individuals. If we can succeed in calming their apprehension and removing them for a time from their gloomy introspective habits we shall have done great service. At Nauheim various strengths of baths are given and it gives a great sense of encouragement to the patient when he is allowed to go from a weak bath to a strong one, especially when he is immersed in the "Strom Bad" he feels he is indeed making progress, and the nervous symptoms are accordingly relieved. Further, the temperature of the bath tends to produce dilatation of the peripheral vessels and so may relieve the heart in that way. For my own part, I also believe that the effect of the carbonic acid at a high pressure increases the dilatation of the vessels and that an effervescent bath has rather more effect than an ordinary bath at the same temperature; I admit, however, the mental processes may again play an important part. On getting out of the strongest bath the skin is certainly red, and, as I say, I believe this stimulation has some real though perhaps slight effect. Next as to the various forms of graduated exercises that have been introduced. The three chief varieties are well known to you—the hill-climbing of Oertel, the mechanical contrivances of Zander, and the resistance exercises of the brothers Schott. It is, indeed, important to remember that in the majority of cases of the class of diseases I am now considering a certain amount of regulated exercise is demanded. It is a great mistake for these patients to consider themselves as bed- or sofa-ridden. But the exercise must be carefully controlled. Generally a few simple precautions are all that is necessary, but in some instances a regular course is of benefit, for the same reasons which I gave in the case of the baths, firstly, because it proves to the patient that "something is being done" for him. The consciousness of this is of surpassing benefit to some minds. Secondly, because a muscle in action requires more blood than a muscle at rest. I consider that muscular action properly controlled is useful in some of these cases. For choice I should choose either the hill climbing or the resistance exercises as being the most easy of application. In addition to the movement of the muscles of the trunk and limbs, the deep respirations which are directed to be taken attract more blood to the lungs and so add to the relief experienced by the heart.

I wish entirely to dissociate myself from the practice sometimes adopted of taking diagrams of the tracings of the area of cardiac dulness before and after the baths and exercises. As far as I am aware these tracings have never been scientifically proved. In percussion the personal element enters strongly—perhaps that may be the explanation. It is quite possible that at the end of a course of treatment the heart may be less dilated than before, but I have never been able to determine any alteration after single baths and exercises. Here again I am only expressing my own opinion; other observers may entirely differ from me. To express the matter in a few words, I consider that the benefit which some individuals experience by a visit to Nauheim or other similar resort is due very largely to the regular *régime* under which they are placed, and but little to the actual potency of the waters.

Can similar results be produced at home by artificial baths? My own experience has not been favourable in this respect. If the patients could be induced to undergo precisely the same *régime* as at the spas I think much might be done, but the arrangements in this country do not permit of it unless one of the English watering-places is visited, and even then, much as one dislikes to say it, with one or two praiseworthy exceptions the necessary support is not afforded by the local and hotel authorities to the medical men. The fault does not lie with the medical profession but with those who are responsible for the general social arrangements. Moreover, the mere fact of being sent to a foreign spa, with all the changes in diet and mode of life, the interest of watching foreign folk and customs, adds to the moral effect of the treatment which, in my opinion, has such an influence on the mental attitude of sufferers from chronic heart disease.

Closely allied to the mechanical treatment is the diet. This should be simple, attention being duly paid to the state of the digestive organs. When the gastric circulation is disordered faulty digestion must follow. But beware of the usual "invalid" diet! When will it be fully recognised that much of the carbohydrates is digested by the ptyalin in the saliva? What can be more favourable to fermentation in the stomach than to give starchy

pultaceous food which is designed to be swallowed at once without mastication and without proper admixture with the saliva? A certain amount of saliva is undoubtedly swallowed but probably not in sufficient quantity to properly act on the carbohydrates which lie unaltered in the stomach with every tendency to undergo undesirable fermentation. Only such substances then should be given which can be thoroughly masticated. Starchy foods should be given in the form of biscuits or "flowered" potato and directions should be given for thorough mastication. Fish, chicken, boiled mutton, and other digestible foods may be given, preferably in small quantities, and the meals may be supplemented by sandwiches of fresh potted meat or preparations containing meat essences in strong solutions. The diet, however, should be as dry as possible, the liquid being taken at the end of the meal.

