SOME NOTES ON DEEP THERAPY.

BY

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It had become evident before the war that if radiotherapy was to progress on a scientific basis some accurate method of calibrating the output from the Roentgen tube must be found. Kienböck of Vienna had introduced a method depending on the action of the rays on an emulsion containing a silver salt, but it gave variable results in the hands of different and even the same workers, and it became evident that if it was to become generally useful the reason for these variations must be ascertained. Professor Wintz at Erlangen found that just as these silver salts are more susceptible to certain rays in the visible spectrum, so there are certain rays of definite wave-length in the x -ray spectrum which exercised a selective action on the silver salts ($\lambda = 0.055 - 0.049 \text{ \AA}^u$). This went a long way towards explaining the variations found, but did not overcome them. A step in advance was to measure the light given off by a screen containing platinum salts. Here the emulsion was protected from direct radiation by a heavy lead shield and only the light rays reached it. Though there were various objections to this apparatus, they were not so pronounced as in the case where the emulsion was acted upon directly by the x rays. Another method was brought forward by two Frenchmen—Villard and Szilard—who made use of the property that x rays have of ionizing air and so discharging an electroscope; they called their instrument the iontoquautimeter. The rate of discharge was given as directly proportional to the output of the tube. The original instrument was both cumbersome and inaccurate, especially in clinical use; it was considerably simplified and improved by Wintz and Baumeister of Erlangen, and has proved remarkably accurate; it has since practically displaced all other methods of measuring the output of different tubes.

This, though a great advance, was only a means to an end. Treatment had been directed more to the surface of the body, and deep effects had taken a long time to obtain. To obtain these effects more rapidly a ray was needed that would exert a minimum effect on the skin, but a maximal effect in the depths of the body. It was necessary to eliminate all the softer rays which are arrested in the superficial layers of the body before they reached the skin. This was effected by increasing the amount of filtration; it was found that a zinc filter $1/2$ mm. thick gave the best result, especially when the time factor was taken into consideration. (This thickness corresponds to 11 mm. aluminium.) The next step was so to increase the output of the tube that the result was obtained in the shortest time. Apparatus could fairly easily be designed to give the required current, but it was some time before a tube was obtained which would stand up to the terrific strain of this continuous high voltage current. The tube evolved was the "self-hardening boiling water cooled tube."

Experiments to ascertain the optimum conditions under which the tube should be worked to give the best dose in the depths of the tissues showed that at the tension used a current varying between 1 and 2.5 ma. was the most satisfactory. Up to this time the condition of the tube had been regulated by an osmo-regulator controlled by the operator, but this method was found unsatisfactory because it allowed great variations in the condition of the tube. The automatic regenerator or regulator was therefore introduced by Wintz; in it the indicator of a current meter, introduced into the secondary circuit, impinging on a long lever, makes and breaks a current going to a solenoid, whose plunger acts as a valve in the tube supplying gas to heat the osmo-regulator. The aim has been all along to decrease the time required for the treatment and to maintain the dose obtained in the depth of the tissues. A great advance has been made by using the Coolidge tube in conjunction with a special resistance, which has not only shortened the time necessary but actually increased the proportion obtained deep down.

On the Continent the difficulty of efficient insulation of coils has been solved, and transformers which give a varying output—up to 250,000 volts—for twelve hours daily without breaking down are in use. Both low and high output types of apparatus are available, but for malignant conditions a type with the comparatively low output of 2 to 2.5 ma.

seems the most favoured, for it allows the concentration of a number of small ports of entry upon a growth, enabling the operator to obtain practically any desired dosage. Generally speaking, apparatus of a higher output requires the use of larger ports of entry, with a corresponding diminution in the total amount of radiation obtained in the depths of the tissues.

Methods of Application.

The methods of application may be considered under three headings:

1. Roentgen irradiation alone.
2. Roentgen combined with radium irradiation.
3. Roentgen irradiation combined with physical agents to increase the efficacy of the applied rays:
 - (a) electrolysis with metallic salts; (b) packing patient in paraffin blocks.

Methods 1 and 2 are in general vogue, though so far as I could ascertain for deep-seated tumours, especially of the rectum and the genito-urinary tract, the operators preferred to use radium to supplement the action of the Roentgen rays. This method, owing I think to insufficient screening, has unfortunately often been attended by unpleasant indurated scarring which sometimes leads to serious disability, and for this reason alone the use of radium has been practically abandoned in Erlangen, where it has been replaced by method 3 (a).

