periods with streptococcal vaccines, never contained the slightest trace of bacteriolytic substance when tested *in vitro*.

To explain the stimulation of nutrition, therefore, it is necessary to look for some action more general than a specific action. According to Ehrlich's theory of cell nutrition, there exists in the protoplasm of an active cell a nucleus with which the special functions of the cell are associated. This nucleus has attached to it a number of atomic groups or side-chains which play an important part in the work performed by the cell. These side-chains readily enter into combination with suitable group atoms presented to them, and it is in this way that the nutrition of the cell is maintained. When toxin molecules are introduced they also can enter into combination with the side-chains and for the time being exhaust the supply. As side-chain molecules are, however, in some way necessary for the life of the cell, the cell is stimulated to further production until finally the side-chains are produced in excess. As has already been stated, these side-chain molecules are there not merely for the purpose of combining with toxin molecules, and so forming antitoxins, they are there for some definite purpose in the cell's nutrition, and therefore, if present in excess, they will combine with other suitable group atoms.

This theory, I believe, explains the improvement in nutrition which in some cases follows upon the use of bacterial vaccines. We may take it that in cases of persistent malnutrition the cells are unable of themselves to produce a supply of side-chain molecules to carry on healthy nutrition. When toxin molecules in the form of vaccines are introduced in suitable quantities the cells are stimulated to produce an excess of side-chains which not only combine with the toxin molecules but also combine with suitable food atoms presented to them by the blood plasma.

That vaccine injections do alter the nitrogen balance can be readily demonstrated by observing the amount of urea nitrogen excreted and comparing it with the urea-nitrogen value of the food ingested. In the cases of five patients who each received $\frac{5}{16}$ mg. T.R. there was a marked increase in the urea nitrogen output in four of them during the week which followed the injection.

Since making these observations on the patients labouring under mania I have had several opportunities of noting the effects of various vaccines on the body weight of the patients under treatment, and I am satisfied that in some cases of obstinate malnutrition vaccine injections do improve the general nutrition. To obtain the best results, the dose of vaccine must not produce a constitutional reaction. When a constitutional reaction is produced there is a loss of body weight. The dose should therefore be too small rather than too large. Secondly, the injections must be sufficiently spaced. In my observations I found that fortnightly injections gave the best results.

MR. JOHN D. ROCKEFELLER, having learnt of the distinguished services to medical science which have been and are being rendered by the researches of Professor Paul Ehrlich of Frankfurt, Germany, has presented to the Board of Directors of the Rockefeller Institute for Medical Research the sum of ten thousand dollars, to be placed at the disposal of Professor Ehrlich for furthering his investigations into the chemical therapy of the protozoan diseases.

THE annual report of the Trained Nurses' Annuity Fund for the year 1909 tells a simple but eloquent story. During the year, the total amount received in the form of subscriptions and donations exceeded that which had been collected in any previous twelve months; but the council is anxious with regard to the future on account of the loss by death of several generous helpers, including the Earl of Hardwicke, the late chairman. In 1901 the number of applicants was so large that it was found that the fund would have to be "closed" until all these claims had been dealt with. It is now reported that these claims have been satisfied, the last three annuities having been granted during 1909 in highly deserving cases. There are nineteen nurses receiving support, and the sum of £219 6s. 3d. was distributed between them during the year. The fund is administered in a most economical manner, no salaried officers being employed, the only expenses being those of printing, postage, transfer, and audit fees. The Honorary Secretary of the fund is Dr. Ogier Ward, 73, Cheapside, E.C.

Introductory Address

ON

SOME OF THE USES OF X RAYS IN DIAGNOSIS AND TREATMENT.

