A second characteristic development of symptoms, and one which, according to Rotch, is extremely characteristic of intracranial syphilis, consists of *separate attacks of paralysis which succeed each other at intervals of days or months*, and are not associated with any such obvious cause as a slowly-growing tumour or recurrent embolisms or intracranial tuberculosis.

13. A child of 18 months was brought to my out-patient department with a flaccid paralysis of the right arm. The paralysis had been discovered accidentally, and the arm was blue and cold. The patient had been treated with mercurials for sore bottom, and her birth was preceded by that of a premature infant. The true nature of the paralysis was overlooked, the condition being attributed to acute anterior poliomyelitis. Steady improvement occurred with simple massage and cod-liver oil. Eleven months later she had a series of six fits in the out-patient room. These fits were stronger on the right side, the eyes deviating also in this direction. The true nature of the case was at once suggested by the second attack, and energetic treatment by mercurial inunction and grey powder was instituted. Notwithstanding this a spastic right hemiplegia rapidly developed. The child became unable to walk, and only acquired a vocabulary of a few words. She is now left-handed. Both legs and the right arm are spastic. The knee-jerks are both exaggerated, and an extensor plantar response can be obtained on each side. Well-marked choroiditis has been found. The blood gives a positive Wassermann reaction, as also does the cerebro-spinal fluid. In addition, the latter contains much globulin and an excess of lymphocytes.

Yet a third method of onset is that in which *prodromal headaches and vomiting* occur, just as they do in many cases of syphilitic cerebral thrombosis of the adult. Even here the actual installation of the paralysis is sudden and definite. (An onset of this character may also occur with tuberculous meningitis.)

I should also be inclined to suspect cases in which the *silent development of acute hemiplegia* is the first sign, although fits may occur later.

Hadden recorded the following case:

14. A boy suffered with thrush and snuffles in infancy, but had no rash. There was no history of miscarriages in the mother. At the age of 1 year and 9 months, with no premonitory or accompanying convulsion, a complete right-sided hemiplegia suddenly declared itself. Convulsions followed the paralysis for one or two days. Improvement was gradual. The boy became left-handed, and speech was delayed until he was 2 years old. The fits did not recur. When seen at the age of 10 he was suffering from interstitial keratitis, and showed extensive choroidal atrophy.

But the family and previous history, and also the mode of onset, will often leave us in doubt as to the cause of the paralysis. The hemiplegia in syphilitic cases may arise out of a first convulsive seizure with or without coma, just as occurs in other forms of the post-natal group. Under such circumstances as this the final, and indeed the only means of arriving at an accurate diagnosis is by examination of the blood and of the cerebro-spinal fluid—the blood for the Wassermann reaction, and the cerebro-spinal fluid not only for that reaction, but also for the possible presence of globulin and an excess of lymphocytes.

REFERENCES.

¹ St. Thomas's Hospital Reports, 1891. ² Brain, 1902.

THE "X" RAYS IN TREATMENT.*

BY

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WITHIN the last few years the question of "dosage" in the administration of x rays for therapeutic purposes has received much consideration. In the appendix to the late Dr. Kassabian's excellent work on electro-therapeutics, published as recently as 1907, the technique of many eminent radiologists is described. In the majority of the descriptions the details give no indications as to the quality of the rays produced or the quantity absorbed by the patient; indeed, the dosage is largely a matter of guesswork based on experience. The following quotation illustrates this point:

¹ Dosage is determined by a light or dark green fluorescence of the tube. The best time to discontinue treatment is at the appearance of any erythema, taking into consideration the number and duration of exposures.

* Read before the Glasgow Medico-Chirurgical Society, March 3rd, 1911.

Now it is true that a certain skill in this guesswork may be gained in time. But I contend that a course of minute doses can be administered in this manner only by one of great experience; even then it is risky; it is unscientific, and happily it is quite unnecessary. To administer the rays in definite measured doses is more troublesome and more expensive; but, when one realizes the extreme potency of the agent and the havoc its injudicious use has already wrought, one must welcome these means of measurement, and use them regardless of either expense or trouble. Already many valuable lives of both medical practitioners and patients have been lost through exposure to the x rays; and Dr. Kassabian himself, one of the latest victims, says in his book (*ibid.*, page 407): "The number of operators who have been disfigured, maimed, and injured would form a deplorable list of tremendous proportions."