Not being altogether satisfied with results they attempted to increase the scattering—and hence the absorption—of the rays in the immediate neighbourhood of the tumour. It seemed that this could be accomplished most easily by the introduction of minute metallic particles in and around the tumour; it was found that one of the less irritating copper salts introduced by means of ionization was most suitable. Nothing has so far been published on this work*; but at the Erlangen Frauenklinik it is claimed to be possible to bring about an even distribution of fine copper particles to a depth of 10 cm. The exact manner, however, in which it acts, whether by secondary radiation or by producing other effects, is still a matter of surmise; but the fact remains that, whatever the manner of working, the condition of the patient is very much improved, and at the present time the method is being employed wherever possible.

The most recent modification is that employed by Chaoul in Munich. Relying on the fact that actively proliferating cells are much more susceptible to radiations, he exhibits a dose to the whole body which is just sufficient to stimulate the cancerous cells to greatly increased activity. He follows this with a full dose some eight days later. He surrounds the patient with blocks of paraffin and delivers the main dose directly over the tumour. By means of the paraffin blocks much of the radiation passing outside the port of entry is caught and deflected back into the body, thus greatly increasing the amount of radiation received by the tumour. Chaoul states that as this method has been in use for only twelve months, it is too soon to draw conclusions, yet his results are very much better and he has had no untoward circumstances. The unit of dosage is in all cases measured by the production of an erythema within four to eight days; the interpretation of the term "erythema dose" varies with the different clinics, but in the end one comes to the conclusion that they agree on the whole about the amount of radiation required to treat the various tumours.

A point that strikes me rather forcibly is the insistence on the opinion that intensive therapy is not to be lightly undertaken, and then not without an extensive clinical examination, supplemented where necessary by the laboratory. Owing to the very real danger of "Roentgen cachexia" supervening, the patient's blood picture must conform to a very definite standard, and when below this, general tonic treatment is instituted in the endeavour to build up his health to this required standard.

The all-important question, however, is that of results. In the earlier results from 1914 onwards radiotherapy appears, on the whole, to be slightly more successful than operation, and there is no doubt that with the improvements in technique the indication is still more in favour of radiotherapy, even more so than of therapy combined with operative procedures. By results cure is not necessarily meant; that is almost impossible, I think, but we can speak of relief being more or less permanent. I do not think that the five years' standard is

* I am indebted to Dr. Langer—Professor Wintz's first assistant—for permission to make use of these notes, although nothing has been so far published on this work.

sufficient indication, because in many instances a relapse occurs between five and eight years.

In widely extended disease the tumour must be treated in two or more sections at intervals of six to eight weeks, and one of the most important effects I have noted is the great improvement in the condition of the patient which follows even the first application. This indeed is sometimes so marked as to be a disadvantage, in that the patients either return to work and so damage the skin overlying the port of entry, which is not so healthy as the surrounding integument, or else fancy themselves cured and fail to return at the appointed date, so that it is only months later, when the disease is often out of hand, that they come back expecting once more—often in vain—the relief they obtained from the first application. Again, not only is there almost entire absence of disability following irradiation, but in most cases where the relief is only temporary—as is also often the case after surgical procedures—the period of improvement is in nearly all instances longer than the surgeon could have given, and that without the considerable discomfort of an operation.

Classification of Results.

Results should be classified according to the method employed.

1. *Roentgen Therapy alone.*—As it is only within the last eighteen months to two years that this method has been successfully employed it is too early to speak of results, which, however, lose nothing by comparison with combined Roentgen and radium therapy data, and there is the added gain that with correct technique there is practically no risk of burning the patient.

2. *Roentgen Therapy together with Radium.*—In Germany the practice is to follow up the radium with Roentgen therapy. Two cases, treated in 1916, were seen in Erlangen; they were both peasant women, and looked as if they had never been ill in their lives. Two other cases seen in Munich, treated at a slightly shorter interval, were equally well. In Stockholm Professor Forssell reserves radium to administer the *coup de grâce* following any exhibition of Roentgen rays.

3 (a). *Roentgen Therapy with Copper Electrolysis.*—This is proving the most satisfactory method of approach. There are some added dangers of burning the bowel owing to copper particles being excreted there; but the added benefits to the patient outweigh any disadvantages from this. It seems almost impossible to explain the reason for the great improvement in the condition of the patient, but there is no doubt about it. There is another advantage in that the scar resulting from this form of treatment is loose and supple, and in fungating conditions suppuration is lessened. This form of treatment is specially effective in malignant skin lesions which have resisted other forms of treatment, even including the application of radium.

