myelitis. If now we cast aside these theories, which are advanced to explain the origin of all tumours or of all malignant tumours, and look at the local changes in the repair of injuries, the problem presents itself thus. The repair of all injuries is effected by means of indifferent cells derived from the white blood-cells, which pass through various developmental changes until they have formed a tissue more or less perfectly resembling the original. At a certain early stage of this process the reparative material resembles more or less exactly a sarcoma, and in such cases as those we are considering we may describe the growth of the tumour as due to the arrest of the development of the "lymph" when it has reached only an immature stage. We know that the development of the reparative material is largely influenced by the living tissues immediately adjacent to it, possibly also by the nerves of the part, so that in one place the same "lymph" will grow into fibrous tissue, in another place into bone, and in a third into nerve. I would therefore submit that we find a clue to the cases under discussion by regarding the origin of the sarcoma as depending upon some dynamic influence of the injury upon those tissues which control the development of the reparative material, and which shows itself by arresting the development when the tissue formed is immature, and when the cells are endowed with great powers of growth. I think we have evidence that injury does exert such dynamic influence upon tissues in some cases of inflammation and abscess after injury, in cases of wasting of muscles after contusion, in brittle nails after pinches of the digits, &c. The rarity of this sequel to an injury is probably accounted for by the *real* dissimilarity of injuries which appear exactly alike, and by the different inherent powers of resistance possessed by the tissues of different individuals. At any rate, the different results in other particulars which follow the most closely similar injuries afford an important analogy. In conclusion, I would merely point out such a supposition as this may throw light upon the facts adduced by Verneuil, Kirmisson, and others, which appear to show that malignant tumours in central organs may develop rapidly after an injury to the extremities; and also upon Nicaise's cases of the growth of secondary malignant deposits only in parts exposed to injury.

I should like further to add a word about the method of amputation adopted in the second of my cases, as it is in my opinion the simplest procedure in such cases. It may be considered as a modification of Furneaux Jordan's plan, inasmuch as the soft parts were divided at the middle of the thigh, and the inner part of the thigh was left intact. It differs from the modification of his first method which Mr. Jordan suggested, and which has been largely practised by Dr. Marshall, inasmuch as a complete circular amputation of the thigh was first made, and after the hæmorrhage had been arrested the upper end of the femur was enucleated by means of an incision along its outer side. The advantages of Furneaux Jordan's method of amputation at the hip are now generally admitted. The additional advantage of the plan I followed is that it relieves the surgeon of all difficulty or anxiety on the score of hæmorrhage. A simple tourniquet easily controls the common femoral artery, and the whole question of hæmorrhage and its prevention is reduced to the simple proportions it assumes in amputations of the thigh. The need for Lister's abdominal tourniquet, Davy's lever, or special applications of Esmarch's cord is entirely obviated. It is better to have skin flaps to cover over the mass of muscles divided, and I therefore preferred this plan to a simple straight section through the limb. (At the close of the meeting of the Medical Society at which this paper was read, Mr. J. H. Morgan informed me that he had practised this method of amputating, and was very pleased with it.)

THE NEW LUNATIC ASYLUM.—On the 26th ult., at a general meeting of the magistrates of the county of Middlesex, it was decided that the provisional contract entered into by the committee appointed to provide an additional asylum for pauper lunatics for the Birch Hall Estate, Theydon Bois, in the county of Essex, containing 136 acres, for £12,750, be approved by the Court, subject to the sanction of the Secretary of State for the Home Department, and that, subject to the approval of the contract by the Secretary of State, the sum of £13,200 be raised on mortgage of the county rates for the purchase of the Birch Hall Estate, for the purpose of erecting thereon a fourth lunatic asylum for the county of Middlesex.

TUBERCLE AND THE TUBERCLE BACILLUS:

A REVIEW.

By H. HANDFORD, M.D., M.R.C.P.,

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(Concluded from p. 989.)