Time will only permit of a few remarks on symptomatic treatment. The most important condition probably is insomnia. Want of sleep is a common symptom in heart failure, and if rest be procured great relief will often follow. Simple means, such as change of position, bathing the face with warm water, a handkerchief over the eyes, or a little warm drink may be tried. Frequently, however, a hypnotic will be necessary. After trying many, I have found chloralamide dissolved in rectified spirit the most favourable, commencing with 20 grains and pushing it up to 70 grains if necessary. Veronal in 2 to 7 grains may also be tried, but must be given with caution. Sulphonal or trional I have not found so good. Paraldehyde is sometimes useful. In some instances opium or morphia must be resorted to, the chief contra-indication being pulmonary engorgement.

Palpitation.—This symptom may be caused by the cardiac condition or by digestive disturbance. Strychnia, nuxvomica, or digitalis may be necessary, but in many cases the bromides are the most useful drugs.

Indigestion.—If this cannot be remedied by diet, relief may be obtained by the use of drugs as usually prescribed in dyspepsia. If there is undue fermentation I have found taka-diastase a useful preparation. Bismuth in the liquid form, given with nuxvomica, may also be tried.

By judicious employment of the methods which I have described in this paper much may be done to relieve the lives of those who are the victims of chronic cardiac disease. Hope springs eternal in the human breast, and although some of our patients may have given way to despair in the belief that their lot can never be improved, yet by perseverance in the directions which I have indicated the lives of such patients may not only be rendered enduring but eventually they may enjoy an immunity from suffering and discomfort which is, indeed, to them a consummation devoutly to be wished.

NOTES ON THE EFFECT OF RADIUM IN RELATION TO SOME PATHOGENIC AND NON-PATHOGENIC BACTERIA.

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THE physical properties of radium are of considerable importance, both from a clinical point of view and in their relationship to x rays, it being a substance which is constantly giving off emanations without appreciably losing weight. These emanations are comprised, as far as is at present known, of three kinds of rays, named respectively α , β , and γ . The α rays consist of particles of matter of the same size as an atom of hydrogen, and travel at one-twentieth of the velocity of light, these properties being similar to those of the anodal rays produced in an x ray tube. The β rays are from 1000 to 2000 times smaller than an atom of hydrogen, and travel with the same velocity as light, these properties being similar to those of the kathodal rays of the x ray tube. Both α and β rays are deflected by a magnetic field. The γ rays differ

from the above in not consisting of particles of matter but of vibrations of the ether of very short wave length, nor can they be deflected or reflected by any known means, travelling always in a straight line. No known substance is absolutely opaque to them, resembling in this respect α rays. The α rays have very little power of penetration but a rather severe effect on the skin, whilst the γ rays are very penetrating but damage the skin very slightly, the β rays occupying an intermediate position in both respects.

Radium when employed for therapeutic purposes was formerly used in powder or small lumps inclosed in either a glass or aluminium tube. This method has now been superseded by spreading the radium, in the form of sulphate, over the surface of a flat metal disc and then fixing by means of a hard varnish.

The earliest form of varnish was employed by Danlos in 1905, but the modified form as used and described by Danne is now commonly used. The sulphate is preferred to the bromide for the form of application on account of its being insoluble, whereas the bromide being readily soluble is more liable to loss and damage in use. When used in the form of bromide it is best used pressed in the thinnest possible layer between a metal back and a thin aluminium or mica window as described by Macleod, who also sums up the advantages of the spreading and varnish method as follows: 1. That by it practically all the rays from the radium are available, the less penetrating rays not being intercepted by the glass, mica, or aluminium window of the older applicators. 2. That in a given quantity of radium a much larger radio-active surface is obtained over which the radio-activity is evenly distributed. And it has been estimated that 1 centigramme of a radium salt of an activity of 100,000 has approximately the same effect on tissue as 5 centigrammes of a salt of an activity of 600,000 collected in a small mass in a glass tube.

