

resulted. It will be seen that carbon electrodes charged with iron or cadmium have twice the bactericidal effect of ordinary carbons, and the cadmium electrodes appear to be preferable to the iron ones, as they burn more steadily in the arc lamp. It has been hitherto supposed that the violet and blue rays are of almost equal bactericidal power to the ultra-violet rays, but this does not appear to be the case, as is shown both by the spectroscopic experiments and by the following experiment made on a hanging-drop specimen of bacillus coli communis.

An ordinary glass slide was used, through which the light from the arc was passed after having been cooled by transmission through a water-circulating apparatus. The electrodes used were charged with cadmium. It was found that although the motility of the bacilli was stopped after an exposure of forty-five minutes, they were not killed even after an exposure of one hour and twenty minutes, that is, a period five times longer than was necessary to kill the organisms when a quartz slide was used. The violet and blue rays, therefore, which pass readily through glass, are not bactericidal under these conditions, or only slightly so. The ultra-violet rays, on the other hand, having been to a great extent intercepted by the glass, were unable to exert their bactericidal action.

On comparing the results obtained with hanging-drop specimens, as just described, with those obtained by exposing superficially inoculated agar plates under the same conditions, we found that although it requires half an hour to kill the bacillus coli communis, when exposed to the light in the hanging drop, the same result can be obtained on an agar plate culture in five minutes. In other words, it takes six times as long to destroy the bacilli when they are suspended in a fluid medium. This fact turned our attention to the following question: What proportion of the bactericidal rays are absorbed by the thickness of the water they have to traverse in the water-circulating apparatus employed?

To determine the influence of this factor, the following experiment was made: The water-circulating apparatus, as already described, consisted of a short brass tube with an inlet and outlet for water, the ends being closed with a quartz disc. The distance between the quartz discs was 2.5 cm., and represented the depth of water to be traversed by the light. An extended image of the arc was projected on to an agar plate, which had been superficially inoculated with the colon bacillus. The arc image was obtained by means of a pinhole in a metal plate interposed between the light source and the agar film. A projected image of the positive and negative poles and of the image of the arc resulted. We found, however, that under these conditions the loss of light was so considerable that a very long exposure became necessary. We therefore substituted for the pinhole a metal plate with a slit in it. The slit was less in width than the length of the arc itself, and was placed about 3 cm. from the arc, with the direction of the slit at right angles to the axis of the carbons.

We thus obtained an image which was in reality made up of a number of superimposed images similar to those obtained with the pinhole arrangement. On the agar plate the image was seen as a central broad violet band, above which was the narrow white band of light projected from the negative carbon and below the brighter white band projected from the positive electrode.

As heat might be a possible disturbing factor, the images from the electrodes were eliminated from the experiments, only the effects of the broad violet band from the arc itself being considered.

Although, therefore, we had no absorbing medium other than air between the arc and the agar plate, the light was almost free from heat rays, any possible rise of temperature being quite negligible. Inoculated plates were then exposed in the first instance without any heat-absorbing apparatus, and subsequently with a water-circulating apparatus interposed between the slit and the inoculated agar film.

It was found that an exposure of five minutes without the water-circulating apparatus had a greater bactericidal effect at the point of incidence of the light than a twenty-five minutes' exposure with it. In other words, that the light on passing through 2.5 cm. of water lost four-fifths of its bactericidal power. This result we had hardly anticipated in view of the researches of Hartley and others, in which water was shown to be but slightly absorbent either to visible or ultra-violet radiations.

The loss of bactericidal power may, however, be attributed to general rather than to selective absorption. The quartz may be regarded as negligible, as its transparency is well

known, and we subsequently found that it transmits the bactericidal radiations practically without any loss by absorption. It would therefore appear that in phototherapeutics the generally used water-cooling appliance might well be dispensed with if the heat could be eliminated by other means, and assuming that the directly bactericidal rays are the only essential ones, which at present is by no means certain.

The next experiment was to determine whether, when using the electric arc, the effect is in any way a function of any particular current. It is well known that the efficiency of an arc as a source of light increases as the current is increased. The ratio of light production is approximately as follows, the standard in this case being an efficient type of oil lamp:

7 ampères	...	...	...	39	|	15 ampères	...	...	...	117
10 "	...	...	...	75	|	20 "	...	...	...	160

On exposing bacterial plates in the above inverse ratios we found that the action was exactly proportionate to the light produced, a current of 10 ampères having approximately double the bactericidal effect of a current of 7 ampères and so on. This was tested carefully up to 25 ampères with unvarying results, showing that the action is exactly proportionate to the light efficiency.

To conclude, when reviewing the experiments made with light by ourselves and others, we are bound to confess that at present the scientific treatment of disease by means of light is still in its infancy. Though undoubtedly a promising remedy in certain affections, phototherapy is still an empirical method of treatment, inasmuch as we do not know which rays of light cause the therapeutic effect, nor how this therapeutic effect is brought about. The bactericidal rays we think we have located with exactitude. It remains to locate those rays which excite the reaction in tissue with equal exactitude, in order that a method of producing the required rays in greater intensity may be devised.

