dysentery lessened the amount of the salivary salt, and it is interesting to observe that Dr. Rutherford, when reviewing the results of his experiments on the secretion of bile in dogs, states that "we have, however, found several drugs that have an indirectly depressant action; thus, when the intestinal

glands are excited to secrete, there is an indirectly depressant effect on the liver, whereby the bile secretion is lessened. We invariably observed that while slight purgation by a purely intestinal irritant scarcely, if at all, depressed the secretion of the bile, powerful purgation produced a very marked effect.”*

I have before pointed out that the sulphocyanide is either absent or in very small quantity in the saliva of persons affected with lead colic, but that as soon as the symptoms are relieved it reappears. Now, if we turn again to the experiments of Dr. Rutherford, we find the following remarkable statement: “It cannot fail to strike the reader as a remarkable fact, that while in the long list of drugs whose hepatic effect we have investigated we have found so many that stimulate the liver, there is only one—acetate of lead—which appears to have a directly depressant effect.”

Let us then look at the matter from another point of view. Physiologists are generally agreed that the main portion of the fat of the animal body is the result of the breaking up of the albuminous material of the food by the liver, and in reviewing the “private cases” in which the condition of the saliva was tested, I find that only 6 per cent. in whom there was an excess of the sulphocyanide were thin; 20 per cent. were moderately stout, and 74 per cent. are recorded as fat. On the contrary, of fifty-three cases where

* Professor Rutherford on ‘The Action of Drugs on the Secretion of Bile,’ p. 170.

the sulphocyanide was below the normal amount, forty are stated to have been thin, three as moderately stout, and only ten as stout. In some of the latter the deficiency of the salivary salt was only temporary, and of the remainder four were stated to have been losing flesh when the saliva was examined. But if we thus find the same circumstances that tend to promote a free secretion of bile also accompany an increase of the sulphocyanide, and the circumstances that lessen the formation of bile also diminish or suppress that of the salivary salt, and if we discover the condition of the body present in those whose saliva presents an excess and diminution of the salt such as we might expect from an increased or lessened activity of the liver, I think we are justified in connecting the presence of the salt in the saliva with the action of the hepatic cells.

I need not remind you that the bile is a complex secretion containing colouring matters, cholesterine, and biliary salts. Now, from which of these may we suppose the sulphocyanide is derived? Clearly not from the cholesterine, for this is excreted; nor from the colouring matters, for they also pass out of the body, and if they were the source of the salt in question, we should always find it in excess instead of being diminished in cases of jaundice, as they are in that disease retained in the circulation.

The biliary salts, therefore, seem to be the only constituents of the bile likely to furnish materials for

the formation of the sulphocyanide, and as they contain a large proportion of sulphur, this view would seem at first sight probable. But it is generally believed that they pass unaltered into the duodenum and there undergo chemical changes before they are resorbed into the circulation, and it is plain that the sulphocyanide is not the result of a direct action of the liver, inasmuch as we find a deficiency of it in cases of jaundice arising from obstruction, in which the salts are resorbed unchanged from the hepatic cells. But if it is necessary that the bile should pass into the duodenum before the sulphocyanide can appear in the saliva, we should expect that any affection of this part that interfered with the absorption of the taurocholate of soda would interfere also with the secretion of the salivary salt. Now, there is, as you know, a form of dyspepsia in which eructations of sulphuretted hydrogen form a most marked and unpleasant symptom, and in every case of this sort I have found an absence of the sulphocyanide in the saliva. Is it not allowable to suppose that in such cases the biliary salts are decomposed into sulphuretted hydrogen, instead of being absorbed directly or of going through their ordinary changes, so that the material from which the sulphocyanide is secreted is therefore not absorbed?

