seized with pain in the left lumbar region; it was unaccompanied by any nausea, or alimentary or urinary disorder, although he admitted having a slight headache. There was some tenderness over the left kidney, but none over the left ureter or bladder.

While in hospital the patient had slight pyrexia in the evenings of the first three days—98.8°, 99°, and 99.2°—and again on the seventh, eighth, and ninth days of 100.8°, 99.2°, and 98.8°; the rise in temperature was associated each time with an exacerbation of pain. The urine was alkaline and contained a trace of albumin and a heavy deposit of pus cells, with a few red blood corpuscles and epithelial cells; but no casts or crystals or other abnormal constituents, nor tubercle bacilli were found.

An organism giving the bacteriological characters of Morgan's No. 1 bacillus was grown in pure culture. This organism was again isolated on March 25th, April 15th, and April 18th, each time in pure culture. A blood culture made on April 8th remained sterile. The results of agglutination tests of the patient's serum against the bacillus isolated proved interesting. Using Professor Dreyer's macroscopic technique, the following results were obtained: On April 2nd, agglutination in a dilution of 1 in 125 in an hour; on April 20th, agglutination in a dilution of 1 in 500 in an hour. In each case a normal human serum was put up as a control. The patient had the first three doses of an autogenous vaccine in the interval between the two agglutination tests.

CASE II.

The second case occurred in a British subject who was in the Khartoum Civil Hospital in February, 1926. He had a typical attack of pyelitis with pyrexia which lasted about three weeks. The urine was alkaline and contained a heavy deposit of pus cells and many coliform bacilli. I isolated Morgan's No. 1 bacillus from the urine, but in this case there were a few *B. coli* colonies present also.

The organism in each case gave the following cultural characteristics, etc.: On agar slopes a thin yellowish-white film was formed, having a sticky feel when touched with the platinum wire, while small colonies closely resembling *B. dysenteriae* were grown on MacConkey's medium. In broth a diffuse turbidity was produced. The bacillus was motile and Gram-negative.

The usual sugar reactions were tested. The result was alkaline with litmus milk; acid and gas with glucose and with galactose; acid on the fourth day with glycerol, and slight with indol. In tests with all the other substances there was no reaction.

Conclusions.

While the findings are very definite in Case I, they are more doubtful in Case II.

Both patients are receiving vaccine treatment, an autogenous vaccine having been prepared in each case.

EXTENSIVE DIVERTICULOSIS WITHOUT SYMPTOMS.

BY

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THE following case is notable as indicating the existence of extensive diverticulosis for at least fourteen years without giving rise to symptoms. Other pathological conditions were also present within the abdomen, including congenital abnormality of the small intestine.

A married woman, aged 51, who had borne six children and had a tendency to obesity, was admitted to the David Lewis Northern Hospital, Liverpool, on May 3rd, 1926, under Mr. G. C. E. Simpson. She complained of "wind" since an operation in 1912, and stated that for the last year she had suffered from occasional attacks of pain in the epigastrium, occasionally going through to the right shoulder-blade; they had no relation to food, and occurred irregularly either by night or by day, were sometimes accompanied by jaundice, and invariably by vomiting. The vomit was frothy, yellowish, and tasted sour. She said she had had typhoid fever when 6 years of age. On February 21st, 1912, she was operated on for gall stones, and five months later a hydatid cyst of the left hepatic lobe was removed. Both operations were performed by Mr. Murray at this institution. She brought to hospital with her a copy, which she herself had made at the time, of her old case-sheets, and also the two summary sheets dealing with the operations. On the back of the first summary sheet was found a pencil drawing of a portion of large intestine showing diverticulosis of the mesenteric attachment. This, she said, was drawn by Mr. Murray in the out-patient department to illustrate her condition. Mr. Simpson, who was then assistant honorary surgeon, remembers the occasion well.

Condition on Admission.—She was slightly jaundiced, the tongue was coated, and the breath foul. She was not constipated. Nothing abnormal could be discovered in the abdomen, and Murphy's sign was not elicited. Faeces and urine contained no abnormal constituents. A fractional test meal showed the presence of blood and bile in the stomach, with 0.03 free hydrochloric acid and 0.07 active.

Operation.

Mr. G. C. E. Simpson opened the abdomen on May 10th, when slight hepatoptosis became evident. The gall bladder, which was adherent to omentum, was full of small faceted stones. The pancreas and the appendix were in a state of marked chronic inflammation. From the caecum to the beginning of the rectum were hundreds of diverticula containing beads of faeces, and varying in size from that of a pea to that of a cherry. They were of the acquired type¹—that is to say, they were hernial protrusions of mucosa. The vast majority were in the concavity of the mesenteric attachment and the appendices, but there were also numerous small protrusions through the taeniae and peritoneum-covered muscular wall. The contents of all those in which it was attempted could be emptied easily into the bowel. There was no evidence of inflammatory reaction round these diverticula, and Mr. Simpson was able to say, having seen the case in 1912, that the only notable progress was an increase in size.