I do not think that it can be too much insisted on that the administration of the x rays, except in carefully measured doses, is absolutely inexcusable.

It is not my intention to discuss minutely the question of "dosage." The problem is very complicated and difficult, and I admit that no one of the methods of measurement at present in use is completely satisfactory. I intend rather to give in detail the application of measurement I have found most simple in the daily routine. Regarding the rays themselves, there are two factors to be considered: (1) The quality of those falling on the part treated, and (2) the quantity absorbed by the tissues. Any system of measurement must necessarily take cognizance of both.

"Hard" and "Soft" Rays.

A beam of x rays is composed of radiations of different penetrating powers, just as a beam of ordinary light is composed of rays of different wave length. Rays are described according to their powers of penetration; those of low penetrating power are called "soft," those of high penetrating power are called "hard," while an intermediate degree is spoken of as "medium." The proportion in which "soft," "medium," and "hard" rays are mixed depends on the degree of vacuum of the tube from which they emanate. When the vacuum is low the "soft" rays abound; when the vacuum is high the "hard" are proportionately increased. When it is desired to affect any deep-seated tissue a tube emitting "hard" rays in abundance is selected, while for superficial effects a tube of low vacuum, giving off chiefly soft rays, is used.

Our means of controlling the penetration are: (1) The regulation of the vacuum, and (2) the use of screens.

1. For the first we use a tube having a self-regulating vacuum (such as Müller's heavy anode automatic vacuum regulating tube). It is so set that the vacuum shall not rise above a certain degree, and as the vacuum tends to rise while a tube is in use (provided it is not over-heated) this device keeps it fairly constant.

2. Screens are used to absorb the softer rays—that is, those whose chief effects are on the skin—when the object is to affect deep structures. They may be made of various substances, such as wash-leather and gelatine. I use sheets of aluminium, 1 mm. in thickness, superimposed on one another, the number used depending on the effect desired. Belot, in a recent number of *Archives of the Roentgen Ray*, states that aluminium is the most satisfactory material for screening purposes.

Action on the Tissues.

The administration of a dose of x rays is followed by a period of time during which no change is observed in the tissues irradiated. This is known as the *latent period*. The latent period is shorter after large doses than it is after smaller ones.

1. A *small dose* stimulates all epithelial structures; there is increased secretion from the sweat and sebaceous glands, and the hair grows more vigorously. In the course of a few days or longer, these effects gradually pass off, and the part returns to its normal condition.

2. A *full dose* may be followed by a slight erythema after a latent period of ten days or a fortnight; the hair will become pale in colour, and in about three weeks it will drop out, the bulb being temporarily atrophied. The erythema passes off in a few days, the hair roots gradually recover, and in from six to twelve weeks a vigorous growth

of new hair takes place, and normal conditions again prevail.

3. A very large dose is followed in about one week by erythema, which steadily increases in severity. Soon marked inflammatory reaction sets in, and vesication takes place. This is followed by necrosis, which will be deep or superficial according to the quantity of rays absorbed. The ulceration thus produced is very indolent, and in bad cases may last for years. Ultimately it may become epitheliomatous. When healing does at last occur, the resulting scar is white, dense, and unyielding; it is poorly supplied with blood vessels, and is prone to ulcerate again.

4. Repeated doses produce results according to whether another dose is or is not administered before the effects of the previous one have passed off. If the doses be such that no distinct inflammatory reaction is produced, and the interval is sufficiently prolonged, a very large number may be administered without producing any very definite organic change. Some increase in fibrous tissue and lessening of epithelial tissues always result. It is probably on this account that the practice of giving a course of x-ray after excision of malignant disease is to be recommended.¹

If the doses are repeated so often that the tissues have not entirely recovered from one when the next is given, a time comes when an inflammatory reaction, more or less violent, results, and thus the rays are said to have a cumulative action.

Chronic radio-dermatitis of operators is the result of small, oft-repeated doses. It occurs chiefly on the backs of the hands. As already mentioned, epithelial growth is thereby stimulated. The result of frequent small stimulations is that the skin becomes hard and dry and warts form. Changes in the blood vessels and capillaries also take place, their walls becoming apparently much thinned. The hands become red and mottled. The only reasonable treatment is absolute protection from the causal agent, and, indeed, from irritation of any kind. Even then the condition improves very slowly. When skin has been rayed to such an extent that it is largely replaced by fibrous tissue, and appears as a dense white scar with telangiectatic vessels over its surface, it should not be rayed again under any circumstances whatever. This is a condition which should not occur. Unfortunately in the earlier days of radio-therapy, when accurate dosage was unknown, excessive raying was common, and this state of the skin was sometimes seen; but with the means of dosage and control now available the risk is very materially lessened.