DELIVERED BEFORE THE BRADFORD DIVISION OF THE BRITISH MEDICAL ASSOCIATION,

By JAMES METCALFE, M.D.,

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I HAVE taken as my text some reflections on the present position of the x rays in diagnosis and treatment. For the past six years I have devoted a great deal of my time to this subject. Considering that Roentgen only discovered the peculiar physical qualities of the x rays at the end of the year 1895, and that it was only during the next two or three years that it was suspected that they had any therapeutic qualities whatever, it is really astounding to think of the elaborate technique evolved during the short period since that time. The diagnostic value of the rays is not now a question of argument—the scope of their use is becoming greater year by year. The therapeutic value of the rays is more open to discussion. They have been tried in almost every conceivable disease, and while it is necessary for the practitioner in this speciality not to allow his imagination to outrun his discretion, yet for certain conditions their application is of indubitable advantage. In some diseases the benefit derived is most unexpected. It seems to me that the results are often astonishing in what I may call the medical derelicts. I mean by that term those unfortunate individuals who have been subjected to every possible and impossible form of medical treatment.

DIAGNOSTIC USES.

To consider, first, some of the diagnostic advantages of the rays, I suppose every one will agree that in fractures and dislocations they are of incalculable value; they do not, however, necessarily make one happier in looking at the results of the treatment of fractures. This is a danger if radiograms fall into the hands of the lay public. They are misread. Only those with a medical education can comprehend the actual position of the parts shown in the radiogram and allow for the distortion produced by the method. But we can see the nature of our fracture, its extent, and the best position to retain it in. Near joints where there is either a dislocation or a fracture, or both, the rays are especially useful.

In all examinations by x rays we can use two methods—the fluorescent screen, in which the picture is shown instantly, or a photograph, which is a permanent record. It is obvious that there are advantages in both methods. Where the parts are very dense, as at the hip-joint, and for the examination of renal calculi, screen examinations are of somewhat limited utility. Radiograms are procurable of almost every part of the body. It is simply a question of the form and quality of the Crookes's tube and the amount of current put into it. Most dislocations can be seen on the screen, and their reduction is assisted if performed at the time of examination. It is a great consolation to be able to see at once that the joint is in its correct position. The examination of bones for inflammatory swellings and new growths is very easy, and a good deal of information in regard to the nature of these conditions can be obtained from a satisfactory x -ray picture. In the examination of spinal malformations, the nasal sinuses, the antrum of Highmore, the pharynx, larynx, and trachea, the x rays can give a great deal of information. Bony abnormalities, foreign bodies, pus, and other things, can often be diagnosed. Abnormalities in the bony parts behind the eye and foreign bodies in that organ can be seen and localized. Foreign bodies can, of course, be seen in any of the soft tissues of the body. The diagnostic value of x rays in many diseases of the thorax is now well known.

In the examination of the chest the fluorescent screen is of the greatest utility. The tube can be placed behind the chest and the screen to the front, or vice versa, for anterior and posterior examinations respectively; but

there are some conditions which do not show well in either of these ways. Lateral views have to be obtained, and what are known as the right anterior oblique, the left posterior oblique, or the left lateral methods have to be adopted. In the right anterior oblique position the tube is placed at the left side and the screen to the front and right side, and in the left posterior oblique position the examination with the screen takes place at the left side towards the back, and the tube is placed at the right side towards the front. In the left lateral the tube is placed at the right side and the screen at the left side of the patient.

Loss of elasticity in the lung tissue is quickly shown by the back view of the diaphragmatic excursion. This may be diminished in extent or jerky and erratic. Anteriorly or posteriorly the lung tissue may be lighter, as in emphysema, or darker, as in early tuberculous deposit. The lung will lighten up on full inspiration if normal, but any patches to which air is not freely admitted remain more or less dark. Loss of elasticity in the lung tissue, as seen by the screen, is one of the earliest possible means of diagnosing commencing phthisis—earlier than auscultation, percussion, or the usually applied methods. New growths in the lung may often be seen by the screen, and also fluid, such as pus, or pleuritic effusion. Cavities in the lung can be seen with comparative ease. If they are filled with air they appear as light areas, but if with pus or broken-down material, as darker patches. A peculiar thing about tuberculous conditions in the chest is the relative size of the heart to the other organs. It is usually smaller and placed more vertically in the earlier stages, but becomes hypertrophied and dilated in the later ones. Tuberculous lung conditions have sometimes been ascribed to this heart condition, but I should think it more probable that the loss of lung elasticity has restricted the area of heart movement. A falling together of the ribs on the affected side, producing what is known as a roof-tile appearance, is often pathognomonic of lung disease.