One case I saw of a middle-aged man who had had an extensive ulcerative epitheliomatous growth of the skin overlying one scapula. He received the usual dose of x rays, which had not the slightest effect. After a period of eight weeks he was treated by copper ionization and again irradiated. Within a very short time an appreciable difference was noticeable, and the ulcerated area commenced to close in. This treatment was repeated after a further eight weeks and again after ten weeks. Within three months of the second treatment the lesion was healed and had remained so when seen two years later. Within the last few months, however, a recurrence took place in the middle of the scar, but this has been successfully treated again.

3 (b). *Roentgen Therapy and Packing with Paraffin Blocks.*—I was not able to see any results from this or even the apparatus in use, as the Surgical Clinic Roentgen Department was being rebuilt at the time of my visit; but despite its originator's claim and satisfaction, I think that a longer period than twelve months ought to elapse before any definite pronouncements can be made; but should it be successful it will lead to a very great simplification in the technique employed.

It is necessary to impress on workers the dangers as well as the benefits contingent upon the use of these newer methods. With the older methods there was very little if any danger of irritating a growth, but a carelessly focused application of the intensive rays may so stimulate an outlying portion of the growth that the patient soon succumbs to this rapidly growing portion.

Furthermore, the old days of haphazard application are gone—I hope for ever. It is no longer sufficient for the patient to come with a rough diagnosis and receive treatment; it is necessary that he should undergo an extensive clinical, laboratory, and if necessary radiological examination

—first, to ascertain the exact situation and extent, so far as is possible, of the tumour; and secondly, the condition of the patient and his fitness to undergo treatment. One of the most important examinations is that of the blood, which serves as the principal indicator of the state of the patient's health, and unless or until this conforms to a certain definite standard treatment cannot be safely undertaken.

The secret of success by these methods is intimate co-operation between clinician, pathologist, physicist, and radiologist; this necessarily means that it is a method which can and should be employed only in large hospitals where this co-operation can be easily obtained. The ideal is that there should be one large central institute in each of the greater cities where these conditions obtain.

Nothing could be worse than the action of some of the smaller hospitals—probably assured by those who do not know that there is no danger attending upon the use of this apparatus—in installing an intensive high-tension outfit, the working of which is positively dangerous in untrained hands. The technique should be employed only when a competent, properly qualified, and trained radiologist can be in attendance the whole time. It is absolutely essential that the greatest care should be taken that the rays are accurately focused, and this entails an accurate knowledge of anatomical relations that cannot be expected of even the best sister or lay assistant. This alone means that this technique should be on no account employed in cottage or even the smaller town hospitals, but only in central institutes in larger towns, as in the former case the radiologist at the best can be only a part-time officer, while the treatment, if justice is to be done it, must have at least one whole-time officer, who must not only personally make every focusing, but must also observe the patient from time to time in order to see that the rays are reaching the desired spot. Apart from the saving in capital outlay, by preventing unnecessary and wasteful duplication of apparatus, the prevention of the tremendous wastage of human life and happiness which would ensue through the inefficient and incorrect treatment that would necessarily obtain at the small local hospitals, is alone an overwhelming argument in favour of the large central institute, where the large number of cases seen and treated, together with the trained staff and opportunities for research and co-operation, conduce to a very much better end-result.

There cannot be the slightest doubt that intensive therapy is a great improvement on older methods, nor that it has come to stay; but it must be remembered, above all, that good and lasting results are only to be obtained by constant care and unremitting attention to detail. It is to be hoped, now that deep therapy is an established fact, that any improvements which follow will come rapidly and be along lines which will allow considerable simplification of detail. It is to be feared, however, that much of the deep therapy apparatus that is being installed in this country will not be properly used and that much discredit will fall on a method that is of very great help in relieving, if not in curing, the dread scourge of cancer.

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THE RESULTS OF TREATMENT IN SYPHILIS OF THE CENTRAL NERVOUS SYSTEM.

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THE following paper is a review of one hundred cases of syphilis of the central nervous system treated at the London Lock Hospital during the last two years. All the patients were men. Many more have been treated, but as a great number of these have been lost sight of, and many have been irregular in their attendance, it has been thought advisable to concentrate on one hundred cases only. Space prevents each case from being reviewed in detail, but it is hoped that the illustrative cases are sufficient to prove the main premisses of the writer. These are as follows:

1. A man is much more likely to develop nervous syphilis if his primary sore is of the papulo-erosive type. In the 100 cases under review 64 showed no trace of any scar, 33 showed the slight and almost invisible type of scar which