Radium is now being extensively used at the Radium Institute in Paris for the treatment of various malignant growths, such as epitheliomata, rodent ulcers, &c., and has also been favourably reported on in treatment of angiomas by Wickham and Degraise. With regard to the action of radium on the lower forms of life, ferments, &c., the following is a brief summary of the principal results recorded.

M. Dauphin, working on the effects of radium emanations on the various moulds, concludes that "the rays of radium stop the growth of mycelium of the *Mortierella* and prevent germination of the spores. This action is, moreover, chiefly paralysing; they cause the appearance of real cysts in the interior of the filaments, evidently organs of defence." He also concludes that spores and mycelium submitted to the action of the radium are not killed, but that they are in a latent state of life and when replaced in normal conditions can once more germinate or continue to develop afresh.

Victor Henri and Mayer found that the radium rays rapidly destroy the activity of the ferments emulsin and tyrosin.

Wilcock later confirmed their results with regard to pepsin, trypsin, and ptyalin, but states rennin to be exceptionally resistant; but Schmidt Nielsen found rennin to be slightly weakened.

Fenton has shown that radium rays produce H_2O_2 in water and Vanderelde showed that these ferments are not only immune to, but more active in, presence of H_2O_2 .

Ch. Bouchard and Balthazard working with various bacteria state that when exposed to the emanation from 0.0006 of a milligramme of radium for one hour these organisms suffered a reduction in colour, virulence, and showed an increase of involution forms. They also showed that when the emanations from 0.003 of a milligramme of radium are applied to a growth of *Bacillus pyocyaneus* the pigment (pyocyanin) was still diffused into the media, and further that the colour of *Bacillus prodigiosus* was unaffected. In the case of a stab culture apparently radium only affects the surface colonies and does not penetrate.

A large quantity of radium has recently been acquired for Guy's Hospital, and the treatment of cases is now in active progress; and with a view of ascertaining the action of radium on the various bacteria, both pathogenic and non-pathogenic, advantage was taken of the presence of the radium above alluded to in the hospital for one of us to conduct the following experiments in the bacteriological

laboratory by the kind permission of Dr. J. W. H. Eyre. Our object was to determine the direct action of this substance on various cultures and organisms as regards their capacity for growth, chemical properties, staining reactions, and also motility, after being exposed for varying periods of time to the direct action of radium emanations.

The first experiment was conducted with a view to ascertain the capacity for growth of organisms after exposure to radium rays, and also to observe any possible effect on the media used. Plates of nutrient agar were poured and dried for one hour in the incubator at $42^\circ C$. After cooling, a loopful of a 24-hours broth culture of *Bacillus pyocyaneus* was spread evenly over the surface of each of these plates. The radium was now applied directly to the surface of the inoculated media, for 10 minutes, 20 minutes, and 60 minutes respectively. After exposure a sterile platinum loop was rubbed over the exposed area and a sloped tube of nutrient agar was inoculated with the loop. Both the tubes and plates were now inoculated for 24 hours at $37^\circ C$. and examined for growth, the exposed and unexposed areas on the plates being carefully compared; three cover slides were prepared from the exposed and unexposed areas on the plates, also from the tube growth. These were each stained by weak carbol-fuchsin, carbol-methylene blue, and by Gram's method. After careful comparison, no difference whatever could be detected in the capacity of the organism to take the various stains after exposure, its capacity for growth and reproduction was unimpaired, as also was the amount of pyocyanin diffused into the media. A virulent culture of anthrax, only two strains removed from the human body, was also inoculated in a similar manner to the above, and no difference whatever could be detected in the growth before or after exposure. In addition, portions of a plate showing luxuriant growth were exposed to the radium rays for 30 minutes and 60 minutes respectively. These were afterwards examined for capacity to grow and multiply in comparison with the unexposed areas and found to be identical. Cover slides from the cultures before and after exposure were also stained with a differential stain to demonstrate spore formation, the only difference observed being that after 60 minutes' exposure to radium it was thought that the organism showed a slightly increased tendency to spore formation.