To Holzknacht is due the credit of first elaborating a system of x-ray dosage. Taking advantage of the property which the ray possesses of producing change of colour in certain substances, he has prepared a pastille—the composition of it is unfortunately kept secret—which under the influence of the rays changes from a canary-yellow colour to brown. He has also prepared a graduated scale showing various tints. These shades are numbered from 3 to 24, and this scale is now generally recognized as the standard of x-ray dosage. The unit is that amount of raying necessary to change the colour of a pastille from one shade to the next. It is symbolized by Holzknacht's initial H.

Sabouraud, taking advantage of the same property, has invented a somewhat similar method. Instead, however, of employing a scale of colours, a pastille of one colour only is used. This represents the same dose as No. 5 on Holzknacht's scale. The method has these advantages—that it is cheap, and that the composition of the pastille is not kept secret. It has the disadvantage of indicating one dose only, namely, 5 H.

A third method, the one which I employ and recommend for routine work, is the use of a milliamperemeter on the tube circuit, and a meter to count the number of x-ray impulses administered at one sitting. An impulse is originated each time the current in the primary circuit is interrupted; one has therefore only to count the number of revolutions the interrupter makes during the sitting. This is done by attaching to the spindle of the revolving interrupter a revolution-indicator, such as is commonly used on the wheel of a bicycle to record the distance travelled.

In using this system, the following are the points to

which attention must be paid—to secure accuracy all are essential:

1. The distance between the anticathode (the point from which the x rays emanate) and the part treated.
2. The penetration of the rays.
3. The amount of current passing through the tube.

1. The distance is determined by the applicators. I find the best working distances are 6 in. and 9 in.; accordingly most of our applicators are made so that the part treated shall be at one or other of these distances from the anticathode. The diameter of the area treated should always be something less than half the "distance" in order that the dose may be evenly distributed over the entire irradiated surface.

2. I have already described how to determine the penetration of the rays and keep it constant. If by any chance the penetration should alter while the dose is being given, this is at once observed by an alteration in the rate at which the current is flowing through the tube; if the penetration increases, the meter shows that less current is passing, if the penetration lessens, the meter indicates an increase in the current.

3. The current passing is indicated on a meter and it is essential that the readings should be correct. Unfortunately there is always a certain amount of the current generated which flows in the wrong direction, with the result that the meter indicates something less than the actual current. To correct this a valve is inserted in the tube circuit which permits the forward current to pass easily but offers a high resistance to the inverse current.

An installation with this method of dose measurement must first be standardized. We must determine how many impulses (under set conditions) are equivalent to 1 H. We do so by inserting one of Sabouraud's pastilles and finding out how many impulses are required to reduce it, this number we know is equivalent to 5 H., and from that data other doses can be calculated.

For example, if a tube having a penetration represented by $4\frac{1}{2}$ in. spark gap has half a milliampere passing through it, and Sabouraud's pastille (placed at 3 in. distance) is reduced in 5,000 impulses, we know that under these conditions, with an applicator to fix the part at 6 in. distance, 1 H. = 1,000, while with an applicator fixing the part at 12 in. distance 1 H. = 4,000. In order to calculate the number for any other distance, one has but to remember the law that light diminishes inversely to the square of the distance.

By this method of measurement one is able to vary the dose within wide limits and the personal equation is eliminated. With the other methods one must be able to appreciate very fine shades of difference in colour, and while it is usually easy to do so in good, diffused daylight, in dull weather or sunshine it is very difficult, and in artificial light it is almost impossible to be accurate.

I shall now very briefly name some of the diseases that are more or less amenable to x-ray treatment, and I shall suggest what I regard as suitable doses.

1. *Rodent Ulcer*.—A very large percentage of such cases heal under the influence of the x rays. It is very important that treatment be continued, not only till all ulceration has healed over, but until all raised edges, however small, have entirely disappeared. Otherwise recurrence will take place almost immediately. The dose should be 6 H. once in three or four weeks, or 2 H. once weekly. Rays of medium penetration should be used and no screen interposed.

