LETT SOMIAN LECTURES

ON

DISORDERS OF DIGESTION: THEIR
CONSEQUENCES AND TREATMENT.*Delivered before the Medical Society of London.*By T. LAUDER BRUNTON, M.D., F.R.C.P., F.R.S.,
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LECTURE II.

BILIOUSNESS and indigestion are terms which we use so frequently together, and which are so intimately connected, that we do not always sufficiently distinguish between them. Yet it may be worth our while to inquire where the one begins and the other ends, and to ascertain, if we can, what the nature of their connection is.

The condition which we term biliousness is, in all probability, of complex origin. Its name points to the liver as its source, while its close connection with disturbances of the stomach might lead us to ascribe a gastric origin to it. The difficulty we have in ascertaining the exact causation of biliousness is no doubt largely due to the fact that disturbance of the liver affects the stomach and intestines, and disturbance of the stomach and intestines affects the liver. Indigestion and biliousness are, therefore, so closely associated in many cases, that we can hardly say where the mischief began unless we can trace it from the commencement, although in other cases we get a clue to the primary origin of the disease by noticing whether the disturbance of function is greater in the stomach or in the liver.

The close connection between the liver, on the one hand, and the stomach and intestines, on the other, is rendered inevitable by the arrangement of the blood-vessels in them. In regard to the liver, on

the one hand we see that, with the exception of a small quantity which passes through collateral branches, all the venous blood returning from the stomach and intestines must pass through the liver before it reaches the general circulation. Thus, any products of imperfect digestion are likely to affect the hepatic functions, and not improbably to derange them. On the other hand, any hindrance to the flow of the portal blood through the liver will tend to cause venous congestion in the stomach and intestines. On looking at the liver in a *post mortem* examination, it seems so hard and firm that we are apt to think that it is not capable of much dilatation and contraction in the living body. But this notion is perfectly erroneous. I have made a number of experiments on the artificial circulation of blood through the livers of rabbits, and have been quite astonished to find what an elastic organ the liver is. When the bottle containing the blood was raised two or three feet above the liver, so as to increase the pressure

Fig. 2.—Diagram to show the effect of artificial circulation of blood through the liver under different pressures. The continuous lines indicate the size of the liver, and the arrangement of the apparatus during circulation, under a low pressure. The dotted lines indicate the increased size of the liver, and the arrangement of the apparatus, with a high pressure.

under which the blood flowed through it, the organ expanded almost like a sponge, and again contracted when the pressure was diminished. We do not usually notice any very great differences of size in healthy livers; but the reason of this, no doubt, is that the pressure of blood in the portal vein is very low, and not liable to great fluctuations. But there was another point which struck me greatly in my experiments. Sometimes the blood would flow very easily through the liver, would, indeed, pour out from the hepatic vein in a full stream, as if no obstacle whatever had been presented to its flow through the hepatic capillaries. At other times, however, the flow would be slow and scanty, the blood evidently meeting with great resistance in the capillaries. These two conditions were sometimes found in the same liver at different periods of the experiment, and they appeared to depend to a considerable extent upon the quality of the blood which was circulating. Bearing in mind this power of the liver to obstruct the circulation through it, we can readily see how a vicious circle may be formed: indiscretion in eating or drinking disturbs the digestive processes in the stomach and intestines; the products of imperfect digestion or of decomposition in the intestine being absorbed into the veins pass to the liver; they may there induce an obstructed flow through the hepatic capillaries; the venous blood returning from the stomach and intestines will no longer be able to find an easy passage into the general circulation, and venous congestion of the stomach and intestines will be the result. Such venous engorgement as this will interfere with gastric and intestinal digestion, and this again will react upon the liver. Here, then, is a vicious circle which it is necessary to break. It may be broken in two ways: (1) by fasting, so as to allow time for matters to right themselves; or (2) by the use of medicines, as we shall afterwards see.

In order to form a clearer idea, however, of what is actually going on in biliousness, it may be well to take advantage of that fortunate accident by which Dr. Beaumont was enabled to examine the interior of Alexis St. Martin's stomach, and discover what was going on there. Although some authorities have denied that the state of the tongue is any index of the condition of the stomach, this is not borne out by Dr. Beaumont's observations, for he found that the state of the two corresponded pretty closely. A healthy tongue is of a pink colour, it is very slightly rough, and its surface is moist. The mucous membrane of a healthy stomach is of a pale pink colour, it has a slightly rough velvety appearance, and its surface is merely lubricated by a thin layer of mucus. When it is stimulated by the ingestion of food, the vessels dilate, the colour becomes heightened, and the gastric follicles secrete a clear transparent juice, which goes on accumulating, and trickles down the sides of the stomach. From experiments upon

Fig. 1.—Diagram of the veins forming part of the portal circulation. The pancreatic and splenic veins, although most important, have been omitted for the sake of clearness.

animals, we know what changes irritation of the gastric mucous membrane will produce. A slight stimulus, as already mentioned, causes the circulation in the mucous membrane to become increased, and gastric juice to be abundantly secreted. This effect may be produced not only by the ingestion of food, but also, though to a slighter and more limited extent, by gentle rubbing with a glass rod or feather; but if the rod be rubbed roughly instead of gently over the mucous surface, an entirely different result occurs; the vessels, instead of dilating, contract, the stomach becomes paler, and a quantity of mucus is secreted. If irritation be carried still further, the animal shows signs of nausea, and may actually vomit.

In the condition known as biliousness, we find several stages upon which the experiments just mentioned throw considerable light. In the first, the appetite is increased rather than diminished; in the next stage, the appetite fails; and in the further stage, nausea or vomiting occur. Even in the first stage, however, it not unfrequently happens that, though the appetite is craving at first, a few mouthfuls of food are sufficient to satisfy it, and sometimes the appetite disappears merely at the sight of food, and is succeeded by nausea. In this case, it is evident that the increased circulation in the stomach due to the introduction into it of food, or perhaps of the saliva excited by the expectation of food, has caused the condition of the mucous membrane to pass from the first to the second stage.

Let us now see what conditions of the stomach correspond to these symptoms. Dr. Beaumont mentions that on one occasion St. Martin's tongue had a thin whitish fur, and the appetite was craving. On examining the stomach, several red spots and patches abraded of the mucous coat, tender and irritable, appeared spread over the surface. The digestion, too, was slower than usual, and seven hours were required for the gastric digestion of his dinner, instead of four and a half or five hours as usual. In this condition, we cannot say that the liver is involved. The stomach is the only organ affected, and the disturbances of its functions are as yet but slight. Here we may say there is indigestion, but not biliousness.

Two days afterwards, the indigestion had advanced to the second stage. His usual appetite was gone, the tongue was covered with a thin coat, no longer whitish but yellowish, the countenance was sallow, and on the interior of the stomach there were several deep red patches. A muslin bag, which had been introduced with some food in order to test the rapidity of digestion, when drawn out, was covered with a coat of mucus and yellow bile. The sallowness of the face, which had now appeared, may be taken as an indication that the liver had become affected, and that biliousness as well as indigestion was now present.