WE will now consider the importance of the dose of the virus used for inoculation. Koch says, it is of the greatest significance whether the infection be produced by few bacilli or by a large number. The different results can be most simply studied in the eye of the rabbit. If as few bacilli as possible be introduced into the anterior chamber, there follow at first separate grey nodules, true miliary tubercles, which become yellow in the centre. Their number gradually increases, they become confluent, and lead, only after a somewhat lengthened period, to general caseation and destruction of the eye, and to the production of tubercle in other organs. If, on the contrary, a large number of bacilli be introduced into the anterior chamber, a diffuse caseous infiltration ensues, and the eye speedily becomes disorganised, general tuberculosis taking place early, usually within three weeks. And, further, with regard to the method of infection, the changes found in animals that have died of spontaneous tuberculosis are very different from those that are produced by artificial infection, so that the method of infection can be determined with complete certainty. In spontaneous tuberculosis one or two large tubercular masses in a state of advanced caseation are found in the lungs, and at the same time the bronchial glands are much enlarged and caseous. Occasionally nothing is found in the lungs, but the bronchial glands are enormously enlarged and caseous. The tubercular changes in the other organs are, on the contrary, relatively slightly advanced. In the artificially produced disease the appearances differ according as inoculation or inhalation of bacillus-containing fluids is employed. In inoculation under the skin of the abdomen the nearest lymphatic glands are greatly enlarged and caseous; but the bronchial glands are almost always so small as only to be found with difficulty. The tubercular changes in the liver and spleen are also far advanced, whereas in the lungs they are relatively slight. In animals that have become infected by inhalation and that have received a large quantity of bacilli into the lungs, there are found not one or two large tubercular masses in the lungs, but a very large number of small tubercles. Thus, in all cases, in man and in the lower animals, a local caseous tubercular mass, with infiltration of the neighbouring lymphatic glands, precedes general tuberculosis by a longer or shorter time. In guinea-pigs inoculated with a large dose, the time that elapses before general infection takes place may be very small. In man, on the contrary, who is generally infected by a small dose, though it may be oft-repeated, the time is generally long, and much more frequently than not general infection never takes place at all. In this respect the course of tubercular disease in man resembles that in dogs, cattle, and fowls, tending to produce local changes, and not a general infection.

With regard to the much-disputed question of the hereditary transmission of tubercle, there are no grounds for supposing that tubercle bacilli can exist in the infant body during intra- or extra-uterine life without in a relatively short time producing visible changes. Hitherto signs of tubercular disease have been very seldom found in the foetus or in the new-born infant, and from this we may conclude that the tubercle virus only exceptionally comes to maturity during intra-uterine life. This is in accordance with the fact that the animals used in Koch's experiments—namely, guinea-pigs,—which frequently became pregnant shortly before or after becoming infected with tubercle, never produced young that were already tubercular at birth. The young of mothers with advanced tubercular disease were free from tubercle and remained healthy for months. We are therefore driven to the conclusion that in hereditary tubercle it is not the *materies morbi* itself that is inherited, but certain special conditions which favour the growth of the virus when at a later period it comes into contact with the body, and which we call predisposition. Although a great part of what is comprised under the expression "predisposition" consists in simple and easily explained condi-

tions, yet there remain certain facts, difficult or impossible to explain, which compel us to allow, at any rate for the present, the supposition of a predisposition. Among these the most important are: 1. The striking difference in the course of tuberculosis in children and in adults. 2. The unmistakable liability of certain families to suffer from tuberculosis. Many examples of the latter, usually attributed to predisposition, may with much greater probability be explained by more frequent exposure to infection. We should also remember that certain conditions, such as liability to catarrh of the organs of respiration and imperfect development of the chest, which are favourable to tubercle infection, also run in families. Nevertheless, there remain observations pointing to a predisposition to tubercle which do not admit of such explanations. Further, individual cases of disease often teach us that *the same person does not at all times afford an equally favourable soil for the growth of parasites*. For, as is well known, cases are not unfrequently met with in which tubercular masses of by no means small extent shrink, cicatrise, and heal. That is to say, the same body which on the invasion of the tubercle bacilli affords a suitable soil, so that they increase and spread, gradually loses these specially suitable conditions, changes into an unsuitable soil, and so checks the further growth of the bacilli. In what the difference consists, whether in a change in the chemical constitution of the tissue juices or in physical conditions—that future investigations must decide. This much, however, is certain, that these differences exist, and it is not improbable that in some persons conditions favour-