Another interesting condition present was an arrested rotation of the small intestine. The duodenum, with the superior mesenteric artery on its inner side, turned back on the head of the pancreas in the shape of a double S. The duodeno-jejunal flexure was at McBurney's point, the mesentery running thence upwards to the left. The mesenterized caecum, which was entered by the ileum from the right, was slightly left of the mid-line in the upper umbilical region. This arrest had apparently occurred at the eleventh week after the caecum had entered the abdomen through the narrowing umbilical orifice.² The gall bladder and the appendix were removed; the colon, with its diverticula, being symptomless, were left.

The patient made an uneventful recovery, leaving hospital in very satisfactory health.

I am indebted to Mr. G. C. E. Simpson for permission to publish this case.

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ULTRA-VIOLET LIGHT FROM OPEN ARC WITH TITANIUM ELECTRODES.

BY

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It is now established that ultra-violet light has important biological effects. Many diseased conditions have been treated with it and much enthusiasm has been evoked over its possible therapeutic value. It has been pointed out that if a list of the diseases said to have been benefited was made it would probably begin with acne and go through the whole official nomenclature to zona, including house-maid's knee and the minor psychoses. But the fact that its value is in many cases overstated and its mode of action is at present rather mysterious is no reason why its effects should not be thoroughly explored.

GENERAL.

The rather widespread impression that these rays are dangerous is illusory. They cause nothing comparable to the injuries that may follow the imprudent use of x rays. Their penetration is very slight and confined at the most to the lower layers of the epidermis. Even at this slight depth we begin to recognize two kinds of action, depending upon the degree of exposure and the precise wave-length of the light employed. It is at present difficult in medical practice to restrict the wave-length to any narrow degree of the ultra-violet spectrum. Where this has been done experimentally we have evidence that rays beyond the visible spectrum down to 290 μ , which have been spoken of as "biologic," are of such a nature as to stimulate biological processes, particularly as the lower limit is approached, whilst beyond this the still shorter rays, called "abiotic," exhibit a lethal action, though on account of their restricted penetration this is of little importance unless the exposure is prolonged. Even these shorter rays, if used with brief exposures, may perhaps act biologically. Taking the germicidal effect as a test, Browning and Russ got a maximum effect between 280 and

255 μ . Hausser and Vahle obtained the maximal erythema effect on the human skin between 300 and 290 μ . Leonard Hill found that rays at 275 μ killed infusoria in twenty minutes, that rays at 275 and 257 μ produced erythema, whilst rays at 232 μ were ineffective (using the lines in the cadmium arc). As regards penetration, he found that under certain conditions rays shorter than 330 μ did not penetrate what he describes as a thin layer of the horny epidermis, which resembles in this a 3 per cent. solution of quinine. It might here be pointed out that the solar radiation available at the earth's surface does not include rays shorter than 300 μ . The eye is more transparent to ultra-violet radiation than the external skin. The cornea is transparent to rays longer than 295 μ , and the lens is the chief barrier to ultra-violet rays reaching the retina. Probably no rays shorter than 380 μ can reach the retina. Conjunctival inflammation from exposure to ultra-violet radiation generally subsides rapidly and is strictly comparable to the inflammatory effect which such radiation has on the skin.

The effect on the blood of exposure to ultra-violet rays has been studied by Koopman amongst others. He found the concentration of erythrocytes to be unchanged; the leucocyte count at first increased, then fell; the lymphocyte count became more permanently increased. Clark points out that this depends upon the wave-length. Rays of 400 to 300 μ cause leucopenia, rays of 300 to 200 μ produce lymphocytosis. Balderry and Barkus found that exposure to ultra-violet rays increases the alkalinity of the blood, and thus runs parallel to the degree of pigmentation. Pech has recently pointed out that there seems to be an antagonism between the red end and the violet end of the spectrum so far as the characteristic effects of ultra-violet radiation are concerned. If this is correct it tends to indicate that the source of the radiation should possess as little as possible of the red end, and suggests that the carbon lamp falls short of an ideal source. Evidence also has been advanced that exposure to ultra-violet rays increases the metabolic rate, but the proof at present is incomplete.