On the succeeding day, the coats of the stomach were still unhealthy and of deeper red than naturally, with patches of a still deeper colour, and the mucous covering abraded in places. This deep colour indicates venous congestion and stagnation of blood, and is as different from the increased rosinness consequent upon arterial dilatation and rapid circulation in healthy digestion, as the dusky hue in mitral disease is from the rosy flush of healthy exercise. This venous congestion indicates, I think, that the liver is already becoming affected, and that the impeded circulation through it is beginning to tell on the venous radicles of the portal system. At this time the secretion of gastric juice was very scanty, and the digestion slower, as well as less perfect than usual.

In this instance, the indigestion seems to begin in the stomach, and to involve the liver secondarily; but I am inclined to think, although it is difficult to prove, that there are some instances in which the indigestion may begin in the liver, and involve the stomach secondarily. Such cases, I think, are met with amongst persons who suffer from malaria. The malarial poison, whether it be a bacillus or not, appears to have a particular power to affect the liver, spleen, and vaso-motor centres. Under its action, the liver may sometimes swell up enormously, and I am inclined to think that it frequently causes an obstruction to the portal circulation, even when the general circulation is unaffected. In such cases, we may expect to find such symptoms of indigestion as would be likely to occur from venous congestion; and this, I think, is actually the case.

The usual symptoms of indigestion are flatulence, weight in the epigastrium, acidity, and pain; and it may be worth while to try to ascertain the conditions to which each of those symptoms is due.

First of all, let us take flatulence. Flatulence is due to the presence of gas in the stomach and intestines, which sometimes rolls about, producing borborygmi, or escapes upwards or downwards, producing eructations or eripitations. If the pyloric orifice be closed, the gas from the intestine will not escape into the stomach, nor gas from the stomach into the intestine; but if the pylorus be open, gas may pass freely from the stomach into the intestine, and *vice versa*.

An analysis of gas from the stomach shows that it consists to a great extent of nitrogen and carbonic acid, in much the same proportion as the nitrogen and oxygen of air. It is therefore probable that most of the gas in the stomach consists simply of air which has been swallowed, but from which the oxygen has been absorbed into the blood, and has been replaced by a corresponding quantity of carbonic acid. We are very apt to forget that, although the mucous membranes in man are much specialised, so as to perform a particular function most efficiently, yet their power is not entirely limited to the one function. The diffusion of oxygen and carbonic acid just mentioned through the walls of the stomach, shows us that the gastric mucous membrane has, though to a very slight extent, a respiratory action; and it is possible that other gases may be absorbed, though to a slight extent, by the gastro-intestinal mucous membrane. Indeed, I need not say it is probable, because we know for a fact that sulphuretted hydrogen may be absorbed in this manner. Some authors consider that the gastro-intestinal mucous membrane may secrete gas in large quantities. However this may be—and I think that it does not occur very frequently—it is probable that an interference with the absorption of gases may be a not unfrequent cause of flatulence.

In patients who suffer from malaria, attacks of indigestion are sometimes preceded, for two or three days, by a tendency to flatulence, without any other symptom. This may simply be due to disturbance of the stomach and intestines alone; but still I am inclined to think that, in these cases, the disorder begins in the liver, and not in the stomach; the portal circulation becoming obstructed first, and the gastric mucous membrane becoming congested secondarily. After violent exertion, such as quickly running up stairs or trying to catch a train, one may observe that, at the same time that the heart is palpitating rapidly, and the breathing becoming short and difficult, there is a great tendency to flatulence. A similar condition is also found in patients with cardiac disease, and my friend Dr. Mitchell Bruce has called my attention to the frequency with which such patients complain of "heart-wind."

Another source of flatulence is the gas given off from the food in abnormal processes of decomposition. The secretion of gastric juice in the stomach is deficient; the food will not be rapidly digested; the secretion, instead of being acid, is nearly neutral, or perhaps even alkaline; and fermentation may occur with evolution of gas. It is evident, however, that a considerable time is required to allow gas to be formed in any large quantity in the stomach: and flatulence from this cause will not occur until some time after food has been taken. Gas, however, may pass into the stomach from the intestines, and distend it, if the pylorus be open; and such distension may occur at any time of the day or night, and is not necessarily dependent on the decomposition of food in the stomach.

I am inclined to think, however, that the most frequent cause of flatulence in the stomach is excessive swallowing of air. There is little doubt that boluses of food may be swallowed without air; but some fluids, especially those of a tenacious character, such as pea-soup and saliva, appear to carry down a good deal. Moreover, it appears to me that, when a small quantity of saliva is swallowed at a time, it does not completely fill the pharyngeal cavity; and that air is actually swallowed along with it. This does not matter—probably it is even beneficial—if it be not carried on to too great an extent. But we can easily see that, if a person go on swallowing air after a meal is over, or in the intervals between meals, flatulent distension of the stomach may readily be produced. The conditions which give rise to frequent swallowing of air, so far as my observation goes, are—(1) a continued flow of saliva into the mouth; (2) a sense of irritation or tickling at the back of the throat; (3) a feeling of acidity in the stomach; and (4) a feeling of weight or oppression at the epigastrium or across the chest. I mentioned before that stimulation of the stomach produced reflex secretion of saliva; and, if the mucous membrane be irritable, the secretion of saliva may go on long after it ought to cease, and give rise to frequent swallowing and accumulation of air.

Acidity in the stomach causes frequent swallowing, perhaps because the feeling is momentarily relieved by the alkaline saliva as it passes from the oesophagus into the stomach. A feeling of oppression or constriction across the chest, like a huge iron hand clutching it, is due to irritation of the vagus, as we know from Czermak's experiments. He had an exostosis on one of his cervical vertebrae, and, by compressing the vagus nerve between his finger and this exostosis, he could stimulate it so strongly as to stop his heart. Such stimulation produced also a feeling of constriction, or, as it is well called by the Germans, of *Beklemmung*. But irritation of the vagus can be produced in other ways than by compressing its trunk. Depressing emotions, such as sorrow, appear to act on the nerve-centre in the medulla, from which

the vagus springs, and it may be stimulated reflexly from many parts of the body, and notably from the stomach. As Kronecker has shown that its action over the heart is temporarily abolished by the act of swallowing, we would naturally expect that any one suffering from the feeling of thoracic oppression or constriction due to irritation of the vagus would swallow frequently, in order to obtain relief. This appears to take place when the irritation of the vagus, and consequent oppression, are caused by grief, so that it has come to be popularly expressed in the phrase "swallowed his grief." So far as my observation goes, frequent swallowing also occurs in cases where thoracic oppression seemed to me to be due to reflex irritation of the vagus from the stomach.