The movements, size, and position of the heart can readily be made out by radioscopy. Pericardial effusions and some conditions of the heart proper, such as mitral stenosis, can be observed. But the greatest advantage is probably in the diagnosis of aneurysms of the aorta. The shadow of the heart vessels is greatly altered in appearance, and can be easily seen, especially in the right anterior oblique position.

With regard to the x rays, examinations for some abdominal and pelvic conditions are now an absolute necessity. Nearly all oxalate of lime and phosphatic calculi, and many of the uric acid calculi, can be seen. It is always necessary to control any one picture of a supposed calculus by a second. If the control picture gives a similar shadow in the urinary tract, it is probably a calculus. Mr. Hurry Fenwick, in his excellent work on *Urinary Calculi*, has given a very useful and definite position in which these calculi can be located. He draws an imaginary line upwards from the centre of the crest of the ilium to the last rib, which he names the mid-vertical, and shows how the kidney or ureteral shadow is nearly always found between that line and the transverse processes of the vertebrae. Faecal concretions, phleboliths, and calcified glands sometimes simulate calculi, and one has always to be on guard to avoid falling into error. It is, of course, quite possible to miss a urinary stone, and a negative print is no absolute guarantee that one is not present; but after careful examination and consideration of the possible fallacies, if a positive result is obtained it cannot fail to be of the greatest service to the surgeon. Gall stones are not readily seen except when very large, as cholesterolin is very permeable to x rays. Some intestinal conditions may be observed, especially after the patient has had a quantity of mucilage of bismuth subnitrate given as a meal some time previously.

THERAPEUTIC USES.

The great field for the therapeutic use of the x rays has hitherto been in the domain of skin diseases; to my mind they have almost revolutionized the study of dermatology. But the effects produced on the more superficial tissues can be obtained on the deeper parts by adequate and scientific methods of filtration. X rays are of various kinds—some act on the superficial tissues, some immediately below the skin, and some penetrate through the whole mass of a

part of the body. The superficial rays can be filtered out by lint treated with a saturated solution of sodium tungstate and dried; layers of felt, sheets of leather or aluminium, thin lead, and other substances. These filters have not yet been placed on any scientific basis, but in time, no doubt, we shall be able to know precisely the kind and amount of filtration required to treat any diseases in the deeper parts of the body. I think there is little doubt that by accurate methods of filtration the inhibitory effects of the x rays on malignant diseases in the internal organs of the body will most certainly be very effective. According to Scholtz, the pathological action of the x rays on the healthy skin is the following:

(1) They cause a slow degeneration of the cellular elements of the skin, in which not only the epidermal cells but also the mesoblastic cells of the corium and the cells of the epidermal appendages participate. This degeneration affects the nucleus as well as the cell protoplasm. They also cause (but to a far less extent) a degeneration of the fibrous elements, the collagen, elastin, and the muscles. (2) As soon as the cellular degeneration reaches a certain degree an inflammatory reaction occurs in which the blood vessels become dilated, and there is an extravasation of serum and leucocytes. The latter seem to act as phagocytes, and completely destroy the degenerated cells.

It appears to be a fact that all pathological cells are more readily prone to degeneration than normal cells. Consequently the dosage of x rays sufficient to inhibit and finally to destroy these cells is much less than that required to destroy the physiologically healthy cells of the part. The x rays have therefore an apparently selective action, the disease cells in the neighbourhood under treatment undergoing degeneration and becoming absorbed. Where this degeneration is produced in internal organs toxic effects may be, and sometimes are, produced, as I have seen on several occasions. One has, therefore, to some extent to be guided by the general condition of the patient under treatment. It is very likely that the effect produced by x rays on the tissues is due to their actinic energy. Chemical changes are produced in the tissues which profoundly affect their condition.

The cases that usually come under this form of treatment are rodent ulcers, lupus, tinea, malignant growths, and eczema. Occasionally one has to treat cases of favus, psoriasis, acne, enlarged tuberculous glands, old sinuses, hypertrichosis, and some other conditions.