2. *Keloid* is another disease which is very amenable to the influence of x rays. The dosage is much the same as for rodent ulcer—namely, 6 H. once in five or six weeks. Perhaps my most successful case was one in which a keloid practically disappeared with one dose of 5 H. followed after a month's interval with a second of 3 H. The keloid was raised and red. It was situated on the neck, in the scar left after removal of glands. It was narrow and straight, measuring about 3 in. in length.

3. *Psoriasis*.—When the disease occurs in large, chronic, solitary patches it is usually very favourably influenced by the x rays. I have seen a patch on the back of the neck, measuring about 4 in. in diameter, disappear after two doses of 6 H., with an interval of four weeks between them. The rays were of medium penetration (the equivalent spark in air being about 4 in.), and no screens were used.

4. *Lupus Vulgaris*.—This disease is, as a rule, best treated by x rays in conjunction with other agents—for example, cauterization, as described by Dr. J. Goodwin

Tomkinson of Glasgow.³ It may also be used along with Finsen's light treatment or curettage. Great improvement usually follows the first few doses, but spots are left on which the rays seem to have less influence, and continued raying is apt to produce dense scar tissue with telangiectasis. It is difficult to lay down rules as to dosage, but in no case should a single dose exceed 6 H. or 7 H., and if so large, the interval should be three to five weeks. A screen of aluminium 2 mm. in thickness should be used, and the rays should be of medium penetration. Possibly 2 H. once a week for six or eight doses, followed by a rest of some weeks, is suitable in many cases.

5. *Tuberculous glands* at any stage, but particularly in the early stages, usually respond well. The rays should be of high penetration, an aluminium screen of 5 mm. interposed, and a dose of 7 H. to 9 H. administered once in from two to four weeks. As a rule progress is slow.

6. *Exophthalmic Goitre*.—A large percentage of cases improve. It is possible that too small doses aggravate the symptoms, and when we remember the stimulating effect of small doses it is reasonable to suppose that some of the failures which we have had are to be attributed to this cause. The object of the treatment is to cause partial atrophy, and not stimulation of the gland. Rays of medium penetration should be employed, 0.3 mm. aluminium screen inserted, and a dose of 6 H. to 8 H. once in two to four weeks should be given.

7. *Alopecia Areata*.—Excellent results often follow the administration of small doses repeated at long intervals. I use rays of low or medium penetration without screening, and give 1 H. or 2 H. once in two or three weeks.

A child 8 years old lost the hair from the entire head. Occasionally some downy hair would appear only to be again shed. After two years, during which various forms of treatment were used, the head still remained bald. She then began x-ray treatment. She received 2 H. once a month for four doses with rays of medium penetration, and by this time—that is, in three months—strong dark hair was growing all over the head. Thereafter, as the child lives a distance from town, and the hair looked healthy, the x-ray treatment was stopped, and the mother applied faradic brushing daily. The hair continues to grow healthily, and has been well for a year.

8. *Leukaemia*.—Patients suffering from leukaemia usually benefit. Especially is this so in the more chronic cases, in which the symptomatic improvement, the reduction in size of the spleen, and the change in the blood count, are occasionally very striking. Unfortunately the improvement is not permanent. The rays should be of fairly high penetration, an aluminium screen of 0.5 to 0.8 mm. thickness interposed, and a dose of 6 H. to 8 H. given once every two or three weeks, or a smaller dose may be given more often. Treatment should be applied to the long bones and to the spleen. I usually treat the spleen over three separate areas, and as the above dose may be given to each area a large quantity of rays can be administered in a comparatively short time.

A man, aged 32, came into the Royal Infirmary under the care of Dr. Cowan (to whom I am much indebted for kindly supplying me with these details for publication). He was suffering from great enlargement of spleen and liver. On February 26th the blood count was, white cells 471,000, reds 2,850,000; the haemoglobin was 62 per cent. On June 2nd the journal note is to the effect that there is great improvement in every way. The spleen and liver are much diminished in size. White cells number 34,000, reds 5,200,000, haemoglobin 96 per cent. A few days later, however, there was unfortunately a sudden rise in leucocytes almost as high as on admission (410,000) and some increase in the size of the spleen. He was now dismissed feeling quite well. Some months later the patient reported himself and it was found that he had maintained the symptomatic improvement but the leucocyte count was still high.

