D.

As the stomach is the place where the food first rests and remains longest, it possesses the most efficacious antitoxic properties. The healthy stomach is sterile, and all food during its stay within its cavity is sterilized as a result of peptic digestion, and this is carried out in the presence of sufficient hydrochloric acid and pepsin. Pepsin is deficient in only the rarest instances, but the supply of hydrochloric acid may be defective or altogether absent. Under these circumstances the administration of hydrochloric or nitro-hydrochloric acid is indicated, but should be in larger doses than those commonly administered. Ten or fifteen drops of hydrochloric acid (*B.P.*) may be added to half a pint of sweetened water, and this quantity used as a drink during or after each meal. Mercurials, especially blue pill or calomel, act as antiseptics in the stomach and duodenum, but most of the so-called intestinal antiseptics have not justified the claims made for them, and it is doubtful whether any antiseptic drug in practicable doses can preserve its bactericidal capacity after passing a short distance down the intestine.

Purgatives unquestionably eliminate toxins, and are among the most powerful means we possess, but many act only on the pelvic colon and rectum, and do not clear the whole length of the large intestine. Senna possesses this valuable property, and one of the best aperients for chronic faecal stasis is an infusion of senna pods taken every night at bedtime.

E.

The practice of drinking large quantities of water, especially of the milder mineral waters, has much in its favour. Unmineralized water is apt to stay in the stomach and so to cause discomfort, but this does not seem to be true of hot water, which many people take on rising and again at bedtime. Small quantities of salines, especially magnesium chloride or sodium phosphate or sulphate, may be added to the water with advantage. This helps elimination by preventing the drying of the faeces in the colon, and stimulates peristalsis. To ensure complete evacuation of the large bowel irrigations or ascending douches are among the most efficient means, but there is a risk of inducing atony of the bowel when their quantity is excessive or their use is continued too long. The "entero-cleaner" of Anton Brosch is the most elaborate of ascending douches, the chief advantage claimed for it being that, as it is administered under water, the external pressure supports the bowel and prevents over-distension. When the above described methods have had a fair trial, and there is reason to believe in serious pathological changes in the colon permitting the continued absorption of toxins, its exclusion or removal should be considered.

CONCLUSIONS.

1. Under physiological conditions the natural protective agencies in the alimentary system are sufficient to shield the body from the dangers of poisons formed therein or of those introduced with the food, provided that these are not in overwhelming amount.
2. Infrequent or incomplete evacuation of the colon is not in itself a cause of disease.
3. Such morbid symptoms as arise result from a breakdown in the protective machinery, in consequence of functional defects or pathological changes in the organs concerned.
4. Wholesome food in reasonable quantities may consist of animal or vegetable protein, carbohydrates, and fat in due proportion, and the evidence does not justify the entire exclusion of animal protein, as being directly or indirectly the cause of toxæmia.
5. When toxæmia is present treatment should be based on the principles of eliminating the poison already present, preventing any further introduction and reinforcing the natural protective agencies.
6. Where there is extensive disease of the wall of the colon the exclusion or removal of this organ is a justifiable proceeding after a reasonable trial has been given to medical methods.

CONSEQUENCES AND TREATMENT FROM A
SURGICAL POINT OF VIEW.

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I WILL endeavour to give a brief summary of the surgical treatment of the auto-intoxication and other effects which result from chronic intestinal stasis. The causation of stasis and the consequent infection of the gastro-intestinal contents are due to improper feeding in early life, and subsequently to the prolonged assumption of the erect posture of the trunk.