Staphylococcus aureus was also investigated in a similar manner and was found to be unaffected as regards its capacity to grow, multiply, and stain evenly and readily after exposure to radium for periods ranging from 15 minutes up to 60 minutes, it being impossible to detect any difference whatever. Various non-pathogenic organisms were also investigated, such as *Bacillus subtilis*, *Bacillus megatherium*, &c., and all were found to be unaffected as regards capacity for growth, staining reactions, and in some cases motility.

Bacillus coli communis, on account of its importance in bacteriology, was investigated fully as regards growth, staining reactions, and motility after exposure to radium for various periods of time, such as 30 minutes, 60 minutes, &c. One culture was exposed to radium for 17 hours and found to be unaffected. In addition, the fact that its biochemical character was unimpaired was demonstrated both by planting colonies after exposure to radium for various periods on to Conradi and Drigalski litmus, lactose plates; by planting into bile salt litmus broth, and observing acid and gas formation; also planting on to mannite neutral red nutrient agar plates. In every case parallel cultures of the same strain of *Bacillus coli communis* not previously exposed to radium were made and carefully compared, but after examination by three independent and competent observers all were agreed that no change whatever had taken place as a result of the exposure to radium emanations.

The influence of radium rays on the motility and agglutinating powers of organisms was investigated in the following manner. A loopful of a young and vigorous strain of *Bacillus typhosus* was planted into sterile nutrient broth. This was then incubated at $37^\circ C$. for 18 hours. At the end of that time a loopful of the culture was examined and was found to be actively motile. To exclude the presence of clumps as a source of error in the subsequent observations a few sterile glass beads were added to the broth culture and placed in an electrical "shaker" for a few minutes. On again examining a hanging drop the organisms were found to be discrete, actively motile, and absolutely free from clumps. Six hanging drops were now prepared from

the same culture and compared at once for motility, freedom from clumps, &c. The controls were labelled Ca, Cb, and Cc, and the others 1, 2, and 3 respectively. They were now exposed to the radium emanations for 15 minutes, 30 minutes, and one hour respectively; then again carefully compared with the control at the end of their respective periods of exposure. This experiment was repeated several times, and the collective results noted. It was found that in the case of *Bacillus typhosus*, in most of the samples examined, a slight increase in motility was observed at the end of 15 minutes, but after 30 and 60 minutes' exposure no difference whatever could be detected between the organisms under observation and the control. This is most interesting, as Fenton has shown that radium rays produce hydrogen peroxide in water, and it would here at least have been reasonable to suppose that, even if the radium rays themselves did not affect the motility and clumping capacity of the *Bacillus typhosus*, the hydrogen peroxide would have done so. Presumably it was formed in very small quantities, if at all in such a short time; consequently being so very dilute the effect was to stimulate the organisms rather than act as a germicide. Cultures of *Bacillus coli communis* were also examined for decrease in motility, if any, a rather more actively motile specimen than usual being used. But none whatever could be detected. Various non-pathogenic organisms were examined at various times and in a similar manner, but in every case the result was negative.

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THE THERAPEUTIC EFFECTS OF RADIUM EMANATIONS IN SOME DISEASES OF THE SKIN.

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WHILE much has recently been written on the effects of radium on skin diseases, especially when spread and set in a thin layer, I am not aware of any publication on the effects of radium emanations in skin diseases, and the following observations will therefore be of interest. At the beginning of 1906 Sir William Ramsay was kind enough to supply me with these emanations, which are given off in the form of a gas from a solution of radium bromide in very minute quantity as regards bulk, but in spite of this with decided and in some cases very powerful effect. Thus the amount given off from 150 milligrammes in 24 hours was estimated by Sir William Ramsay to be about the fortieth of a large pin's head. At the same time some of the water is decomposed into its component parts of oxygen and hydrogen and the three gases are conducted through capillary tubes to a bulb where by an electric spark the oxygen and hydrogen are reunited into water and the radium emanation is held in solution and after dilution up to two cubic centimetres the fluid is sealed in a glass tube ready for use, which should be soon after it is prepared, as it rapidly loses effect.