ducing the disease if properly cooked. Uncooked, it is only dangerous if the bacilli are in the spore-bearing condition, for the bacilli themselves are killed by the gastric juice, though the spores pass through the stomach unharmed. But even then, owing to the long time they take to develop, they pass out of a healthy intestinal canal without being able, in the immense majority of cases, to effect a lodgment.

Among predisposing causes may be mentioned hereditary predisposition, inflammatory attacks, such as measles, bronchitis, &c., which cause the respiratory tract to lose its protecting epithelium in places, so that the bacilli can more readily penetrate the bronchial walls. Pleuritic adhesions, imperfect or abnormal development of the thorax, and other conditions which impede the free expansion of the lungs and cause local accumulations of bronchial secretion, also favour the lodgment and growth of the tubercle bacilli and the production of tuberculosis. But if tubercle bacilli are so widely spread, how is it that anyone escapes infection? The presence of tubercle bacilli has been demonstrated in the air of the wards of a consumption hospital and in the breath of phthisical patients. And yet it was shown by an elaborate inquiry² at the Brompton Hospital that phthisis was not more common among the resident officials and nurses than among the general population. Nor do all those who come into close contact with consumptives catch the disease; indeed, it has been difficult to show such an origin in any case. And yet there can be no reasonable doubt that the tubercle bacillus is the essential cause of tubercle, just as much as the anthrax bacillus is of splenic fever.

DEATH-RATE FROM PHTHISIS PER 10,000 LIVING AT EACH AGE.

England, 1851-60, top line; 1861-70, middle line; 1871-80, bottom line.

able or unfavourable to the growth of tubercle bacilli persist, not merely for a definite time, but during the whole of life.

The chief source of tubercle bacilli is no doubt the excreta—more especially the sputum¹—of human beings. The bacilli are carried into the air on particles of dust, and are inhaled or swallowed, and set up tubercular disease in the manner already described, or they may infect food and be swallowed. Another source of the tubercular virus is the tubercular disease of domestic animals. But as they produce no sputum, no tubercle bacilli are set free from the respiratory tract, and the intestinal contents appear, even in tubercular animals, only in exceptional cases to contain tubercle bacilli. The milk of tubercular cows may in some cases reproduce the disease when consumed. Experiments on this point have given widely different results. The real state of the case probably is that the milk only contains tubercle bacilli when the udder is affected with tubercular disease, which only happens exceptionally, and that the milk even of tubercular cows does not reproduce the disease unless it contains tubercle bacilli. The flesh of tubercular animals, when eaten, may reproduce the disease; but this is probably not a frequent source of infection for the following reasons. The tubercular affection of cattle (perlsucht) remains generally localised, and only the consumption of the diseased parts—viz., the lungs, lymphatic glands, pleura, &c.—would be capable of causing infection. But even if meat contain tubercle bacilli and their spores, it is incapable of repro-

What is the explanation? In the first place, it is probable—nay, almost certain—that a large number of persons inhale or swallow the tubercle bacillus or its spores without becoming infected. Many of the organisms thus inhaled are expelled by the cilia of the epithelial cells lining the mucous membrane of the bronchi before they have time to develop, for, as I have stated before, the tubercle bacilli require a month to reach their full development, and show scarcely any signs of growth under a week or ten days. Of the rest, some produce tubercular changes in the walls of the bronchi or of the alveoli; others enter the lymphatics and are carried to the bronchial glands, which consequently enlarge and become caseous; and yet others enter the blood. Here the bacilli cannot grow while in rapid motion, for rest is required for their development. They may, however, pass through the capillary walls in different parts of the body and produce miliary tuberculosis. But, no doubt, many organisms that enter the blood, and the tubercle bacillus among them, are very speedily excreted by the kidney. But, still further, besides those that are expelled from the bronchi, excreted with the urine, or that pass through the alimentary canal without being able to effect a lodgment and grow, there can, I think, be no doubt that many of those that remain do not find their host a suitable soil, and either do not grow at all, or else, which perhaps is more frequent, produce only a local tubercular deposit, which not only does not lead to general tuberculosis, but does not *spread* locally, the soil being so unfavourable