The changes that result in the drainage scheme are evolutionary in nature, and simply mechanical in origin. To meet the tendency to downward displacement of the viscera which results from an accumulation of faecal matter, at first in the large intestine, and later in the small intestine and stomach, membranes or mesenteries develop. These bands represent the crystallization of resistances. They form, in the first instance, as thickenings on the peritoneum, and later as distinct membranes or mesenteries, which support the viscera and tend to obviate their prolapse. Some observers regard these new developments as being congenital in origin, while others consider that they are inflammatory products. Against both these hypotheses are the facts that they do not exist at birth, that they can be seen in every stage of development during the lifetime of the individual, that they vary distinctly with occupations, that they commence at that point in the mesentery which is most distant from the bowel, and are obviously developed for the purpose of securing that particular portion of the intestine more closely to the abdominal wall, that they appear only on one surface of the mesentery, and that surface is the one along which the greater amount of strain is exerted, and that they correspond exactly in situation and direction to the lines of force. Besides this, they occur in the layers of peritoneum in which the main lymphatic trunks do not run, while they do not develop on such peritoneal surfaces as are chiefly in relation with the lymphatic glands and vessels.

At their commencement they serve a useful purpose. Later they tend to impair the function of the part and consequently to shorten life. This is a common characteristic of such evolutionary changes as develop during the lifetime of the individual.

While the effluent through any portion of the intestine may be controlled by some mechanical means applied externally, as, for instance, by a band, membrane, or appendix, the contents of the intestine may also be dammed back merely by the accumulation of material in the bowel beyond. This is illustrated by the puddling and obstruction in the much elongated pelvic colon seen so frequently in tuberculosis and rheumatoid arthritis in young people, and again in the delay of the contents of the ileum, and their consequent infection when material is accumulated in a large dilated caecum occupying the true pelvis, or occasionally when the caecum is fixed immovably in the iliac fossa. In any case the result is the same—namely, stagnation of the intestinal contents and the changes consequent on such delay.

The result of this stasis of the intestinal contents manifests itself in two distinct ways, which may or may not be obviously associated clinically. The mechanical results of such delay in the small intestine are interference with the effluent from the duodenum and consequent distension changes in the duodenum, more especially in its first part. This obstruction produces engorgement of, and later inflammatory changes in, the mucous membrane of the bowel, and may finally cause ulceration and perforation, or cicatrization and stenosis of the first part of the duodenum. Spasm of the pylorus follows on distension of the duodenum, and this brings about dilatation of the stomach with hypertrophy of its walls. Because of the strain exerted by the heavy contents of the stomach, often increased by the weight of an habitually loaded transverse colon, engorgement, inflammation, ulceration, and finally cancerous infection of the mucous membrane may develop along the lesser curvature at the site of greatest strain. This area of excessive tension approximates to the

pyloric end but varies with the position of the liver. Spasm of the lower end of the oesophagus occasionally complicates this condition and material may accumulate in the oesophagus. The term "cardio-spasm" has been applied to this condition, which exists in very varying degrees of severity and intermittency. Its symptoms and treatment have been fully described by Dr. Plummer. The alteration that takes place in the contents of the stomach and small intestine, due to their infection by organisms and consequent chemical changes, produces a quantity of gas, etc., and this determines the symptoms which are grouped under the comprehensive term "indigestion."

The ducts of the pancreas become infected by the direct extension of organisms along them, and induration, inflammation, and cancer of that organ may result. Similarly in the case of the liver, gall stones are developed with all the troublesome sequelae of their presence, the last of which is too frequently cancer. The infection of the ducts may extend up into the liver and inflammation of that organ may result.

Besides the mechanical changes in the gastro-intestinal tract and in the ducts which open into it, the chief trouble consequent on the stasis is the autointoxication produced by the absorption from the gastro-intestinal tract, and especially from the small intestine, of a greater quantity of toxic material than the liver and kidneys can deal with. This autointoxication produces a degeneration of every tissue in the body. It is particularly manifest in the organ which converts the poisons, in the heart and vessels which convey them, and in the kidneys which excrete them. The effect of the poisoning is shown especially by a loss of fat and by a degeneration of all the muscular tissues of the body. These factors are of especial importance in the female, whose function of accommodating and transmitting a fetus renders her more liable to change in consequence. The outline of her body is lost because of the dropping of the breasts and abdomen and the wasting of the buttocks. The uterus becomes soft and heavy and bends about. It drops backwards in most cases, so that the gorged heavy fundus rests on and tends to obstruct the rectum. The kidneys, being no longer cushioned in fat, prolapse, as do all the other viscera of the abdomen. In this manner a vicious circle is set up, by which the stasis and consequent autointoxication are still further exaggerated. Thus a condition of premature senility is brought about. The skin becomes thin and stained and its secretion frequently offensive.