The experiments have been carried out principally with the bacillus coli communis, but the following organisms have been also employed with similar results: Bacillus prodigiosus, bacillus subtilis, micrococcus tetragenus, staphylococcus aureus, and bacillus tuberculosis.

We have to thank Dr. Allan Macfadyen for the suggestion that the research should be undertaken, and for much help and advice during the progress of the work.

A CASE OF DOUBLE GANGRENE OF LEGS FOLLOWING A MILD ATTACK OF ENTERIC FEVER.

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THE following notes on a case of the above comparatively rare complication of enteric fever may prove of some interest:

Early History.—The patient, A. D., was a Scotchman, aged 22 years, and an engineer on one of the mines here. He was first seen at the mine on May 10th, and was admitted to the Primrose Hospital two days later suffering from enteric fever. He went through a typical mild attack, his temperature never going above 101°.

After-Progress.—On the evening of May 22nd he, for the first time, complained of pain in the right calf, his temperature then being 97.6°. Next morning the calf felt hard to the touch, but was not inflamed, and there was no evidence of phlebitis. There was an area of anaesthesia on the outer surface of the leg. Belladonna was applied locally to relieve the pain. On the same morning the nurse in charge noticed some twitching of the left side of the face and eye, drawing down of the angle of the mouth, and a slight thickness of speech. This passed off in two hours time. On May 24th the dorsum of the right foot commenced to show discoloration, extending as far up as the ankle, and the patient complained of great pain in the right calf. There was now total anaesthesia of foot. At the same time the patient began to complain of a similar pain in left leg, and, coincident with the pain, an area of anaesthesia developed on outer side of the left leg. On May 25th discoloration began to show in the left leg as well. The discoloration in the right leg now extended up to within 1½ in. of the knee-joint, being more marked on the outer than the inner side. With the appearance of the gangrene the application of glycerine of belladonna was stopped and the treatment changed to swathing the affected parts with cotton wool, keeping them warm with hot-water bottles, and administering morphine hypodermically. On the 26th the discoloration of the right leg appeared to have diminished slightly, and there was some return of sensation on the dorsum of the right foot, which did not, however, extend to the toes, and these now began to shrivel. The discoloration of the left leg was now getting more distinct. This dis-

coloration was not universal in both legs, as there were areas which retained their normal colour, though devoid of sensation. From the commencement no pulsation could be made out in either limb from the popliteal space downwards, though the femoral was pulsating freely in the groin. There was no appearance of moisture in either leg and as yet no sign of any line of demarcation. On May 28th the right leg was very painful, but discoloration was still diminishing. On May 29th the right leg began to get worse, and bullae began to appear on its outer side, over the most gangrenous area. The left leg showed no change, but now there was an area of extreme tenderness in both legs above the gangrene, but not extending in either leg above the knee-joint.

On the 30th the outer side of the left leg showed a similar large discoloured patch, without bullae.

The question of amputating both legs through the thigh was now broached, but the patient refused to hear of it and preferred to await results. During the discussion the patient mentioned having a brother at home who had gone into hospital to get a toe amputated. Gangrene of the foot followed on the amputation, and though it remained for some time eventually it cleared up. He also mentioned a sister who suffered at various times from an "internal varicose vein." On June 2nd a line of demarcation began to form on the right leg $\frac{1}{2}$ in. below head of fibula, extending downwards and inwards. This gradually encircled the leg, but there was still an excessively tender area above. Next day the bullae on the right leg broke, and for the first time an offensive smell was noticed.

On June 6th blisters began to appear on the left leg, and next day a line of demarcation began to form here also, but at a slightly lower level than on the left side. This line was completed on June 8th.

By this time his pulse time was about 120 per minute and the pulse wave was dierotic in character. On June 11th the patient consented to a double amputation, and, though it was felt he had little chance of pulling through the double operation, it was decided to give him the slight chance there was. Accordingly it was arranged to amputate the right leg on the following day and the left leg on the day after.

Operation.—On June 12th the patient was chloroformed, and an amputation by long anterior and short posterior flaps was carried out at the junction of lower and middle thirds of the right thigh. The patient stood the operation well. There was a thrombus in the artery above the point of division, and during the operation there was very little bleeding from the flaps. An incision in the popliteal space and back of the thigh of the amputated leg revealed it to be full of foul-smelling pus.

Progress.—On June 13th the patient was very bright and was taking his food well. When the stump was dressed there was very little sign of discharge, but the area of skin over the end of the femur showed signs of commencing discoloration. The left leg was now commencing to smell.

June 14th. The patient seemed still to be improving, but he was not considered well enough to risk a second amputation.

June 15th. As the left leg was becoming very offensive, and as the patient's general condition was considerably improved, it was decided to amputate it.

Second Operation.—On June 17th the amputation of the left leg was successfully performed, the patient standing the operation very well. As there was a gangrenous area of skin over end of femur in the stump of the right leg it was removed, along with a further piece of end of bone.