Flatulent distension of the intestines may also be produced by excessive swallowing of air, and provided the pylorus be open, so that the air can pass through it, either temporarily, as when the contents of the stomach are passing out, or permanently, as in pyloric dilatation or paralysis. The enormous distension of the bowels in hysterical cases, and the rapidity with which it occurs, has often been a puzzle to medical men, and has led some to think that the only possible explanation is a rapid evolution of gas from the blood. From the observations of Ebstein and Zeckendorf (*Pathogenese der Bauch-tympanie*, Inaug. Diss.; Göttingen, 1883), however, it seems more probable that the true cause of this enormous dilatation is to be sought in a paralysis of the pylorus, which allows the air to pass freely from the stomach into the intestines.

But whilst the air which has been swallowed is probably the chief agent in the production of gastric flatulence, the gases formed by decomposition in the intestine constitute the chief factor in cases of intestinal flatulence. They are found, on chemical examination, to consist of nitrogen, but in smaller proportion than in the gas of the stomach, of hydrogen, of marsh-gas, and of carbonic acid; sometimes, also, there is a certain quantity of sulphuretted hydrogen. Some kinds of food are extremely apt to give rise to flatulence, and an analysis by Kolbe and Ruge¹ of the gases passed *per anum* by a man after different kinds of food, seems to show that it is the formation of marsh-gas which chiefly gives rise to the flatulence. The proportion of marsh-gas in their analyses amounted to a mere trace only, on milk-diet; to 27.5 per cent. on a flesh-diet; but it rose to no less than 55.9 when peas had been used as food. Marsh-gas can only be formed in the absence of air, and so it is not produced in the stomach.

It is sometimes, however, passed in eructations. C. Anton Ewald (Reichert und Du Bois-Reymond's *Archiv*, 1874, p. 217) had a curious case under his care, in which the patient was astounded to find, on trying to light a cigar, that inflammable gas was issuing from his mouth. Here, however, there can be little doubt that the marsh gas was formed in the intestines, and passed through the open pyloric and cardiac orifices into the mouth.

Sulphuretted hydrogen is a product of the decomposition of albumen, and its odour is well known as that of rotten eggs. It is usually found in mere traces, if at all, in the intestine, and sometimes may occur in such quantity as to make the eructations very unpleasant, not only to the patient himself, but to his friends. When such eructations occur persistently, they are generally indicative of serious organic disease.

Another symptom of indigestion is acidity, and this is not unfrequently combined with flatulence. In some cases, as in that curious one of Ewald which I have mentioned, it may alternate with flatulence. As his patient expressed it, "sometimes he had within him a vinegar-manufactory, and at other times a gas-work." The difference between these two conditions probably depended on the nature of the fermentation which was going on. As I have said, however, they are frequently associated, and I am inclined to think that a feeling of acidity frequently gives rise to flatulence, because the irritation which it causes in the stomach leads to frequent swallowing of saliva and air. I have said purposely "a feeling" of acidity, because all cases of acidity do not depend, as is often imagined, on an increased proportion of acid in the contents of the stomach, but upon increased sensitiveness of the stomach or œsophagus, or upon some abnormal condition of the cardiac orifice, which allows the contents of the stomach to come more persistently into contact with the œsophageal mucous membrane than they ought to do. The œsophagus is much more sensitive than the stomach, as anyone of you can easily discover for himself. If you will only swallow a bit of hot potato, you will be able to trace its progress right down the œsophagus to the pit of the stomach, and you will be able to ascertain precisely where your cardiac orifice is situated, because at that point the burning heat of the potato ceases to be felt as it drops into the stomach. Now this very

point where the hot potato ceases to be felt, is the point where the feeling of acidity and heartburn are felt most strongly. A feeling of acidity coming on immediately, or very shortly, after a meal, is usually ascribed to increased proportion of acid in the gastric juice secreted by the stomach; while acidity coming on an hour or more after meals, is usually attributed to the formation of acid from the food by decomposition or fermentation.

There is no doubt that sometimes the contents of the stomach do become strongly acid from fermentation; and the matters vomited will not only burn the throat, but will set the teeth completely on edge, just as drinking a mineral acid would do. The secretion of gastric juice containing an excessive proportion of acid is, however, by no means proven.

It is quite possible that the stomach might secrete an excessively acid juice, but Dr. McNaught (*Medical Chronicle*, January, 1885, p. 330) has shown in a recent paper that, although heartburn and acidity were present to an extreme degree in his patients suffering from irritative dyspepsia, in no case was the acidity above the normal. The same thing has been observed by Professor Talma of Utrecht (*Zeitschrift für Klin. Med.*, Band viii, p. 414), who has shown that the feeling of acidity may be a feeling, and nothing more, by putting into the stomach of persons who suffer from it an artificial gastric juice containing only the normal proportion of hydrochloric acid, a proportion so small that, as is well known, it hardly gives an acid taste to the healthy tongue, much less excites any feeling of pain. In these persons, however, this dilute acid caused a feeling of acidity and pain. It is evident, then, that the feeling of acidity in cases of nervous or irritable dyspepsia, which is often great and very painful, which is usually associated with a clean tongue, and often occurs in gouty patients, is dependent upon hyperæsthetic conditions of the mucous membranes, and not upon excessive secretion of acid by the stomach. At the same time, we must bear in mind that there are other cases in which acidity is due, not to hyperæsthesia of the mucous membranes, but to increased formation of acid by the decomposition of food.

The stomach is much less sensitive than the œsophagus, and usually irritation of the mucous membrane in the body of the viscus gives rise to a feeling of weight rather than of pain. This fact seems to indicate that the pain of heartburn is due to irritation of the cardiac end of the œsophagus, rather than of the stomach itself. It not only occurs just at the spot where a hot potato ceases to cause discomfort on its way downwards, but occasionally heartburn may be brought on by certain positions, and relieved by others. Thus, it sometimes happens, that the contents of the stomach cause an acrid burning feeling in the epigastrium when the person is lying down, and especially lying on the back, but the feeling disappears when the upright position is assumed. It sometimes happens, also, that a little escape of flatulence from the stomach will cause the burning feeling to travel up the œsophagus.

Frequently, however, an escape of wind gives relief. It is difficult to determine, with certainty, the cause of this relief; but I am inclined to think that distension of the stomach by flatulence may tend to pull the edges of the cardiac end of the œsophagus apart, and thus expose the sensitive mucous membrane to the action of the acid contents of the stomach. When the distension is relieved, the cardiac end of the œsophagus will close more completely, and thus protect the sensitive surface of the œsophageal mucous membrane.

The stomach itself rarely contracts with such violence as to give rise to pain like that of colic, but it appears sometimes to do so, and then the pain is excessive. The intestines are much more liable to spasmodic contraction, giving rise to the pain of colic.

