of them being severely ill for several days prior to admission. Despite this handicap, however, there were sixty-eight recoveries, representing a percentage recovery rate of 81.92, a figure which might well have been exceeded under more favourable circumstances.

It cannot be too strongly emphasized that *early administration* and *generous dosage* are factors of supreme importance, and that if these essentials are observed a very material reduction in the number of deaths from this disease may confidently be expected. Opinions based upon indifferent results from fourth- and fifth-day administrations are of little value, since failure in such instances is primarily due to lateness and, it may be, to too small dosage. A late initial dose gives attacking haemolytic streptococci greater time and opportunity to invade the circulation, multiply at a rapid pace therein, and freely elaborate their toxins. In these circumstances the phagocytic value of the leucocytes, of which the polymorphonuclears play a leading part, becomes negated by the steadily increasing army of invaders. The blood stream

then becomes so drenched with toxins that neutralization of them is impracticable; and even if it were not so the deadly effect of these toxins is by this time imprinted upon the tissues of the unfortunate patient.

Experience convinces me that to avoid such disastrous consequences as these, the *early* and *generous* employment of anti-scarlatinal serum may be relied upon with every confidence.

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PRINCIPLES OF RADIOLOGICAL TREATMENT AND THEIR BEARING ON HOSPITAL X-RAY ORGANIZATION

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The Position Attained in Radium Therapy

The position to-day in Great Britain is that for a country of its size and population the general level of treatment of malignant disease by radium compares not unfavourably with any other. The excellent results at such a centre as l'Institut du Radium in Paris are not a reliable guide to the general level of attainment throughout France; the same remark is not so applicable in the case of Sweden, for the Radiumhemmet at Stockholm is able to control, to a great extent, the form of treatment of a large percentage of the patients who require radium treatment throughout the country. But the small Swedish population and the relatively large economic resources on which the Radiumhemmet can rely combine to make a system that, while serving them extremely well, is not one which could be applied in general. Even with our much bigger population we shall very soon be in the position that we need not fear a comparison of statistics.

Our present position in radium therapy is mainly due to the medical groups or individuals by whom the treatment has been given, but there have been three contributory factors which have played an important part in the development of this form of treatment. First, there is the service rendered by the Medical Research Council in 1921 in forming research centres throughout the country, their main functions being to explore the possible ways of using radium in the treatment of malignant disease. Periodic reports issued under the heading "Medical Uses of Radium" have been prepared by the Radiology Committee of the Council under the chairmanship of Sir Cuthbert Wallace; these reports have discussed the development of technique, the advances in our knowledge of radium reactions, the importance of pathological as well as clinical diagnosis, and finally they have exhibited comparable statistics relating to several sites of cancer.

Secondly, there are the services rendered by the National Radium Commission since 1929 in ensuring that

the large quantity of radium put at its disposal by the National Radium Trust is, in the words of its Charter, administered so as:

"to make arrangements for the proper custody, equitable distribution, and full use of the radium which may from time to time be the property of the Trust with the object of promoting the treatment of the sick throughout Great Britain and the advancement of knowledge of the best methods of rendering such treatment and of securing due economy in the use of radium for the purposes of such treatment. . . ."

The chief steps taken by the Radium Commission were the concentration, so far as possible, of such work at the chief university medical centres, the exploration of the facilities not only for radium but for all the ancillary services, and the requirement of guarantees from all participating National Centres that methods of treatment (selected and agreed upon by the medical members of each centre) should be carried out for long enough to enable their value to be determined statistically. Five-year figures from the Radium Commission cannot appear until next year, but a "Preliminary Report on Radium Treatment in Cancer of Certain Sites" has recently been published, and this is to be followed by similar publications.

The prestige of British physicists in the domain of radio-activity has contributed to the advance of radium therapy. The work of men like Lord Rutherford leaves its mark on the whole field of science, but it also has a distinctive effect upon the nation's science. As a consequence, knowledge of radio-activity became widespread here at a time when this could not be said of many other countries, and thus developments of technique were made very much more easily. An instance which comes to mind is the technical advance in the use of radon, which was initiated by the late Professor Joly so long ago as 1914.

It is submitted that the Medical Research Council and the National Radium Commission have been largely contributory to advances in radium therapy, and that the lack of similar supporting and co-ordinating help is now being felt in the domain of x-ray therapy.

Facts and Tendencies in X-Ray Therapy

It is probably true to say that up to the year 1920 x-ray treatment developed chiefly in the light of clinical experience, and from the technical side the exponents of it received the amount of support from manufacturers of apparatus which they asked for; the voltage and output of x-ray tubes were increased by gradual stages.

But an epoch, and as it turned out a not very happy epoch, was in 1920 associated with the name of the town of Erlangen, where Drs. Seitz and Wintz laid down certain working principles in the treatment of cancer. Briefly, this mode of treatment was based on the idea of the so-called "carcinoma dose." For reasons which are rather difficult to discover there was a pilgrimage of radiologists to Erlangen, and the teaching was brought over to this country and practised as the "Erlangen treatment" or "deep-therapy treatment." Stripped of its non-essentials this form of treatment aimed at giving, in the shortest possible time, a dose which would be fatal to the carcinoma cells of the growth, the damage caused to general health being considered of minor significance. Imposing x -ray apparatus, combined with a cut-and-dried quantitative claim to the dosage adequate in the treatment of cancer, were two things which contributed to the favour which the method enjoyed for a few years, but more especially it had the practical advantage, shared with surgery, that the treatment could be completed in a comparatively short time. The position to-day is that there are few radiologists who administer at one or two sittings these carcinoma doses, and the claims made were actually of the greatest disservice to the sound development of x -ray therapy.