The most impressive and important observations are, however, in relation to the effects in such deficiency diseases as rickets, and it seems legitimate to assert definitely that such diseases may practically be cured thereby. And here we may also refer to the exalted resistance to disease which exposure to ultra-violet rays brings about, and which accounts for the beneficial effect of sun-ray treatment in such diseases as tuberculosis.

MODE OF ACTION OF ULTRA-VIOLET RAYS.

At present we can do little more than speculate on the mode of action of ultra-violet radiation. It appears necessary to revise our views somewhat as to the functions of the skin, or at any rate its deeper layers (Malpighian layer). It has long been recognized to be a protective covering and a mechanism for the regulation of the temperature of the body. But in recent years evidence has been accumulating that it may possess other functions—notably that of acting as a regulator of internal functions by means, perhaps, of secretions formed in its deeper layers. It may, indeed, play a direct part in the general metabolism of the animal body.

In order to influence this possible cutaneous metabolism it is, of course, essential that any environmental stimulus should penetrate the external protective and indifferent layers of the epidermis. It is conceivable that part of the advantage accruing from the old practice of blistering, or the application of mustard poultices, lay in the indirect stimulation of the deeper layers to appropriate secretory activity rather than in the excitation of superficial nerves which seems to be involved in the older explanations of the efficacy of "counter-irritation." The undeniable advantages of the effect of sunlight and the different forms of light-ray treatment seem most probably to depend upon certain radiations of sufficient penetrating power stirring up the activity of the Malpighian layer of the skin, and thus leading to an augmentation or modification of their processes. But evidence has lately been adduced that some of the longer rays may actually penetrate into the dermis.

THE SOURCE OF ULTRA-VIOLET RADIATION.

I have been engaged now for some twelve years in studying the effects of radiations from different sources upon the body, particularly in different diseased conditions. In my experience the most potent rays are from metallic arcs in which titanium is the prevailing element. Titanium rays are rich in lines in the extreme ultra-violet, and are of great potency when applied to bacteria. There is a rich line spectrum also in the region of 300 μ . The richness of the bright lines in the ultra-violet region in the case of titanium radiation means considerable effect with short exposures. Three minutes' exposure of the naked body may bring a tingle to the spine, and with repetition produces pigmentation. In the majority of cases two or more baths produce marked results. Patients who are mentally disturbed are benefited, and many forms of anaemia react to this ray treatment. Examination of the blood before, during, and after treatment has demonstrated in some cases a rapid return to a normal condition and to a permanent improvement.

For the purpose of treatment a suitable apparatus has been designed to operate from one to twelve arcs, and applicable in either the standing or recumbent position.

A comparison of the spectra from the titanium arc with those from iron and carbon arcs makes it clear that the radiations from the titanium arc are very rich in rays of shorter wave-length.

I have been greatly assisted by my technical colleague Mr. W. G. Moore, who has designed special apparatus and electrodes for the different forms of treatment.

CASES.

Of the many different kinds of cases I have had under treatment during recent years I will report some in which a diseased state left what is presumably chronic fibrosis.

Case A.—A woman, aged 28, with chronic arthritis. At the age of 18, during a course of nursing, she developed rheumatic fever. She recovered and resumed duty, but would constantly have to go off duty on account of pains in the wrists and ankles. Eventually she had to give up work in April, 1918. In September, 1918, many joints became affected and gradually got worse until November, 1920, when she went into Bath Hospital, remaining until February, 1921. In March, 1921, she had her tonsils removed. In April, 1921, she went into another hospital and had the legs, which were drawn up, put into plaster and straightened under an anaesthetic. No improvement followed. When this patient came to me she could only walk feebly with assistance, and suffered much pain. All her joints were swollen; there was complete fixation of knees, hips, and elbows; the ankles and wrists were also affected. It was decided at first to try and improve the knees, ankles, and wrists. For this the rays were applied daily focally for three minutes. After four days the rays were applied to the whole body and light massage given to the joints. At the end of a month the patient could walk and flex the knees. At the end of nine weeks she was able to walk well, going up and downstairs, getting in and out of buses, etc. She is now at her home in the country doing household duties, and taking good walks.

Case B.—A man, aged 75, was received as a case of "arthritis" dating from 1915; he had been confined to bed for eighteen months. On examination there was almost complete fixation of the knees and hips, and the tissues around felt hard. He suffered almost continuous pain, could only stand for a few minutes and walk but a short distance. He had tried many kinds of electrical treatment without deriving benefit. The rays were applied focally to the base of the spine, hips, and knees every other day for two weeks, followed by light massage. They were then applied to the whole body in the hope of improving the general health. After two months there was a marked improvement, and at the present time the patient is free from pain and can walk a considerable distance. He expresses himself as feeling a different man.