Another case was that of a young man, aged 28, who was admitted to the Royal Infirmary in 1907. On October 4th the leucocyte count was 200,000, and by April 17th, the date on which he was dismissed, the leucocyte count was 11,000. This patient was shown before this society some years ago by Dr. W. K. Hunter, under whose care he was, and to whom I am indebted for these details for publication.

9. *Hyperhydrosis*.—This disagreeable trouble can usually be relieved or improved. Rays of medium penetration are used without screening; 5 H. once in four or five weeks for several doses is usually sufficient.

10. *Hairy and pigmented moles*, such as are sometimes seen on the face and neck, can be greatly improved; the hair removed, and the pigmentation lessened. Fairly

large doses should be given with rays of medium penetration, and no screen used; 5 H. or 6 H. should be administered once in three to five weeks. Many doses may be required, and care must be taken not to produce a violent reaction. One is, therefore, inclined after the first few applications to reduce the dose.

11. *Naevi*.—Both the flat port-wine stains and the raised cavernous varieties can be vastly improved by raying. It has been stated that marked inflammatory reaction must be produced, but with this I do not agree. I use rays of medium penetration without a screen (perhaps the use of an aluminium screen 0.1 mm. in thickness might be an advantage), and I give 3 H. or 4 H. about once a fortnight. A large number of sittings are required, and as radium gives more excellent results, and is much more easy of application, especially when the patient is a young child, I have largely replaced the use of the x rays in cases of naevus by radium.

12. *Deep-seated Malignant Disease*.—Some relief of pain and checking of the rate of growth are all that can be expected. In saying this I do not deny that a number of cases of undoubted cancer (other than rodent ulcer) have disappeared under x-ray treatment. One such case—a round-celled sarcoma in the naso-pharynx—I showed before this society some years ago. The percentage of cases, however, in which this happy result is obtained is so very small that I think one cannot say more at present than I have said. In operable cases I am strongly of opinion that a short course of x rays should be administered; perhaps before, but certainly always after excision. The risk of recurrence, it is believed, is thereby lessened.

13. *The epilatory property* of the rays is made use of in the treatment of such diseases as ringworm and favus. The object is to give such a dose as shall produce complete temporary epilation, and the greatest care must be taken not to exceed the dose, otherwise permanent baldness may result. The dose is 5 H. with rays of medium penetration (4 to 5-inch equivalent spark gap). No screen is used, and one dose only should be required. It cannot be denied that there is a small risk of occasionally producing permanent partial baldness. I therefore think that x-ray epilation should only be had recourse to in those cases which resist all other forms of treatment; and I believe there are very few indeed that will not yield to ionic medication with iodine or mercury.

I have by no means exhausted the list of the diseases in which x-ray treatment has been found of service. It was not my intention so to do. Perhaps, however, I have said enough to show that the x rays have a large field of usefulness in the treatment of disease, and that definite dosage is not only obtainable but absolutely essential to the practice of radio-therapy. The time is past when such phrases as "ten minutes three times a week" or "mild doses daily" are permissible. Like strychnine and arsenic, the x rays are safe and useful when properly prescribed and administered; but like them, too, they are capable of doing terrible damage.

REFERENCES.

¹ Sampson Handley, *The Prophylaxis of Breast Cancer, Practitioner*, April, 1910, p. 463. ² *Proceedings of the Royal Society of Medicine*, April, 1908.

THE arrangements this year for the E.M.I. (Enseignement Médico-mutuel International) include a tour in Scandinavia, starting from Paris on August 12th and returning via Berlin on August 30th. Detailed information can be obtained on application at the offices of the association, 12, Rue François-Millet, Paris. The association has recently been reorganized, its full title now being Association Internationale de Perfectionnement Scientifique et d'Enseignement Médical Complémentaire. Its honorary president and general secretary are Professor Roux and Dr. C. Legendre respectively. A German body of a corresponding kind (the German Central Committee for medical study tours) has also chosen part of Scandinavia for its principal tour this year. The party starts on August 26th, and visiting Christiania, Bergen, and other places in Norway, and several of the German islands, including Borkum, of which so much has recently been heard, remains away three weeks. A party is also to visit the various watering places in the east of Germany in connexion with the International Congress of Thalassotherapy. The general secretary of this committee is Dr. A. Oliven, 134B, Potsdamerstrasse, Berlin.