The breasts undergo degenerative changes, manifested in the first instance as induration, to be followed by inflammatory and cystic degeneration, and possibly, lastly, by cancerous infection. The thyroid may enlarge, form tumours, and symptoms of exophthalmic goitre may not infrequently develop. The circulation is much affected. In some cases the blood pressure is abnormally high when it is associated with pretty obvious changes in the heart and aorta, while in others it is subnormal. The general body temperature is subnormal, whereas that of the extremities is always so, sometimes in such a marked degree as to suggest Raynaud's disease.

Microbic cyanosis may also be present.

The cerebro-spinal system is affected in a very marked manner by the poison. The patient is always depressed, feels stupid and unfit for physical or mental exertion, and suffers from headache which varies in character and intensity. Neuralgia or neuritis are frequently complained of. The sufferer sleeps badly, tends to fall asleep at all times of the day, dreams greatly, and awakes from sleep without feeling refreshed. These and other symptoms may exist in any degree of severity. In some cases the individual is mentally so dull as to appear imbecile, while in others the misery is so great that the patient willingly resorts to drugs, drink, or suicide as the only available means of alleviation or freedom from suffering. The eyes are definitely affected in many ways from the autointoxication. The condition of the conjunctiva is characteristic of its presence and degenerative changes in the tissues of the eyes are brought about. The sense of hearing also becomes defective in some cases, probably on account of degeneration in the nerve tissue or of infection in the spaces in connexion with the middle ear. The resisting power of the tissues to the entry of organisms is lowered. The effect of this is seen, perhaps, most

commonly in the sockets of the teeth, and especially around the lower incisors. Organisms establish a foothold in the gum about the fang, and produce a condition of inflammation which may sooner or later destroy the teeth. The products of suppuration from the infected gums being swallowed increase the infection of the upper portion of the gastro-intestinal tract, and seem to aggravate the general depression. A similar infection may occur in the sinuses and lymphatic tissues about the nose and throat. The genito-urinary tract of the woman is particularly liable to infection, and innumerable troubles affect her in consequence and interfere with the satisfactory performance of her functions. These patients readily develop tubercle or rheumatoid arthritis. I do not believe that these diseases can exist except in the presence of autointoxication. The evidence in favour of this statement is that these cases invariably show very definite clinical and x-ray evidence of stasis, and that the symptoms disappear and the patients recover sometimes with startling rapidity when the condition of stasis has been effectually dealt with. I would remind you of the remarkable confirmation of the extreme importance of effective drainage which Carrel's experiments afford. He has shown that tissue is immortal provided that it is properly drained, and that it obtains sufficient food. The difficulty that has to be met by us does not lie in the supply of sufficient nutrition, but in dealing with the defective state of our drainage apparatus. Carrel's observations are of the greatest possible service at the present moment, since they afford us the same confidence in our methods of treatment that x rays did in the case of operation for simple fractures, when the opposition to that form of treatment was intense and to a great extent unscrupulous in its methods. If we wish to deal with primary causes and not merely with effects, it is our business in all cases of autointoxication resulting from intestinal stasis to improve the drainage of our bodies so that material is no longer allowed to stagnate, decompose, and poison our patients. We cannot now pursue obsolete methods and be satisfied with the treatment of end results. We must deal with the defective condition of the intestines, the prime factor in the development of disease and death. Whether this can be effected sufficiently by the use of lubricants, abdominal pressure and diet, or whether some operative treatment is required, must depend on the nature of the stasis and the condition of the patient. Here again x rays afford us very great assistance, since they indicate not only the rate of passage of the contents through the several portions of the tract, but they often demonstrate the exact nature of the obstruction. Besides this, they show many of the changes in the heart and aorta, which are often serious complications of autointoxication.