Case C.—A doctor, aged 50, had suffered for years from Dupuytren's contraction of the right forefinger, and had been advised that surgical intervention was the only remedy. The hand was exposed to intensive rays for periods of from four to five minutes. After ten treatments the tissues became softened and the finger could be straightened. The improvement is maintained.

Case D.—A woman, aged 30, had suffered with severe varicose veins of the legs, which had both been operated on. She was sent to me complaining of pain in the ankles which prevented walking, and also kept her awake at night. On examination both external ankles were found to be swollen and varicose. Intensive rays were applied every other day for two weeks, after which the pain disappeared. The rays were then applied twice a week for a fortnight, and the condition further improved. The patient can now walk long distances, play golf, etc., without any discomfort.

Case E.—A woman doctor, who had suffered for years with chilblains on both feet, had endured much pain and could get no relief. Focal radiation was applied to the feet for periods of three to five minutes twice a week. After ten treatments the chilblains disappeared, and although cold and wet weather prevailed she had no recurrence.

Case F.—A man, aged 57, with severe anaemia, diagnosed as probably pernicious. The blood count at the commencement of treatment (September 23rd, 1924) was as follows: Red blood corpuscles 2,600,000, white corpuscles 23,000, haemoglobin 46 per cent. Counts taken at monthly intervals showed a gradual improvement, and the last count, taken in April, 1925, showed a decrease of white blood corpuscles to 9,000 per cubic millimetre. The patient when last seen seemed practically normal.

Another type is seen in the following case.

Case G.—A man, aged 35, with neurasthenia of some years' standing. He was melancholic, had lost his grip on life, and had to give up his work. He suffered from insomnia and loss of memory. In this case the whole body was treated for three minutes every other day, gradually increased to four and a half minutes. There was marked improvement at the end of two weeks. At the end of a month he was able to take a fresh post, and I understand that he has not suffered since.

These cases are only samples, and I feel convinced that titanium rays, used with discretion, are frequently of extraordinary value. When there is an obvious psychological element in the diseased condition titanium rays are often of extreme value, but I believe that the improvement is out of all proportion to the mere "psychical appeal" a course of treatment involves.

At the present stage it has been deemed advisable to withhold treatment in certain cases, but the success attending such a large percentage of those who do come under treatment seems to justify further strenuous investigation. It may be pointed out that three to four minutes' exposure to the titanium rays is equal to many hours of the sun's rays. Considerable caution is required in the selection of cases. At present phthisis in an advanced stage is one disease for which these rays should never be used.

Among other forms of disease in which the results of this treatment are highly encouraging are tuberculous wounds, septic and irritant conditions of the skin, sciatica and lumbago, etc., but space will not allow me to deal with these in detail at the present time.

I append some controlled laboratory observations on the bactericidal effects of titanium rays. I quote these as indicating the richness of the radiations in the extreme ultra-violet.

"Experiments were carried out with the titanium rays as evolved in the apparatus used in the treatment of patients. Petri plate cultures were used, one series containing twenty-four-hours' cultures of the test organism, and the other thickly sown with the respective test organisms an hour before the exposure. To avoid the temperature factor the rays were used openly, and not focused on the plates. The results were as follows:

"*A. Pneumococci.*—A twenty-four-hours' culture on blood agar was exposed for five minutes to the rays. Some of the growth was then removed and inoculated into blood agar tubes. No growth of the organism was obtained after forty-eight hours' incubation at 37° C. A similar plate not exposed, and kept as a control, gave rich subcultures under the same conditions of incubating. A blood agar plate thickly spread with a young culture of the pneumococcus was exposed to the rays for five minutes and then incubated for forty-eight hours. No growth of organisms took place except at one margin where there was a fringe of colonies at the outer circumference of the medium. This was found to be due to the holder casting a shadow at the lower extreme edge of the plate, and so this area unavoidably escaped subjection to the rays. A control plate of pneumococci similarly spread and incubated yielded a rich growth of the organism.

"*B. Streptococci.*—A *Streptococcus pyogenes* plate showing twenty-four-hours' growth of the organism and exposed to the rays for five minutes was sterilized, no growth of the organism being obtained. The control plates gave rich growths. The newly spread plate of the streptococcus submitted to the rays showed no growth except at the extreme margin where shadow was unavoidable. The control plate showed a rich growth under similar conditions of incubation.

"*C. Typhoid.*—A *B. typhosus* plate culture containing a confluent growth of twenty-four hours was sterilized by five minutes' exposure. Subcultures could not be obtained. The newly spread plate of *B. typhosus* exposed for five minutes gave no growth of the bacilli except at the extreme margin where the shadow prevented exposure. The control plate showed a rich growth of *B. typhosus*.