¹ Schill and Fischer (Mitth. a. d. Gesund., Bd. ii., Berlin, 1884) recommend the disinfection of phthisical sputum with a view of removing a very common source of the spread of the disease.

² The Contagion of Phthisis, by C. Theodore Williams. Brit. Med. Journ., vol. ii., p. 618. 1882.

to its extension that it soon becomes enclosed by a fibrous capsule, or calcifies and remains quiescent. From observing the very varying degrees of susceptibility to tubercular infection among the lower animals, we might naturally expect that there would exist among the individuals of the same order different degrees of sensibility to infection. Moreover, we must recollect that, though tuberculosis can be produced with certainty in the lower animals, the dose of the tubercular virus employed is generally relatively large, and by endermic or hypodermic inoculation is placed in the most favourable position for growth. It runs no risk of being swept away again, and is not injuriously influenced by gastric or intestinal secretions. And when infection has been produced by the inhalation of bacillus-containing fluids, the dose employed has been immeasurably larger than we can imagine would ever be the case in the accidental infection of human beings. Also in dogs, which are very insusceptible, tubercular infection cannot be produced with certainty by a small dose.

That tubercle in man is very frequently a local affection, never becoming general, is shown by the large number of cases of strumous disease of joints (now shown to be tubercular) which, under appropriate treatment, eventually recover without leading to general tubercular disease. Lupus, though now shown by Koch to be a tubercular affection of the skin, never leads to general tuberculosis. Numerous post-mortem examinations of bodies dead of other diseases reveal isolated tubercular deposits that have remained quiescent for years, and have had no share in causing death. Clinically, too, many cases are met with where the physical signs of tubercular disease of the lungs are found and incipient phthisis is diagnosed. When, however, they all, or in great part, disappear, and the patient regains robust health, the physician is apt to doubt his own diagnosis and to suppose that he has made a mistake. Such was frequently my own case till I read Dr. Austin Flint's admirable paper³ on the "Self-limited duration of Pulmonary Phthisis," where he calls attention to this point. These considerations, and the very remarkable differences in the course of tubercular disease in children and in adults, point to the supposition that *all individuals do not afford an equally suitable soil for the growth of the tubercle bacillus, nor does the same individual at all times.*

At present the diagnosis in the vast majority of cases has not been helped by the discovery of the tubercle bacillus, whatever may be the case in the future. It requires a considerable amount of skill to demonstrate the presence of tubercle bacilli, especially in sections of tissue; and although in good specimens and by a practised observer they may be recognised under a good $\frac{1}{2}$ in. objective, in doubtful cases a $\frac{1}{10}$ in., or preferably a $\frac{1}{15}$ in. homogeneous immersion is required. It was thought that the discovery of tubercle bacilli in sputum would prove of considerable diagnostic value, and would be employed clinically; but it must be remembered that the bacilli are not present in the sputum till the tubercular deposit is breaking down and cavity formation has commenced, and then the diagnosis can generally be made from the symptoms and physical signs. Although the prognosis in tubercular diseases generally is much better than it used to be, that is owing to the great advance in treatment independently of, and in a large measure preceding, the discovery of the tubercle bacillus.