In the vast majority of cases the ileal effluent is at fault. Sometimes this can be met by the removal of an appendix controlling the passage of the ileal contents into the caecum, or by the division of a membrane or a ligament reducing the lumen of the last two or three inches of the ileum, while at other times the best result is obtained by fixing the divided ileum into the pelvic colon, and by exaggerating the last kink by means of a suture, so as to avoid the ascent of faecal matter into the iliac colon. This last method of treatment is by far the most efficient, and results in immediate benefit in the vast majority of cases. Within a few hours of the operation the patient asserts that she is quite different, and that she has lost that feeling of intense misery and depression from which she had suffered for years. The feel of her hands, etc., is altered, and she looks a greatly improved woman. In a certain proportion of cases it is advisable to remove the large bowel at the same time or subsequently. This is particularly called for when the condition has existed for a long time and there is much change in the large intestine. The only risk of these operations is that common to all abdominal operations—namely, the formation of adhesions, which may anchor or obstruct the lumen of pieces of small bowel. This can be best prevented by rigid asepsis, and by avoiding exposure and manipulation of the intestines, and by approximating the edges of peritoneal surfaces as accurately as possible. It is now too late for mere quibbling, and for the negation of facts that are perfectly obvious and capable of demonstration in the clearest manner possible. This condition of defective

drainage has already been dealt with by surgeons all over the world, as well as by myself, and those who have had a large experience in the operative treatment of these cases are arriving at definite conclusions as to the best mode of dealing with them. Chronic intestinal stasis is a subject that is growing very rapidly in importance, and it cannot be decided merely by conjecture or on previous experience, but by the light of hard facts as afforded by the results of operative interference.

The Goulstonian Lectures ON DEATH BY ELECTRIC CURRENTS AND BY LIGHTNING.

DELIVERED BEFORE THE ROYAL COLLEGE OF PHYSICIANS
OF LONDON.

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LECTURE III.—DEATH BY LIGHTNING.

HAVING discussed the subject of death by industrial electric currents very thoroughly in the last two lectures, I am in a position to approach the obscure subject of death by lightning-stroke with the more confidence. This form of death is much commoner in most countries than it is in ours. In England and Wales the Registrar-General reported 124 fatal instances of lightning-stroke, 108 in men and 16 in women, during the ten years 1901–1910, a yearly average of only 12.4 deaths, or 0.36 per million living. In the twenty-nine years 1852–1880 there were 546 such deaths, the yearly average for that period being 18.8, or 0.88 per annum per million living. The number of these deaths varied widely in different years; three people were killed by lightning in 1863, 46 in 1872. The annual death-rate from lightning also varies widely in different parts of England. In the North Midlands from 1852 to 1880 it was 1.8 annually per million living; in the metropolitan district only 0.13 (Lawson)—a figure that should be of comfort for anybody who is in London during a thunderstorm. On the Continent much higher yearly death-rates are found. In Hungary the annual death-rate from lightning is said to be sixteen per million living (Milham); in Styria and Carinthia about ten per million, in Prussia 4.4, in France and in Sweden three, in Belgium two, so far as the imperfect statistics available go (McAdie and Henry). In the United States of America the annual death-rate per million is high, about ten, in consequence of the frequency of thunderstorms on the one hand and of the large percentage of the inhabitants engaged in outdoor labour on the other; about 700 or 800 deaths from lightning were estimated to occur in the United States every year by Henry in 1900, in a population of 76 millions.

Many more people are struck by lightning than are killed. For example, Jack records an instance in which a church was struck; 300 people were in it, 100 were injured and mostly made unconscious, 30 had to take to their beds, but only 6 were killed. Weber gives an account of 92 people struck in Schleswig-Holstein; 10 were killed, 20 paralysed, 55 stupefied, and 7 only slightly affected. In 1905 a tent with 250 people in it was struck, and 60 were left on the ground in various states of insensibility; one was killed outright, another breathed for some minutes before dying, the rest recovered.⁴⁴ As many as eleven⁴⁵ and eighteen⁴⁷ persons have been killed by a single stroke of lightning. Vincent mentions a stroke that threw down 1,200 and killed 556 out of a flock of 1,800 sheep. Dechambre believes that children are perhaps less liable to be struck than adults; but statements such as these are really not capable of proof or disproof.