Another consequence of indigestion, or, perhaps, rather I ought to say, of biliousness, is the occurrence of piles, which consist, to a great extent, of dilated hæmorrhoidal veins; and here, again, it is of great importance to remember that the blood from the intestines, as well as from the stomach, has to pass through the liver on its way to the general circulation. No doubt some of the blood may return from the rectum by the middle and inferior hæmorrhoidal veins, without passing through the liver; yet so much is returned through the portal vein, that any interference with the circulation through the liver will tell upon the veins of the rectum, as well as those of the other abdominal viscera. In the fact, however, that part of the blood returns from the rectum, without passing through the liver, we see a new proof of the important function which the liver exercises in preventing the entrance of poisons into the general circulation. I have already mentioned that the liver has the power of excreting with the bile the poisons which have been absorbed by the portal blood, and also of destroying, to a certain extent, vegetable or animal poisons which are circulating through it. We would, therefore, expect that some of the

¹ Quoted by Landois. *Text-book of Human Physiology*. Translated by Stirling, p. 372.

vegetable alkaloids injected into the rectum would prove more fatal than when taken by the mouth, as they would be able to pass by the lower hæmorrhoidal veins into the general circulation without passing through the liver. This actually appears to be the case, for Mr. Savory has shown that strychnine is more poisonous when administered by the rectum than when given by the mouth.

While a retarded circulation through the liver may give rise to discomfort, and even pain, by causing congestion of the stomach and intestines, or by giving rise to piles, it is not without its advantages to the organism; for it is in the portal blood and in the liver itself that the process of building up the smaller molecules of peptones and of sugar into the larger ones of globulines and glycogen takes place. If these products of digestion be absorbed in large quantity, and pass too rapidly through the liver, so that they reach the general circulation without undergoing sufficient elaboration, they will either prove injurious to the organism or be excreted as waste products, or both. Indeed, we find this to be the case, for we frequently meet with affections of the respiration, circulation, and nervous system, which actually seem to be due to a kind of poisoning by products formed, either in the intestinal canal itself, or in the blood; and we also meet with cases in which sugar, peptones, and albumen are excreted by the kidneys, instead of being applied to the repair of the tissues. I have elsewhere insisted strongly on the distinction which is to be drawn between glycosuria from the mere presence of sugar in the urine and the disease diabetes. (Article on Diabetes, Reynolds' *System of Medicine*, vol. v.) Simple glycosuria may occur in perfectly healthy persons, and, indeed, is much more frequent than people generally believe. If you will examine the urine of several healthy persons a couple of hours after breakfast, it is highly probable that you will find distinct evidence of sugar; for breakfast is a meal at which a much larger proportion of bread is eaten than at other meals, and at which, not unfrequently, a good deal of sugar is taken along with tea or coffee. But glycosuria depending on digestion is a transitory condition, whereas the glycosuria of diabetes is permanent. That glycosuria occurring during the process of digestion and absorption, is due either to some alteration in the circulation in the liver, or else to the absence from the portal blood of bodies which will build up the sugar into larger molecules, appears to be shown by an observation of Lehmann. He found that sugar, injected into the mesenteric veins of a rabbit, during digestion, did not appear in the urine, although the same quantity, injected in the same way into a fasting animal, would produce glycosuria. (Lehmann, *Akadem. Proefschr.*, Amsterdam, 1873.)

Within the last few years, the occurrence of temporary albuminuria has been shown to be much more frequent than was previously suspected. In some statistics of life-insurance drawn up in New York,² one out of every eleven healthy persons who applied for life-assurance was found to present traces of albumen in the urine. Some experiments made by Leube (Salkowski and Leube, *Lehre vom Harn*, p. 369) on 119 soldiers showed that in 4 per cent. the morning urine contained albumen, and albuminuria occurred in no less than 16 per cent. after a severe march. The proportion found by the American insurance-office is intermediate between the two values found by Leube. It is, I think, considerably higher than what one is accustomed to find in examination of persons proposing for life-assurance in London, but nearly corresponds to the proportion of cases of temporary albuminuria (12 per cent.) found by Parkes (*On Urine*, p. 187) in hospital-patients.

The prognostic importance of albuminuria is very great, not only in regard to the question of life-assurance, but in regard also to the dietetic and hygienic treatment of the individual. If we were to assume that because albumen is present in the urine the individual is suffering from serious disease, we should fall into as grave an error as if we were to suppose that every patient whose urine contained sugar was necessarily suffering from diabetes.

As Dr. Warburton Begbie says, "it is surely a satisfactory consideration that a condition of excessive albuminuria—the urine becoming nearly solid on the application of heat and nitric acid—may, after all, not indicate the existence of any structural change in the kidney."³

In my first lecture, I insisted, at some length, upon the probable difference in the size of molecules, and mentioned that, whilst small ones diffuse through animal membranes, large ones will not. In the process of digestion, large albuminous molecules are split up into smaller ones, which become absorbed and then undergo reconstruction, being built up again in the portal blood, in the liver, and in the tissues, into larger molecules. The albuminous substances of the

blood appear to consist of such large molecules that they will not diffuse through the glomeruli of a healthy kidney, but the products of digestion—peptones and hæmialbumose—will diffuse through the glomeruli, and pass into the urine, producing peptonuria or hæmialbuminuria. It would appear also that white of egg has a smaller molecule than serum-albumen; for white of egg, injected under the skin, appears again in the urine, giving rise to pseudo-albuminuria, while serum of blood, or a solution of serum-albumen, injected in a similar way, causes no albuminuria. White of egg, when swallowed, does not usually pass into the urine as it does when injected subcutaneously, because it undergoes digestion in the intestinal canal, and is again built up after absorption into larger molecules. If taken in large quantity, however, a sufficient quantity of it will be absorbed unchanged to pass out through the kidneys and appear in the urine. I have tried the experiment by swallowing six eggs in succession. This quantity was insufficient to produce albuminuria, but it brought on such a violent headache and sickness, that I was deterred from ever making the attempt again. My friend, Dr. D'Arcy Power, who was making the experiment at the same time, succeeded in taking a sufficient number to produce albuminuria. Coagulated albuminous bodies, such as boiled eggs or cooked meat, cannot be absorbed without being previously digested, and so are much less likely than raw eggs to produce albuminuria, even when taken in very large quantities. But, as I have already mentioned, the products of imperfect digestion, such as hæmialbumose, behave in much the same way as egg-albumen, and may give rise to a form of albuminuria. Both egg-albumen and serum-albumen, when present in the urine, will cause a cloud on boiling, or on the addition of nitric acid; and yet it is obvious that the prognostic importance of the cloud, due to a dozen eggs swallowed one after the other, will be very different from that of one due to degeneration of the kidney. It is, therefore, of great importance that we should distinguish between the different kinds of albumen present in the urine. This can be done, to a certain extent, by noting the point of coagulation, which is usually lower in the case of serum-albumen than it is in that of other albuminous substances.