Rodent Ulcers.

Rodent ulcers readily respond to x -ray treatment. They quickly scab over, the scabs drop off, and the ulcer heals up. If the applications are continued at somewhat long intervals for a considerable time after the growth has apparently been cured the result is permanent, but if treatment is stopped as soon as healing appears to have taken place there is sometimes a recurrence. For some reason or other it appears to be very difficult to get the ulcer to heal up a second time with the x rays. In such cases, if the ulcer be small, healing may be promoted more readily by the application of radium. I have treated a good many of these cases during recent years, but have not used measured doses of the x rays. Short-period applications of five to ten minutes' duration with a tube of proper penetration have in the majority of cases healed up the ulcer in from twelve to fifteen applications.

Lupus Vulgaris.

Cases presenting large patches and those with ulcerated surfaces are especially suitable for x -ray treatment. Far more applications are, however, required than in rodent ulcer, and when the ulceration is healed I have found that the application of the Finsen light has in many cases acted much more quickly in causing a return to a state of healthy tissue than the continuation of the Roentgen rays. Some cases of lupus do not improve at all with the x rays but readily respond to the Finsen light. A case in point suggests itself to me. A widow, aged about 65, had an ulcerated lupus at the end of the nose. She was sent to me for treatment, but failed to keep her appointment. She came back at the end of fifteen months with the nose eaten away at either side and the central tip hanging in rather a precarious condition above the septum. She had had x -ray applications during the whole of that period. I gave her light applications with a Finsen-Reyn apparatus, and was pleased to see her nose heal up absolutely. The result, in fact, was so remarkable that I found shortly

afterwards that she had been able to find a second husband. I think that in obdurate cases it is of distinct advantage to have the opsonic index taken and gradually raised by injections of tuberculin. Dr. Eurich has on several occasions carried out this part of the treatment for me.

Lupus Erythematosus.

I have treated two or three cases with indifferent results, though one which had been coming to me for a long time appears now to be nearly cured. She is a farmer's wife, typically healthy in every other way, who has for some years had a batwing condition, extending across the front of the nose. I have applied x rays, Finzen light, and the ions of some of the metals, but without any great amelioration of the condition. Some months ago I began using a small high-frequency glass electrode with small sparks, and to my great pleasure the condition at once began to improve. I think now it will soon be quite cured, the skin appearing to be almost normal in appearance over the portions formerly attacked.

Tinea.

As is generally acknowledged now, the most effective treatment of tinea is by x rays. In favus, removal of the hairs by forceps is possible; but in tinea the brittleness of the hairs prevents this, the hair giving way at the most diseased part, leaving the parasite in the roots. Too much emphasis cannot be laid on the fact that the x rays do not kill the parasite. What they do is to cause some withering of the hair follicles, with an epilation commencing a fortnight to three weeks after the irradiation. The parasite and its spores come out with the hair root, but it is necessary to use antiseptics to the treated area until the part is completely denuded of hair. By the application of a carefully measured dose of the x rays, as introduced by Sabouraud, the epilation is nearly always certain. A point of some importance frequently raised by parents is whether the irradiation has any action on the child's brain. This question was discussed at the recent meeting of the British Medical Association in Belfast, and the consensus of opinion was that the applications were absolutely innocuous. Sycosis can be very successfully treated in a somewhat similar way. A complete alopecia is produced, which eventually leads to a rapid recovery from the irritative pustular condition.

Hypertrichosis.

Many women who are afflicted with an unusual growth of hair on the upper lip or chin desire its removal. Where the hairs are comparatively few in number and coarse, my practice has been to employ electrolysis, by which the individual hair is destroyed permanently, and as any small new ones have sprung up I have attacked them in a similar manner. The results are, as a rule, satisfactory. But even with a previous anaesthetization with cocaine by electrical osmosis the process is somewhat painful and is extremely tedious both for the practitioner and the patient. X rays, on the contrary, are neither tedious nor painful. The dose required to cause epilation is not sufficient to cause permanent alopecia. Smaller doses have to be applied at intervals of two or three months for one to two years, when a complete atrophy of the hair papilla is produced. But there is some danger of an acute erythema and of pigmentation occurring in the course of the treatment. Personally I have not had much trouble, and I think most women would rather run this risk than endure permanently an unsightly disfigurement.