It was decided to test the effect of the emanations in two forms, locally and by subcutaneous injection. For the local application I asked Sir William Ramsay to have the solution of the emanation diffused through a weak gelatin jelly. The tube containing the freshly prepared jelly was immersed in warm water to melt it, the tube broken, and the fluid applied to the surface to be treated and covered first with muslin and then with lead foil which was bandaged on. The first case to which it was applied was that of a fireman, aged 44 years, who for the previous two years had suffered from a troublesome eczema of the fingers largely due to having to clean his fire engine. It was in the form of horny scaling of the backs of the fingers of the right hand chiefly but slightly on the left; when the hands were in contact with water the skin became softer and almost "raw." In other ways he was a healthy man. The patient stated that

he had a constant succession of attacks; one month the hand was bad, then it would take a month to clear up, and then it would break out again. The affected fingers were wrapped up for a week in a glycerine of subacetate of lead solution without any marked difference. On Jan. 16th, 1906, the right index finger was treated with radium emanation solution as above described for one hour, and the middle finger in the same way for two hours, the glycerine of lead being continued on the thumb and other fingers. On the 19th the skin on the radium-treated fingers was quite pale and the horny thickening much diminished, and the old skin was peeling off, leaving the skin beneath healthy looking. The lead-treated fingers, although showing some improvement, were much behind those treated with radium. On the 23rd the relative improvement was maintained and gelatin without radium emanation was applied to the lead-treated finger to eliminate any source of error in the comparison. On the right fourth finger radium emanation was applied for four hours, and three days later the skin was pale and the diseased epidermis exfoliating. The second finger, which had had the emanation for two hours on the 19th, was better than the index which had had it for one. On the 30th the index, middle, and fourth fingers again had the emanation for two hours. On Feb. 6th there was no marked difference except that the middle finger was no longer painful. The application was repeated for two hours. On the 9th there was a thick layer of scales on the treated fingers but when this was picked off the skin beneath was pale. On the 13th the application was kept on for 12 hours and on the 16th the improvement was much more marked. The greater part of the thickened skin had exfoliated and where this had occurred the skin appeared normal. The contrast between the fingers treated and the ring finger which had had no emanation was very marked. On the 27th the improvement was maintained and the patient was discharged from the hospital.

The case showed first that radium emanations can be used with beneficial effect in a chronic eczematous dermatitis, and secondly, that a more prolonged application (12 hours) was not only safe but much more efficacious than the shorter applications at first employed for fear of evil results from an agent of unknown power. In the next case, therefore, a girl, aged 12 years, with palm-sized hard patches of psoriasis on the knees, the application was made more boldly and she was treated as an out-patient. The procedure was on the same lines and the patches were completely removed and the knees remained well, speaking from memory, for a year or more.

In the two following cases the radium emanation was dissolved in 2 cubic centimetres of distilled water and injected subcutaneously in the interscapular region. The first, a man, aged 30 years, who had been in the Marines from the age of 16 for 12 years, having gained his early admission by saying that he was 18, had seen service in the Mediterranean, off the west coast of Africa and Ascension Island, Spain and Portugal. He had some granulomatous tumours which were diagnosed as due to mycosis fungoides, and although, contrary to his statements, there was reason to believe that there was a syphilitic element, the fact which is important as regards the radium emanation remains that he had granulomatous tumours which yielded to a great extent to the radium injections. The man had been in the University College Hospital in June and July, 1905, and most of the tumours had yielded to x ray exposures. He was readmitted in February, 1906, with nodular tumours from a hazel nut to a walnut in size, chiefly in the scapular regions, especially on the right side. The first injection was made on Feb. 9th in the middle of the vertebral border of the right scapula. The injections were repeated weekly, or nearly so, until May 4th, 13 injections in all. There was slight aching for a short time after the injections, otherwise they gave very little inconvenience, and under their influence the tumours had in great part cleared up and the arms also had improved, but all the lesions had not entirely disappeared.

The second case, a woman, aged 32 years, was an indubitable and uncomplicated case of mycosis fungoides. She first came under my notice as a private patient in June, 1907, the disease dating from June, 1906. As she could not afford x ray treatment and the disease being already in the tumour stage she was admitted into University College Hospital where she was treated for seven weeks with the x rays with