Time, however, will not allow me to enter further on this subject at present, and I have already discussed it elsewhere.⁴ But while the mere occurrence of a little albumen once or twice in the urine is not to be regarded as of necessarily fatal import, it is not to be lightly passed over as a thing of no importance, even although the albumen should prove not to be serum-albumen, but only hæmialbumose. Clinical experience had indicated a connection between long continued digestive disturbance and organic disease of the kidneys, and this was experimentally demonstrated by Stokvis, who found that hæmialbumose injected under the skin once or twice will pass out through the kidneys without doing them any apparent injury, but if the injections be frequently repeated, the hæmialbumose, in passing through the kidneys, appears to excite in them organic disease.

Another disturbance of the urine connected with digestion is oxaluria. When we find oxalate of lime crystals in the urine, we must not at once conclude that the patient is suffering from oxaluria, any more than we must conclude that he is suffering from diabetes, or Bright's disease, because we find sugar or albumen in the urine. It is not the occasional occurrence, but the more or less persistent presence of crystals of oxalate of lime in the urine, that is associated with a peculiar group of symptoms, of which the most prominent perhaps is mental depression. Oxalate of lime present in the food will be absorbed from the intestine, and a considerable proportion of it, at least, will be excreted again in the urine. We may thus expect that oxalate of lime would occur in the urine after stewed rhubarb had been taken for dinner; but there are other kinds of food which do not contain oxalate of lime, or only contain it in very small quantity, and yet give rise to crystals of oxalic acid in the urine. When I was house-physician to the late Dr. Hughes Bennett, a glass containing the patient's urine was invariably placed at the bedside; and, in going round the ward in the morning, I used frequently to notice in the urine the hummocky mucous cloud, with its sharply defined white top, resembling the woolly clouds in a summer sky, which is characteristic of oxaluria. On inquiry, I found that this appearance next morning almost always resulted from the patient's having had cabbage for dinner. Now, according to Esbach, cabbage is really singularly free from oxalic acid, and the oxaluria which it produced must be ascribed to some other cause than simple excretion of oxalate of lime taken in the food. The true cause, I have little doubt, is digestive disturbance; cabbage being one of those articles of diet which is exceedingly apt also to produce flatulence. We do not know exactly how oxalic acid is formed, either in the intestine or in the body, and any obser-

² *Medical Investigations in Life-Insurance*, United States Life-Insurance Company, 261, Broadway, New York.

³ Albuminuria in Cases of Bronchocele and Exophthalmos, *Edin. Med. Journ.*, April 1874; and Begbie's *Works*, Syd. Soc. Ed., p. 355.

⁴ Lauder Brunton and D'Arcy Power, *St. Bartholomew's Hospital Reports*, vol. xiii, 1877, p. 283.

variations regarding oxaluria must be to a considerable extent speculative. Thus, according to some, it is said to be due to the oxidation of uric acid, whilst others say that imperfectly oxidised uric acid splits into oxalic acid and urea. Others attribute it to incomplete oxidation of sugar, starch, and fat, in the food, or non-nitrogenous fatty acids formed within the body; while others again say that it is entirely due to the re-excretion of oxalic acid taken in the food, and that no formation of oxalic acid in the body occurs at all. In the midst of these conflicting opinions, it is somewhat difficult to come to any conclusion, but it is worth while for us to note two facts, and see if there be any connection between them. Esbach (*Journal des Connaissances Méd.*, 1883, p. 155), who denies the formation of oxalic acid in the body, points out that if a reducing agent, such as sulphuretted hydrogen, be added to a strong solution of urates, crystals of oxalate of lime are at once produced. The other fact which we have noted is the tendency of cabbage to produce oxaluria, and also to give rise to flatulence, which probably depends, as it does in the case of other vegetables, on the production of hydrogen or marsh-gas. Most plants of the order *Cruciferae*, to which cabbage belongs, contain sulphur in unusual quantity, and it is possible that this may give rise to sulphuretted hydrogen or sulphides, which will act as a reducing agent, and tend to reproduce in the body the experiment which Esbach performed in a test-tube.

In cases of imperfect digestion, not only are substances that ought to be used for the nutrition of the body excreted as waste, but products of the digestive process may act as poisons to various parts of the organism, and produce serious symptoms.

A common symptom of dyspepsia is shortness of breath, but in many instances this is merely of physical origin, the distended stomach pressing the diaphragm upwards, and interfering with the expansion of the lungs. There may be shortness of breath, also, which is of cardiac origin, the circulation being affected by the digestion in a manner which we will presently discuss. In addition to these different kinds of shortness of breath, however, we meet with actual asthmatic conditions, in which the entrance of air into the lungs appears to be prevented by contraction of the involuntary muscular fibres surrounding the bronchi. The pathology of asthma is too little understood to enable us to decide whether the bronchial muscles are made to contract by abnormal substances circulating in the blood, and irritating either the muscular fibres or their nerves, or whether the contraction is reflex, and is excited by a congested condition of the mucous membrane lining the respiratory passages.

Cough is another condition frequently associated with indigestion—so frequently, indeed, that a kind of cough has come to be known as "stomach-cough." This popular name, though perhaps not scientifically correct, yet conveys a true impression. Reflex acts are generally adopted for a purpose. Cough is fitted to expel irritating substances from the respiratory, and vomiting from the digestive, passages. Irritation of the stomach will not of itself produce reflex coughing; the act corresponding to it is vomiting. Irritation of the respiratory passages, on the other hand, produces reflex coughing, and not vomiting. Nevertheless, it so happens that the action of an irritant, either in the digestive or in the pulmonary tract, may be aided by irritation elsewhere; and thus it happens that, when there is congestion of the pharynx and the other parts of the trachea, which is not in itself sufficient to produce coughing, the presence of any irritant in the stomach will assist this irritation in the respiratory passages, and coughing will occur. Thus I have observed a paroxysm of coughing coincident with acidity in the stomach, in a case where the fauces were much congested; and possibly also (although I did not make a laryngoscopic examination) the larynx and trachea may also have participated. This irritation was not in itself sufficient to cause coughing, but the additional irritation of the acidity in the stomach at once excited cough; and when the irritation was removed from the stomach by a dose of bicarbonate of soda, which neutralised the acid, the cough at once ceased. Now it is just at the pharynx—at the place where the respiratory and digestive tracts cross one another—that irritation is most likely to give rise both to coughing and to vomiting; and this point, as we might readily expect, is one which is very readily affected by digestive disorders. I saw a very instructive case of cough some time ago. A gentleman suffered from cough, which gave him a good deal of trouble; the back of his pharynx was congested, and I ordered him a gargle. He used this for some time without benefit, and then, for some reason or another, somebody gave him several blue pills, and the cough disappeared.