You may here fairly say: "You have stated that when there is a necessity for an unusual general or local growth of tissue the nutritive organs are called

upon to supply an increased amount of material, and if they are in a healthy state they respond to the demand made upon them ; ought we not under such circumstances to find in fatal cases some congestion or other change in the intestines indicative of such increased action ? ” I think we have evidence of this in the congestion of the duodenal villi so often observed in those who have died from typhoid and cancer. Twenty years ago, and long before I commenced these inquiries, I examined microscopically a large number of persons who had died of these diseases, and then stated, “ The most common morbid appearance in persons who had died of cancer was a dark condition of the villi ; indeed, in only three cases out of seventeen where no disease of the stomach existed was this change absent, but when the stomach and villi were loaded with nuclei it did not present itself, except to a small extent in one case ; in two out of the three exceptions the mucous membrane was in a soft, fatty condition. To the naked eye this appeared in many cases of a uniform dark hue, whilst in others the colour was more intense, and the villi could be readily distinguished as minute black spots. When examined by the microscope, they were seen to be loaded with dark cells and nuclei, which were in greatest numbers at the free ends, but often extended the whole length. In some instances the villi were universally coloured by dark spots of an irregular form ; occasionally they were loaded with a fine, dark,

granular matter, and in two or three instances I detected minute crystals in their interior.

“I need not add that the dark appearance of the villi is not peculiar to cancer; it has been described by other observers as occurring in other diseases. I have met with it chiefly in fever, but as I have never found it in persons killed by accidents, and once only in upwards of 100 dissections of wild animals, we may assume that it indicates an important alteration in the intestine.”

The changes just described in the villi of the duodenum* may be susceptible of some other explanation, but they seem to me to point out that congestion had been present in every case during life, excepting where structural changes had taken place in the stomach or the intestines.

But a difficult question now meets us. The albuminous materials of the food absorbed from the digestive canal undergo certain changes which fit them for the purposes of nutrition, and the greater part of these are again broken up into urea and carbonic acid, without entering into the composition of any of the organs of the body. Is, then, the substance from which the sulphocyanide is derived (? taurocholate of soda) the product of the chemical changes connected with the conversion of the peptones into the circulating albumen, or is it the result of the

* ‘The Morbid States of the Stomach and Duodenum,’ by Samuel Fenwick, M.D., p. 281.

decomposition of the vitalised material? If the latter were the case we should find the amount of the salivary salt bear some relation to that of the urea in the urine, and I have not, unfortunately, a sufficient number of cases recorded in which the quantities of these two substances were simultaneously determined so as definitely to settle the question.

In non-febrile conditions I have generally found that an excess of the sulphocyanide corresponded with a high specific gravity of the urine, but this probably arises from the fact that the introduction of an undue amount of nutriment into the system is quickly followed by an increased metabolism, whereby the surplus nutriment is broken up and eliminated. But during the course of a febrile disorder the quantity of the salivary salt is not increased, as you will see in the case of typhoid fever, although the amount of urea eliminated is excessive, and it is not until the fall of the thermometer and the renewal of the functions of the stomach and liver that the quantity of the sulphocyanide is augmented. Pointing in the same direction is also the fact that, as was before observed, the quantity of the salivary salt in acute rheumatism is not in proportion to the average height of the fever, so that from the data we possess we have no reason to conclude that the material from which the sulphocyanide is derived results from the destructive processes of the system. In addition to this, let me remind you that in the cases of granular kidney ad-

mitted with uræmic convulsions there was no large amount of sulphocyanide, but it increased as the patients improved in health; showing there is no connexion between the retention of the albuminous materials in the state of retrograde metamorphosis and the quantity of the salivary salt.

I think, then, as far as we can at present see, the facts we possess seem to point to the conclusion that the sulphocyanide is derived from some substance separated from the peptones absorbed into the system from the digestive canal, and produced during the process (of the exact nature of which we are ignorant) by which these are converted into material fitted for the purposes of nutrition. This substance we have before seen reason to suspect is the taurocholate of soda, which is secreted by the liver and forms one of the constituents of human bile.

But if the sulphocyanide is only the ultimate product of the action of a number of secreting structures, such as the liver, duodenum (? pancreas), and the salivary glands, are we justified in expecting that its quantity can be accepted as a measure of the activity of the first of these alone? There can be no doubt that, as in the case of dyspepsia accompanied by sulphuretted hydrogen, an abnormal action of any of these structures may alter the amount of the sulphocyanide and it is from feeling the force of this objection that I have trusted to averages rather than to isolated observations. By so doing, the statements have lost

much in force, but they are, I think, more trustworthy for the purposes we have in hand.