The Nature of Lightning.

Nothing was known or even, apparently, guessed as to the true nature of lightning and its connexion with electricity till 1708, when Wall drew attention to the similarity

between it and electric sparks obtained by rubbing a piece of amber. The identity in kind of electric sparks and lightning was proved in 1752, when the experiment suggested by Franklin in 1750 was carried out in France by D'Alibard, and ordinary electric sparks were obtained, during the passage of a thunderstorm, from an insulated iron rod forty feet high set up in a garden at Marly-la-Ville. A few months later Franklin proved the same thing by his celebrated experiment of flying a kite up into a thunder-cloud during a rain-storm, and drawing sparks from the wet cord that held the kite. In this way it was proved that a flash of lightning is no more than a particularly large and powerful electric spark.

When electric sparks and their methods of production are examined, it is found possible to determine a large number of physical data about them—the voltage that is required to produce a spark of a given length, for example, the duration of a spark, the direction of its flow, the quantity of electricity (measured in coulombs) it contains, the rate of flow in amperes of the current that produces it, the amount of energy (measured in joules) expended in its production, and the rate and number of the oscillations composing it—for in a great many cases an apparently simple and single electric spark is really a complex built up of a rapid succession of sparks of diminishing intensity, first in one direction, and then back again in the opposite. All these measurements can be made with some accuracy, and many of them are of importance in determining the lethal or non-lethal effects of electric sparks upon animals.

But with lightning flashes the dangers of such investigations as these are obvious, and not one of the measurements just described above has ever been made as yet with any approach to accuracy in the case of lightning. One only has a number of vague suppositions and a few somewhat sketchy experimental facts to go upon. Still, such as they are, these are worthy of consideration.

1. *Voltage*.—This has never been measured, but has always been assumed to be very high. Lodge calculated that the production of a flash a mile long might require a difference of potential of five thousand million volts, and reckons the difference of potential concerned in an ordinary flash at millions or hundreds of millions of volts. Most authors content themselves with saying that the voltage of a flash must be millions or many millions of volts. Trowbridge found that his battery of twenty thousand small secondary batteries joined up in series gave him initial sparks 3.5 to 4 cm. in length, at a voltage of about 40,000 volts; but, when the two sparking terminals were quickly drawn apart, he could get a flaming discharge 60 cm. in length. He also found that the apparent resistance of the air was much diminished, and the sparking distance at any given voltage was increased, when large quantities of electricity were employed and transmitted in the spark.

2. *The quantity of electricity in a flash*, in coulombs, never has been measured. Faraday believed that it was quite small, not enough to decompose a drop of water into oxygen and hydrogen, and later writers have agreed with this estimate. Lodge, for example, mentions seventy coulombs as the quantity in a certain flash, enough to decompose only one-tenth of a grain of water.

3. *The amperage*, or rate of flow of the electricity, has always been assumed to be large. Here, at last, we meet with a quantity that has been measured, though not by a method capable of very accurate results. Pockels has described some experiments made with the lightning flashes that struck lightning rods on an observatory in the Apennines; and from the amount of permanent (remanent) magnetism induced in some small basalt prisms by the current flowing down the lightning conductor when it was struck, he has calculated that in these particular lightning flashes the current was from 11,000 to 20,000 amperes. Trowbridge's view that with sparks of large amperage the resistance of the air seems to be reduced has been mentioned already.

4. *The duration of lightning flashes* has not yet been investigated as carefully as it ought to be; it is a matter for the meteorologists to settle by actual observations. Schmidt's experiments showed that the duration of many flashes was under $\frac{1}{5000}$ second, while others were multiple or oscillatory in character, and lasted for $\frac{1}{2000}$ – $\frac{1}{200}$ second, and yet others lasted for longer than $\frac{1}{200}$ second.