The heart is very liable to be affected by digestive disturbance, and, like the lungs, it may be affected mechanically; for there is nothing between the heart and the stomach but the diaphragm; and when the stomach becomes distended with gas, it may interfere with the action

of the heart, and give rise to functional disturbance. This may evidence itself in faintness, the shortness of breath which I have already mentioned, and intermittent pulse. The intermittent pulse, however, as well as the faintness, may be produced reflexly through the nervous system, instead of merely mechanically. Sensory nerves run from the stomach to the medulla oblongata, and, through these fibres, the heart may be reflexly affected. The resulting effects may differ according to the kind and amount of irritation; sometimes palpitation being produced from an affection of the acceleratory fibres, and sometimes slow or intermittent pulse by an affection of the inhibitory nerves. It is quite possible that, in addition to the effect produced upon the heart directly and reflexly by the stomach, both the heart itself and the vessels may be influenced by substances absorbed from the intestine into the general circulation, and carried, not only to the heart itself, but to the nerve-centres which regulate both it and the vessels.

We have not as yet, so far as I know, any distinct evidence of alkaloids which have an action on the heart like that of digitalis or other cardiac poisons, being formed in the intestine, and passing from it into the circulation. We know, however, that alkaloids, having an action like muscarine, and having, like it, a powerful action on the heart and vessels, as well as on the intestinal canal, are formed by the decomposition of albuminous substances outside the body; and, in all probability, similar substances may be occasionally formed in the intestinal canal. It is probable that a microbe is the cause of cholera, but the symptoms occurring in the disease are probably due to the action on the tissues of a poison generated by the microbe, and not of the microbe itself, just as intoxication is due to the alcohol produced by the yeast-plant, and not to the action of the plant itself, on the nervous system and blood.⁵

An interesting question, on which the formation of alkaloids in the intestine may throw some light, is, "What is the cause of sudden death in some gouty patients?" Such a case as the following is by no means rare. A hale old man, of a gouty family, has seemed unusually well, strong, and in good spirits. He eats an unusually hearty dinner, goes to bed, and is found dead next morning. In such a case, *post mortem* examination reveals nothing. The kidneys may be contracted, but the change in them has been of a chronic nature, and gives no clue to the cause of the patient's sudden death, unless it be that contracted kidneys will not excrete so quickly as healthy ones, and if a substance should be absorbed from the intestinal canal capable of acting as a cardiac poison, it will be more likely to cause death in a patient with contracted than in one with healthy kidneys.

But whether alkaloids which affect the heart are formed in the intestine or not, we have evidence that other alkaloids are formed which affect the nervous system very powerfully. In a paper which I wrote some years ago, I pointed out the great resemblance between the symptoms met with in indigestion, and in those in poisoning by curare. When an animal is poisoned with this substance, and the motor nerves begin to be paralysed, the increasing languor and difficulty of movement appear to strike the animal as strange, and it frequently looks at itself as if it were itself puzzling over its unwonted condition. The very same thing may not infrequently be noted in cases of dyspepsia; an unwonted languor comes over the patient generally about two hours after a meal, and the patient wonders why his limbs feel heavy, like lead, and why he should have such a disinclination to exercise, either bodily or mental. I may, perhaps, here be allowed to quote from the paper to which I have just referred (Lauder Brunton, *Indigestion as a Cause of Nervous Depression*, *Practitioner*, October and November, 1880), as the analogy which I then pointed out between the languor occurring in dyspepsia and curare poisoning has since received such a remarkable confirmation, and, indeed, it would appear, from recent researches, to be due in both cases to alkaloidal poisoning.

"The feeling of muscular weakness and lassitude, which I have already had occasion to mention as frequently coming on about two hours after meals, is not uncommonly met with in persons belonging to the upper classes, who are well fed, and have little exercise. It is, perhaps, seen in its most marked form in young women, or girls who have left school, and who, having no definite occupation in life, are indisposed to any exercise, either bodily or mental. I am led to look upon this condition as one of poisoning, both on account of the time of its occurrence, during the absorption of digestive products, and by reason of the peculiar symptoms, namely, a curious weight in the legs and arms, the patient describing them as feeling like lumps of lead. These symptoms so much resemble the effect which would be produced

⁵ For a fuller discussion of this subject, vide *Researches relating to the Pathology and Treatment of Cholera*, by Lauder Brunton and Pye-Smith, *Practitioner*, November 1884, *et seq.*

by a poison like curare, that one could hardly help attributing them to the action of a depressant, or paralyser, of motor nerves or centres. The recent researches of Ludwig and Schmidt-Mühlheim render it extremely probable that peptones are the poisonous agents in these cases, and an observation which I have made seems to confirm this conclusion, for I found that the weakness and languor were apparently less after meals consisting of farinaceous food only. My observations, however, are not sufficiently extensive to absolutely convince me that they are entirely absent after meals of this sort, so that, possibly, the poisoning by peptones, although one cause of the languor, is not to be looked upon as the only cause."

At the time when I wrote this (October 1880), alkaloids had not been shown to be formed in the body, and I was inclined to attribute the languor to the poisonous action of peptones; but now the evidence which we have to prove the presence in the circulation of alkaloids formed in the intestine is just the same as that which we have to show their presence when injected subcutaneously. When curare is injected under the skin of a frog, we know that it has been circulating in the blood, not only because of the effects it has produced upon the motor nerves, but because, if we take a little of the frog's urine, we find that the poison has been excreted by the kidneys, and that the urine will produce symptoms of paralysis when injected under the skin of another frog. Now, Bocci (*Arch. per le Scienze Med.*, vol. vi, No. 22, 1883) has found that, from human urine, an alkaloid can be extracted which has got exactly the same action as curare. This alkaloid has not been shown as yet to be identical with the alkaloid obtained by Brieger (*Bericht der Deutsch. Chem. Gesell.*, Band xvi, pp. 1186 and 1405, 1883) from the peptones formed by digestion of fibrin with gastric juice, to which he has given the name of peptotoxin. But, whether these alkaloids be absolutely identical or not in their chemical constitution, they appear to be identical in their action, both acting, like curare, in paralysing the peripheral terminations of motor nerves.

I have already insisted more than once on the function of the liver in arresting and destroying poisons which have been absorbed from the alimentary canal; and I have already pointed out that excessive bitterness is of the common characteristics of organic alkaloids. Now, there is a curious point about the bile which has, I think, not obtained the attention it deserves. "As bitter as gall" has come to be a household phrase, and we frequently notice that the bile vomited in cases of indigestion is very bitter indeed, so bitter as to be nauseous. But bile is not always bitter, as I once found to my astonishment when making some experiments with digitalis. I had taken nearly half a grain of pure digitalin on each of two consecutive days, and the poison began to produce, as one of its effects, very violent vomiting. During this, I brought up a quantity of matter resembling both in appearance and taste the yolk of a fresh egg, and perfectly destitute of bitterness.⁶ Not having eaten any eggs, I could not see what it could be but bile; but I was so strongly impressed with the notion that bile was always bitter, that I did not put it down in my notes definitely as being bile, but only as yellow and liquid, somewhat like the yolk of an egg. The absence of bitterness from freshly secreted bile has also been observed by Mr. W. E. Green, of Sandown, in the case of a biliary fistula; and I am inclined to think that the bitterness which is supposed to be characteristic of bile does not really depend upon biliary constituents, but upon admixture with some alkaloidal substance derived from digestion. Some years ago, Dr. Bence Jones and Dr. Dupré showed that, in the liver and in other animal organs, an alkaloid was present resembling quinine in many of its reactions; but, for some years past, their observation has fallen out of notice.