The saliva of a person in good health varies but slightly, as regards the quantity of the sulphocyanide, at different times of the day, or from day to day. If secretion is very active, the colour with the iron is a little less deep ; if there is much dryness of the mouth, it is somewhat deeper, from concentration. The quantity of the saliva is of course increased for a few minutes after a copious drink of water and the amount of the salt is lessened.

The amount of sulphocyanide has appeared to me to be increased in persons in the habit of using alcohol in any form, and especially in those who consume malt liquors. Whenever, therefore, the salivary salt has been in abnormal quantity, I have advised these to be given up ; and in most instances where the amount was deficient I have recommended either wine or some other form of alcoholic stimulant. In cases of excess of the sulphocyanide, I usually lessen the quantity of the animal food, and forbid soups and all fatty materials ; when the opposite condition of the saliva is present, I prescribe as liberal a diet as the patient is able to digest. In the treatment of cases of dyspepsia I have been often greatly assisted in the choice of an appropriate diet by the examination of the salivary secretion.

As regards the action of drugs, lead is the only one that has appeared to me directly to check the secretion

of the salivary salt, but I have seen a temporary decrease produced by citrate of caffeine; but as the administration of it had been followed by nausea and vomiting, it is doubtful whether the change in the saliva may not have been produced by the sickness. The quantity of the sulphocyanide is always lessened by a long course of aperients, especially by salines, calomel, and podophyllin; but a single purgation, however brisk, seems to have little effect in this way. The alkalies, iodides, and bromides, in like manner, reduce the salivary salt; but all tonics, such as iron, quinine, and the vegetable bitters, have the opposite effect, probably by increasing the appetite, and thus augmenting the supply of albuminous material. Cod-liver oil seems to be especially efficacious in increasing the quantity of the sulphocyanide, but it rarely agrees where this is in excess.

The most accurate method of ascertaining the amount of the salivary salt is to obtain all the saliva the person is able to secrete in five minutes, taking care that he has not drunk much liquid within a few minutes before the experiment. The tincture of perchloride of iron in the proportion of one drop to a drachm, should be then added to it, the mixture should be filtered, and the colour compared with solutions of sulphocyanide of iron carefully graduated. The bottles containing the tests and those to be compared with them should be of exactly equal size, and

those used by spectroscopists are best fitted for the purpose.

I found that 320 milligrs. of sulphocyanide of potash added to 300 cc. of water containing 24 cc. of the tincture of perchloride of iron produced a colour eight times the strength of that which I adopted as the normal. The plan of using graduated solutions of the sulphocyanide of iron has, however, the disadvantage of requiring the tests to be replaced every six or eight weeks, as in that time the colour begins to fade. A better method is therefore a great desideratum. For ordinary use I have been in the habit of using my own saliva as a test, and guessing the amount of increase or decrease as compared with it.

In bringing before you this interesting subject, I must remind you that the facts I have adduced, and the attempts to explain them, rest on a very different footing. The facts you can easily verify or disprove—only, in doing so, be careful to use the necessary precautions to avoid errors, and do not too hastily condemn the results of many years' experience. I cannot expect to have solved all the difficulties of such an intricate subject, for, as in the case of the thermometer, varieties must occur from the temperament of each person, and the circumstances by which he is surrounded. As regards using the facts for practical purposes, let me remind you that, although the nutrition of a patient is a most important matter, it is not the only thing to be attended to, for circumstances

may force you for a time to put aside its consideration and direct your attention to other structures, the abnormal condition of which are threatening his existence.

As regards the explanations of the facts we have been considering, they seem to me to be the most probable I can offer you, but it would be absurd of me to say they are necessarily correct. Let me remind you that physiology has as yet not offered even a plausible conjecture as to the occurrence of the sulphocyanide in the saliva, the uses it performs, or the materials from which it is derived. Nor is more known of the changes that the incoming tide of nutriment undergoes before it is fitted to perform its part as a portion of the living animal, although we are sure a knowledge of this subject must be of the greatest interest both to the physiologist and to the investigator of disease. Physiology should ever precede and guide inquiries into all disordered functions, and it is only when it fails that pathology may venture to cast its more dubious light upon the darkened path. If I can be the means of attracting the attention of those better fitted than myself to overcome the difficulties environing the whole of this intricate subject, I shall consider the labour I have expended upon these inquiries as amply repaid.