"*D. Anthrax.*—A forty-eight-hours' culture of *B. anthracis* showing spores was spread on agar plates and one of them given ten minutes' exposure, the extra time being allowed to compensate for the very resistant character of the spores of this organism. After forty-eight hours' incubation the exposed plates showed growth of the bacillus at the shadow margin and a very occasional colony towards mid-centre of the plate. The control plate showed rich confluent growth, and on comparison it was seen that the control plate contained at least 90 per cent. more growth than the exposed plate, not counting the colonies at the shadow margin, which it is fair to regard as an unexposed portion."

REFERENCE.

¹ Macht, Bell, and Jävers: *Amer. Journ. Physiol.*, 1926, lxxvi, p. 210.

ADVANCED TETANUS CURED BY INTRATHECAL INJECTION OF ANTITOXIN.

BY

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THE prophylactic value of antitoxin was fully established during the war, but even at the end of it doubt was expressed as to its value in the treatment of the clinically declared disease. Permin and Faber,¹ quoting Danish statistics, give a mortality of 79 per cent., the prognosis varying directly with the incubation period prior to development of the primary symptoms. Cases developing symptoms in ten days or under from the primary trauma show a mortality of over 90 per cent. British cases in the war showed a mortality of 50 per cent., the common causes of death being cardiac failure and exhaustion.

In considering the treatment of declared tetanus the pathology has to be taken into account. A combination has formed between the toxin and the motor nerve cells of the central nervous system, toxin is circulating in the blood, and is still being manufactured in the wound.

Sherrington's experiments on monkeys showed a 56 per cent. cure of experimentally established tetanus by intrathecal injection of antitoxin. The early researches of Sicard² showed much quicker results in the time of onset of spasms by injecting tetanus toxins into the subarachnoid space than by the intravenous or subcutaneous routes. Hence, *per contra*, antitoxin administered intrathecally should act more powerfully and quickly than by the other routes.

The case about to be described illustrates the value of treating the various pathological phenomena of established tetanus by the intrathecal administration of powerful doses of antitoxin, by supporting the patient's heart and general system during the muscular spasms, and by removing promptly the site of infection.

A Chinese boy, aged 12½, had his left leg crushed in its middle third by the wheel of a Chinese cart. A bad compound comminuted fracture of both tibia and fibula was the result, and the native doctor was immediately called to attend.

The child's condition became progressively worse, and on the ninth day following the accident he was brought to hospital. Below the seat of injury absolute dry gangrene had been established, and when the patient was lifted off the stretcher the lower part of the leg fell off. There was no haemorrhage. The child had fever (102° F.) and a rapid pulse (120), and definite head retraction was present, with masseteric spasm and the typical "risus sardonicus" of declared tetanus.

In view of these facts I at first refused to operate, but, on the pleading of the parents, attempted what I regarded as a forlorn hope.

The child was given morphine 1/6 grain, and put under open ether anaesthesia. A pint of intravenous saline was administered, and a rapid circular amputation performed at the seat of election, no attempt being made to suture flaps. Two premolar teeth were extracted with difficulty to permit easy feeding, and then a large intrathecal injection of antitoxin was administered.

Arguing on the principle that the lumbar enlargement of the cord was the site of attack, the lumbar puncture needle was introduced through the eleventh dorsal intervertebral space, and about 15 c.cm. of cerebro-spinal fluid drained off; 20 c.cm. of standard antitoxin, representing 20,000 units, were then injected. The shoulders and pelvis of the patient were raised, in order to make the site of injection the most dependent part, for four minutes, and 4,000 antitoxin units were then administered subcutaneously.

On the next day typical opisthotonic and pleurothotonic spasms were present; the trismus was much worse, and there was considerable rigidity of the rectus abdominis muscles. The temperature was 101°, and the pulse 134. The wound was slightly septic. A further intrathecal injection at the same site, of 20,000 antitoxin units, was administered, and followed by 10,000 units subcutaneously. Mouth-feeding with a tube and funnel was established, through the dental space previously prepared, and rectal salines (10 ounces, with 5 per cent. glucose and 30 grains of potassium bromide) were administered every four hours.

On the third day the temperature was 100°, and the pulse 126; opisthotonos and trismus were present; 4,000 units were administered subcutaneously, and salines and tube feeding were continued.

On the fourth day the opisthotonos was very slight, but trismus persisted. The temperature was 99°, and the pulse 118; 4,000 units were again administered subcutaneously, and rectal and tube feeding continued.

On the fifth day opisthotonos had practically disappeared, and there was a slight relaxation of the masseteric spasm. The child's general condition was much better.