Malignant Disease.

Malignant diseases of the skin can be frequently treated successfully by the x rays. Some cases of epithelioma on the face are best treated in this manner. Here permanent disfigurement results from any operative interference and the probability of recurrence is greater than after x -ray treatment. But the after-treatment of cases in which malignant growths have been removed by surgical procedure is one of great importance. It appears to me that the time is coming when it will become a routine method to apply x rays after the removal of malignant growths. It is quite impossible even in the most extensive removals to be quite sure that some malignant cells have not been left in the surrounding tissues. The selective destructive influence of the Roentgen rays on these cells is surely

worth the expense and trouble involved in their application. It is scarcely desirable to wait until nodules appear in the cicatrix or surrounding tissues before their application. To my mind it is imperative at once to begin applying them occasionally to the suspected parts. Even when nodules and masses have appeared the rays certainly have, under favourable conditions, a powerful action in retarding or even destroying them. In certain cases of inoperable growths the rays have a tendency to make the progress of the tumour slower and to relieve the symptoms. Take such a condition as malignant disease of the rectum. I have in mind a gentleman of advanced years in whom the condition was considered inoperable by several distinguished surgeons. It was thought that it would be impossible for him to exist for more than a very short period without the performance of colotomy. By means of a lead glass speculum I was able to introduce the rays directly to the diseased part, and after a number of applications he was able to pass his motions with comparative comfort. He continues in this condition, which I think any one who knows the discomforts suffered by the person operated on by colotomy will appreciate as a great boon.

Sarcomata are more amenable to x -ray applications than epitheliomata, and I have seen sarcomatous growths gradually diminish under a prolonged course of treatment. In all malignant growths a distinct retardative influence is exerted, and I believe that when the methods of filtration and technique of the application of the rays have been more carefully worked out the results will be marvellously better.

Eczema.

It is astonishing how quickly many cases of eczema improve under the application of the x rays. It has been suggested to me on several occasions that where the eczema is due to some constitutional condition, as gout or rheumatism, no permanent result could be produced. I do not think this theory holds good. I believe that the constitutional condition in the course of a long period sets up some irritative condition in the skin, and the diseased skin cells react to every little external influence allowed to come in contact with them, and that they often remain in this peculiar condition even when the constitutional condition has been cured. The x -ray applications stimulate the growth of the healthy cells and retard the growth of the pathological cells, and quickly bring the part into a more normal condition.

Psoriasis.

Patches of psoriasis often respond to x -ray treatment, but I should like to mention especially cases of the peculiar condition known as psoriasis vulgaris unguium. The thickened hoofy nail substance, in which there is sometimes a good deal of pain from pressure symptoms, is gradually reduced in bulk and the opacity much diminished. After applications extending over a considerable period, I have been able to get a cure, with healthy nails, in several cases which had resisted all other forms of treatment.

Enlarged Cervical Glands.

If it be undesirable to operate, or if there be a prejudice against operation, x -ray treatment should be tried. I have treated many cases of this class, and by covering the glands with sodium tungstate lint, and giving repeated applications, have been able to reduce the gland to a mere core of atrophied fibrous tissue. Old broken-down glands and tuberculous sinuses have often healed up remarkably well.

CONCLUSION.

I have only dealt with some of the more important conditions in which I have myself found the x rays of practical utility. I do not suggest for one moment that we should rush into x -ray treatment for every condition I have mentioned. Where surgical interference is possible, or when ordinary medical means are applicable, I believe these should be used. But after all has been done that is possible by the classical methods, and the results are not perfectly satisfactory, then I think the judicious use of x rays is advisable.

[A large number of radiograms were shown, some of which were kindly lent by Dr. F. Howard Humphris of London, and some lantern slides of instantaneous radiography by Messrs. W. Watson and Sons, Limited, London.]