Progress.—Temperature, which was 102.6° F. on previous evening, dropped to normal. June 18th. Improvement continued to be marked. Both legs were dressed and found to be doing well. Slight discharge from the right leg and none from left. The patient was rather excited during dressing.

Result.—June 19th. The patient seemed well, but while his leg was being dressed he got very excited, finally lost control of himself and attempted to sit up in bed. He fell back, became very pale in the face, and commenced breathing with great rapidity. Then his breathing became very slow and his pulse began to flutter. Stimulants both hypodermically and by the mouth were freely administered, but without avail, as though he appeared to rally a bit he gradually sank and died.

Necropsy.—A necropsy was held at which the stumps were found to be both doing well, and apparently in the process of healing. The ileum showed typical healed enteric ulcers. The heart was anaemic, while the lungs only showed thrombi in the pulmonary arteries.

MEMORANDA:

MEDICAL, SURGICAL, OBSTETRICAL, THERAPEUTICAL, PATHOLOGICAL, Etc.

THE DURATION OF MALTA FEVER.

A PATIENT of mine was invalided for "Mediterranean fever," and landed in England on the nineteenth day of the disease, which persisted until the ninety-second day, that is, seventy-three days after arrival.

It was of the intermittent type, which accounted for the supposition that, when the patient was sent away from Malta, the fever had "aborted," the temperature, which had been over 106° , falling practically to normal (98° - 99°) on the tenth day.

This fall, however, was really the ending of the first "wave," the second commencing the very day of departure, and culminating with a temperature of over 104° the day after arrival, the journey lasting four days.

This second "wave" lasted twenty-one days, the temperature showing an intermediate rise each seventh day. A "wave" of low range now commenced, the morning temperature being normal, afternoon 100° , with one rise, again on the seventh day, to 101° . This third "wave" lasted eighteen days.

Next day, the fifty-third of the disease, a fourth "wave" of much higher range set in, the temperature rising to 103.5° , but usually registering between 100° and 102° . This lasted thirty-two days, the seventh day intermediate rise being again noticeable.

Three days of morning subnormal and evening normal temperature followed, when, on the eighty-eighth day of disease, the temperature again rose a degree a day, reaching 102° . This fifth "wave" only lasted five days, ending on the ninety-third day of the disease.

The temperature has now been subnormal in the morning, and normal in the evening for eighteen days. The chart—temperatures taken five times in twenty-four hours—shows beautifully the undulant character of the fever, the highest readings being between 2 and 6 p.m., and although it bears some similarity to that of remittent fever there is no question of malaria, the blood having been carefully examined and no plasmodia found. Moreover "the serum test" was applied in Malta, and the diagnosis of Mediterranean fever confirmed. Joint affections were also present.

The question of duration is of importance, as friends naturally cannot understand "why the fever lasts so long." Three to six months may, I think, be expected. Hughes gives the former period for uncomplicated cases.

In China I have seen many similar cases, distinctly not malarial (as proved by the microscope) nor typhoid, of a prolonged, undulant fever, in which so far the micrococcus melitensis has not been found, and which have not reacted to "the serum test." This may have been due to defective cultures or technique.

As to treatment, although we are told no medicines are of any use, I have certainly found salol most beneficial in the so-called typhoid stage. Having had some experience of carbolic acid in typhoid fever and plague (where it certainly seemed useful), and this also being apparently a filth disease, I tried the creolin (medical) palatinoids (Jeyes) when the fifth "wave" began, which promised to be a "high-range wave," the temperature being 101° on the second day. Whether *post hoc vel propter hoc*, it only lasted five days, as against ten, twenty-one, eighteen, and thirty-two days—the previous "wave periods." I have still continued the creolin μ xii a day, so many "relapses" having occurred.

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TOXIC EFFECTS OF COLCHICUM.

ON being recently summoned hurriedly to Mr. X., aged 58, I found him with a typically "abdominal facies"—drawn, anxious, and dusky; bluish lips and nails; quick, shallow respirations; small and quick pulse, and clammy, pale skin. I knew him to be ordinarily a healthy, temperate man, though slightly gouty. He complained of intense cutting epigastric pain, of sudden onset one and a-half hour earlier, beginning with vomiting of much yellow fluid "all over the road," and several violent actions of the bowels, the motions being profuse and sanguineous. The abdomen was tender all over, the temperature 96.5° .

The clinical picture was that of a sudden serious abdominal lesion, but local indications were wanting, as was also any proof of the existence of actual involvement of the peritoneum.

Inquiry as to recent ingesta elicited that he had taken on an empty stomach some two and a-half hours before, two "Blair's gout pills," and the diagnosis seemed to lie between (1) pill poisoning, (2) ptomaine poisoning, (3) abdominal lesion, for example, perforation of appendix. The history negatived (2) and (3), but the patient's state inclined one strongly to (3). Could these two pills possibly do all this to a man? In one's painful hesitation between opposite courses of treatment, the point insisted on in an address of Sir William Broadbent's on the importance of respiratory immobility of the abdominal walls in the diagnosis of peritonitis,¹ recurred to the mind, and was of great assistance. This immobility

¹ *Clinical Journal*, October 27th, 1897, p. 3.