Though our treatment has suffered some alterations in consequence of the discovery of the tubercle bacillus, it is doubtful if it has been improved thereby. Various attempts have been made to introduce germicide remedies into the system, either by inhalation or by the mouth, with a view of destroying the bacilli. Hitherto all such attempts have been failures. Dr. Hassall⁴ has shown that the quantity of the antiseptic that enters the lungs in inhalation is so small as to be quite incapable of destroying the bacilli, much less their spores, which are so very much more resistant. This applies not only to the oro-nasal inhalers, but also to the method of inhalation by the vapour of hot water. By both methods beneficial effects are often produced, more especially in the way of allaying cough, but the action is probably chiefly on the larynx and trachea. As yet, also, no germicide has been found which can be administered in sufficient doses to render the fluids and tissues

of the body poisonous to the bacilli without at the same time proving hurtful, if not fatal, to the patient. Nor is it likely that any such substance will ever be discovered. Far more probable is it that such germicide medicines as quinine, corrosive sublimate, or arsenic may be administered in sufficient doses to render the fluids and tissues of the body an unfavourable soil for the bacilli, and so prevent their growing and multiplying, without being able to kill them, and also without proving harmful to their host. It is not unlikely, however, that in the future, as in the past, that treatment will be most successful which aims chiefly at increasing the general nutrition of the body. A high state of nutrition with an active circulation seems to be unfavourable to the growth of tubercle bacilli. Mainly by dietetic and hygienic measures the death-rate from phthisis for the decade 1861-70 has been diminished from that of 1851-60, at all groups of ages, and for the ten years 1871-80 the decrease has been still more marked, as seen in the chart in the preceding page. We may hope that with the recent advance in our knowledge of the pathology of tubercle, and with the great improvement in our methods of treatment the diminution in the death-rate from phthisis will continue to be progressive.

TREATMENT OF URETHRAL STRICTURE BY ELECTROLYSIS.

By S. T. ANDERSON, M.D.

IN a recent LANCET I read an article on Urethral Stricture, which inclines me to call attention to a different mode of treatment than that practised in the case referred to by Mr. Norton. I refer to the operation known as electrolysis—i.e., electric analysis. We may better understand this matter if we bear in mind this fact that an equivalence exists between electric and chemical action. Attfield tells us that an electric force which will liberate from its combinations 127 parts of iodine will set free eighty parts of bromine. But this is exactly the proportionate work we expect from chemical analysis. Apply electric force in a proper manner to the tissues which produce the condition we call stricture, and disintegration results. The parts are not "burned out," as some infer, but the abnormal growth is resolved into its primary elements, is absorbed and permanently removed, whether the stricture be the result of injury or of the ordinary inflammatory causes. I cannot claim originality of method, and I must acknowledge my obligation to Dr. Robert Newman, of New York, for valuable advice. I know how electricity has been debased in public estimation by medical sciolists, and I have thought the results obtained in a few interesting operations performed by this strange potency might stimulate ambitious professional brethren to study and emulation. Presuming that results will be of greater interest, as they will doubtless be also of greater value, than theories, I will briefly state the points in a few of the cases treated.

CASE 1.—Mr. H—, aged about thirty, had a stricture developing slowly for a long time until catheterisation became needful, and later impossible. His physician informed him that the catheter could no longer be introduced, but the patient not crediting the statement, and believing the doctor did not use sufficient force, made an effort to introduce a metallic catheter, which, entering a pocket, was forced forward, making an opening into the rectum. In this condition he applied to Dr. Wm. Hill, a surgeon of this city, who brought the man to my office on July 18th 1884. On account of the passage made into the rectum we thought proper to administer chloroform, and then a No. 17 French electrode bougie slowly decomposed the stricture and entered the bladder in twenty-three minutes. The electrode was slowly withdrawn so as to more fully absorb the stricture tissue, and the instrument then passed quite easily. So soon as the chloroform effect had sufficiently subsided, the patient went into the street and passed unaided a good stream of water "about an hour" after the operation. No blood was lost in the operation, except that a few small clots escaped with wind from the rectum. The only complication which resulted was an orchitis a few days after he returned home to a neighbouring village, and the man remains well to this date—fifteen months after the operation.

³ Brit. Med. Jour., vol. ii., p. 617, 1882.

⁴ The Inhalation Treatment of Diseases of the Organs of Respiration, including Consumption. By Arthur Hill Hassall, M.D. 1885. Longmans.