It is very curious to observe how views of all sorts seem to turn round and round again, though not quite in a circle, for at each turn they generally have advanced a little. For a long time the liver was regarded as a most important organ, and well it might be, for it is the largest gland in the body; and yet, for a while, it has sunk into comparative unimportance, its chief function being considered to be the secretion of bile. But to regard the liver in this light, is just about as rational as to think that an Atlantic steamer has been built for the express purpose of throwing out from its sides the two jets which are formed by the waste water from the engines. The condensed steam may be utilised, and so may the bile; but the condensation of steam is not the main object of an Atlantic steamer, nor is the secretion of bile the chief function of the liver. If we look at the liver, not as a mere secretor of bile, but as the organ in which probably the most important synthetical processes in the body go on, and the small molecules resulting from the digestion of food are built up into the more complex ones required to supply the waste of the various tissues in the body, we shall at once see a good reason for its enormous size,

and for the important position which it occupies. If we recollect also its function as a porter to watch over the entrance into the circulation, and prevent the passage of noxious substances from the stomach or intestine, we shall readily understand how a slight disturbance of its function should give rise to such important functional alterations in other organs.

The Greeks showed their wisdom when they placed the seat of Hypochondriasis under the ribs, and when they connected depression of spirits with disorder of liver by giving to it the name of Melancholy. In her *Histoire de ma Vie*, George Sand says on this subject:

"Whether it is the bile which has made me melancholy, or the melancholy which has made me bilious—this would resolve a great metaphysical and physiological problem, which I will not take up—it is certain that sharp pains in the liver produce symptoms in all those that are subject to them, of profound sadness and a wish to die. Since my disease first appeared I have had happy years, and when it seized me again, although I was in the condition most favourable to love of life, I felt myself suddenly seized by a desire for eternal repose." (*Histoire de ma Vie*, George Sand. Vol. xviii, p. 295. Paris: 1855.)

Sydney Smith describes in a very humorous way the connection between dyspepsia and low spirits. He says: "Happiness is not impossible without health, but it is of very difficult attainment. I do not mean by health merely an absence of dangerous complaints, but that the body should be in perfect tune, full of vigour and alacrity. The longer I live the more I am convinced that the apothecary is of more importance than Seneca; and that half the unhappiness in the world proceeds from little stoppages, from a duct choked up, from food pressing in the wrong place, from a vexed duodenum, or an agitated pylorus. The deception as practised upon human creatures is curious and entertaining. My friend sups late; he eats some strong soup, then a lobster, then some tart, and he dilutes these esculent varieties with wine. The next day I call upon him. He is going to sell his house in London, and to retire into the country. He is alarmed for his eldest daughter's health. His expenses are hourly increasing, and nothing but a timely retreat can save him from ruin. All this is the lobster; and when overexcited nature has had time to manage this testaceous incumbrance, the daughter recovers, the finances are in good order, and every rural idea effectually excluded from the mind. In the same manner, old friendships are destroyed by toasted cheese, and hard salted meat has led to suicide. Unpleasant feelings of the body produce corresponding sensations in the mind, and a great scene of wretchedness is sketched out by a morsel of indigestible and misguided food. Of such infinite consequence to happiness is it to study the body." (*A Memoir of the Reverend Sydney Smith*, by Lady Holland, vol. i, p. 125. London. 1855.)

Usually, the melancholy and depression of spirits which are associated with disorder of the liver are attributed, like the bitter taste in the mouth, to the bile which is circulating in the blood. No doubt, bile is a muscular poison; but we have already seen that the bitterness of bile is probably not inherent in the secretion itself; and there is, therefore, good reason for doubting whether the bitter taste in the mouth is due to bile. Moreover, we sometimes find the bitter taste with very little evidence of the presence of bile in the blood, the conjunctiva being, at most, only slightly tinged; whereas we sometimes see patients who are deeply jaundiced, and yet make no complaint of any such taste. For similar reasons, we may regard it as probable that the depression does not depend upon biliary matters, but rather upon the noxious substances which have been able to pass through the liver and enter the blood. We may regard, indeed, the association of bile with other noxious substances in the blood in very much the same way as the association of disagreeable smells with noxious properties in gases. The presence of a disagreeable smell often warns us of the presence of noxious gases; but these may occur in their most deadly form with little or no disagreeable smell; and, on the other hand, we have disagreeable smells which are not associated with any danger. As a rule, people are now fully alive to the risks they run from poisoning by sewer-gas, or, to put it more widely, from poisoning by products of decomposition outside the body; but perhaps we do not all of us keep so clearly before us as we ought the fact that inside the body there are all the conditions for the formation of putrefactive products, and the most favourable arrangement for their rapid absorption. As the late Mr. Darwin once remarked to me, after reading my paper on Indigestion and Nervous Depression, "It is a wonder that we are alive," running, as we do, a constant risk of poisoning by the products of our own digestion. Slight poisoning does, no doubt, occur, and perhaps more frequently than we generally suspect. Severe poisoning is less common, but still may take place. One or the commonest constituents

⁶ On Digitalis, with some Observations on Urine, p. 67. London: Churchill, 1868.

⁷ I am indebted for this to my friend Dr. De Havilland Hall, who showed it to me in Tanner's *Practice of Medicine*, 7th ed., vol. ii, p. 100.

of sewer-gas is sulphuretted hydrogen; and Senator (*Berlin. Klin. Wochenschr.*, 1868, No. 24) described, in 1868, a most instructive case in which the patient became collapsed, and nearly died, with all the symptoms of poisoning by sulphuretted hydrogen generated in his own intestines.

A particular class of nervous symptoms, in which hypochondriasis and depression of spirits are accompanied by a deposit of oxalate of lime in the urine, has been thus described by Dr. Golding Bird. "The patients are generally much emaciated, excepting in slight cases, extremely nervous, painfully susceptible to external impressions, often hypochondriacal to an extreme degree, and, in very many cases, labour under the impression that they are about to fall victims to consumption. They complain bitterly of incapability of exerting themselves, the slightest exertion bringing on fatigue. Some feverish excitement, with the palms of the hands and soles of the feet dry and parched, especially in the evening, is often present in severe cases. In temper they are irritable and excitable; in men the sexual power is generally deficient, and often absent. A severe and constant pain, or sense of weight across the loins, is generally a prominent symptom, with, often, some amount of irritability of the bladder. The mental faculties are generally but slightly affected, loss of memory being sometimes more or less present" (Golding Bird, *Urinary Deposits*, 5th ed., p. 251).

But in this condition we find the same difficulty of attributing the symptoms to the presence of oxalate of lime that we found in ascribing the depression of spirits in biliousness to the presence of bile in the blood; for, as Dr. William Roberts (*Urinary and Renal Diseases*, 3rd ed., p. 79. London: Smith, Elder and Co.) points out, "these symptoms may be present in typical completeness without oxaluria, and, conversely, oxaluria may exist in its highest intensity, and even go on to the formation of a mulberry calculus, without evoking any of the above mentioned symptoms."

In this condition then, as in biliousness, we are almost forced to ascribe the symptoms to the presence of some poison, of whose presence in the blood the oxaluria in one case, and the yellowness of the conjunctiva in the other, are merely indications. The irritability which occurs in gouty persons is another example of nervous disturbance due to the presence of injurious substances in the blood, and their action upon the nervous system. But this has been already so graphically described by Murchison in his book on *Diseases of the Liver*,⁸ that I must refer you to it, and to the classical work of Garrod, as the subject is too wide to enter upon here.

There is only one so-called minor ailment connected with digestion which I will mention now, and that is headache. As I have pointed out elsewhere,⁹ headaches are usually dependant either upon the presence of decayed teeth, or of some irregularity in the eyes, more especially in the quality of focal lengths between the two eyes, or astigmatism. The site of headache depending upon decayed teeth varies with the teeth affected. The headache depending on inequality of vision is frequently frontal or occipital, although it may also be temporal. I am at present uncertain regarding the precise way in which indigestion produces headache; but I may remark that, as a rule, in headaches of this sort, the upper surface of the eyeball will be found to be excessively tender, and that the tension within the eyeball itself appears to be increased, so that sometimes the eyes feel like marbles or metal bullets under the finger when they are pressed. Another curious point that I have observed regarding headaches is that, as persons who are subject to them in their youth grow older, bilious headache is very apt to be replaced by giddiness; and that this change occurs about the time when the eyes are beginning to become a little hypermetropic, and the person begins to find the need of spectacles for reading.

Dr. Haig has made (*Practitioner*, August, 1884) the observation that in some persons the occurrence of headaches may be prevented by using nitrogenous food very sparingly, and avoiding butcher-meat altogether. This accords with my own observation regarding muscular weakness and langour, and, I think, renders it probable that some headaches, as well as langour, may be due to poisonous products derived from nitrogenous food.

⁸ *Clinical Lectures on Diseases of the Liver*, 2nd ed., p. 565.

⁹ Headache, Neuralgia, and other Nervous Diseases connected with the Teeth, *Transactions of the Odontological Society of Great Britain*, 1880; and On the Pathology and Treatment of some Forms of Headache, *St. Bartholomew's Hospital Reports*, vol. xix, p. 329, 1883.

THE BACILLUS OF TUBERCLE.

A Speech made during the discussion on Dr. Kidd's paper at the Royal Medical and Chirurgical Society, London, on January 13th, 1885.

By W. WATSON CHEYNE, M.B., F.R.C.S.

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I do not know, Mr. President, that, as regards the distribution of tubercle-bacilli in tubercular lesions, I have much to add to what I have already published, or to what Dr. Kidd has brought forward; but I have brought specimens to show a point as to the exact relation of the bacillus to the tubercular lesion, which, I think, is of considerable importance. The epithelioid cells of tubercle are now well known, and are always present in the centre of young tubercles. They are readily recognised in specimens stained more especially with methylene-blue, by their large, often oval, nuclei, which present a granular appearance, and are more faintly stained with the blue than the nuclei of the inflammatory cells which surround them. Now, I have always found that the bacilli are more intimately connected with these cells than with any other part of the tubercle, lying among them, and very often in them, and generally nowhere else. Further, I have been able to trace development of these cells into giant-cells in a number of instances. This is, perhaps, best seen in the lung, where these epithelioid cells are, as far as I can judge, developed in most instances directly from the epithelium of the alveoli, as shown in a specimen under the microscope. Certainly this is the case in phthisis. And there, also, the development of giant-cells from these epithelioid cells is often distinctly traceable, and is further evidenced by the fact that the giant-cells often contain a considerable quantity of carbon. Now, this fact of the relation of the bacilli to these cells is, I think, of great importance in searching for bacilli in the lesions of phthisis. Before looking for bacilli in a section of phthisical tissue, I always search with a low power for a collection of epithelioid cells, or of caseating cells, and then look at that place with a high power. This is of especial importance where fibroid changes are marked, for I have never yet found bacilli among this fibrous tissue, nor would I now expect to find them, on the view which I take of the pathology of phthisis. I believe that one reason why we have difference of opinion as to the presence of bacilli in the so-called fibroid phthisis is that search has been made among the fibrous tissue, and not in the real seat of the disease.

One word about the caseation of tubercles. I must confess that, since I have begun to think of the matter, I have become very sceptical about the view that the centre of a tubercle caseates on account of deficient supply of blood; for, among other reasons, degenerative processes are often evident even in the very early stage of a tubercle. Now, the elements which first undergo degeneration, are these epithelioid cells to which I have just referred. These, again, are the especial seat of the tubercle-bacilli. May not the bacilli have something to do with the degeneration? How do the bacilli act in producing a tubercle? It cannot be merely a mechanical action; I consider it most probably a chemical one. I have here photographs of preparations to which I made reference in my recent paper in the *BRITISH MEDICAL JOURNAL* on micrococci. Here you see a dark central mass—a mass of micrococci—a clear ring around, and then, beyond, an inflammatory ring. The course of events is clear; the micrococci, growing in mass, have produced a poison which has killed the tissue around; but further away has been more dilute, and has there set up inflammation. I need not enter into the details given in that paper, nor need I refer to several other known instances, where poisonous substances are produced by micro-organisms. Now, I conceive the state of matters in phthisis to be the following; and, of course, the view as to caseation applies to tubercles anywhere. Bacilli are inhaled into the air-cells of a lung which is in a fit state, whether by predisposition, or otherwise for their growth. They at once attack the epithelial cells, and, in the first instance, cause their hypertrophy and multiplication. The bacilli growing in these cells produce poisonous chemical substances and the cell, which, in the first instance, was stimulated to increased growth by a small quantity of the poison, soon succumbs to the in-

¹ As the accounts of my speech in the reports of the meeting are necessarily very short, and are in several points inaccurate, and as Dr. Creighton's criticism is published, I have thought it well to publish my remarks. The present paper may not be absolutely word for word, but it is as nearly as possible what I said.

HER Majesty the Queen has been graciously pleased to present to the funds of the Booksellers' Provident Institution, through Sir Henry Ponsonby, K.C.B., a donation of £20. Her Majesty has been the patron of this society since the year 1868.