Meanwhile radiologists in other countries, notably France, were pursuing systematic studies on the reactions of the body and of malignant growths to x rays, and these are at last having an influence upon practice. The most noteworthy clinical research of this character is, by general consent, that of Dr. Coutard; but the results of this work are to be learnt far more effectively by active contact with the work of his clinic than by his infrequent publications, most valuable though these are. So far from x -ray treatment being a comparatively easy treatment, Dr. Coutard, after long experience, says two things, one being that the x -ray treatment of cancer is still very difficult, and the other that it is often very dangerous. According to him it is impossible to treat quickly many of the commoner forms of cancer, such as cancer of the breast and rectum, composed as they are of very differentiated types of cells. Successful treatment requires repeated daily doses, continued until an effective total dose has been administered, each dose being so small that no damage is done to blood vessels and surrounding tissues. He considers that heavy radiation in these cases is directly responsible for encouraging the development of malignant glands and general metastases. Though it is possible to treat successfully in a comparatively short time, by using heavier doses and greater intensity, the more superficial types of malignant disease, especially those arising in situations where injury to the normal structures is of minor importance and easily repaired, the treatment of the deeper infiltrating cancers, with very differentiated cells, requires a different method. At these sites it is clearly essential that damage should not be done to the blood vessels, and the treatment must be slow; it actually lasts two, three, or four months. The most important principle of successful treatment is "primum non nocere." The radiation treatment of cancer is essentially a biological problem depending on the varying response of different cells, normal and malignant, to x rays, a fact not to be lost sight of in the desire for more elaborate machinery and x rays of greater penetrating power.

Nothing could be more obvious than the diametrically opposite views of Wintz and Coutard, but one method of treatment has been largely abandoned while the other is being increasingly adopted in other countries. Coutard has already obtained valuable results of long standing.

Qualifications of the Radiologist

Nothing can be more fallacious than to suppose that a nation possessing a few brilliant exponents of any form of therapy has necessarily got such treatment shared by its people at large, and if there is going to be any radical change in the level of x -ray treatment in this country it cannot be accomplished by equipping centres with high-grade apparatus unless there is a high standard of qualification for the work of those in charge. The standpoint adopted here is that those who practise x -ray and radium treatment and hold responsible positions at big centres should have the same qualifications and clinical experience as are required of members of the medical and surgical honorary staff.

It is common knowledge that the diplomas in radiology, excellent purposes though they serve, do not emphasize the importance of "radiotherapy," and it would be a mistake to suppose that the possession of this diploma was a guarantee of a man's qualifications for conducting and directing the x -ray therapy of cancer. In the opinion of Coutard, an experience of radiological treatment covering a period of about four years is necessary for this purpose. It seems to be inevitable that a prolonged experience is necessary before the radiologist is in a position to co-ordinate biological reactions with the doses of radiation which have produced them.

Physics and the Rationale of Treatment

Physicists have contributed to the present-day rationale of treatment by devising a basis of measurement of x rays as used clinically and by the measurement and comparison of the doses at different levels in the body. We are not aware of similar publications prior to that communicated to the Physical Society in 1923 entitled "The Measurement of X-Ray Intensity and the Necessity for an International Method." Shortly afterwards an X-Ray Unit Committee was formed under the chairmanship of Sir William Bragg, its work being helped by a grant from the Medical Research Council on the recommendation of its Radiology Committee. Partly as the outcome of the work of this committee and of the National Physical Laboratory, with joint action by similar laboratories in France, Germany, and the United States of America, agreement was found for the establishment of an international unit, the "r" unit. Its medical use quickly followed, and it is not too much to say that it is the most important aid to the dispensing of accurate doses of x rays which has been put into the hands of the radiologist.

The data upon depth doses have proved of very great value to the radiologist, but there has been a disposition in some quarters to apply these data too rigidly and to interpret their implications incorrectly. The radiologist's desire for larger percentage depth doses has led to requests for machinery of higher voltage and x rays of greater penetrating power, and the electro-technical expert has produced a machine able to produce a million volts and an x -ray tube which will stand the tension. Such tubes are in use, though not in general use, but they may increase unless other counsels prevail. The arguments in favour of their use are that they do what the radiologist has asked for; the rays are considerably more penetrating than x rays at 200 kV, though not as penetrating as the more penetrating types of γ rays from Radium C. But there are arguments against their use which should receive the most careful consideration before a general policy of adoption can be recommended with confidence. First there is the feature of gigantism about the higher voltage installations; the man becomes subjugated to the machine, the x -ray tube has to be

fixed, and the patient accommodated to the beam. This is perhaps one of the most vital indictments of the million-volt appliance.

Though we cannot lightly set aside the requirement of a bigger percentage depth dose, there are other ways in which it can be realized without resort to these very high voltage plants. Apart from the use of radium in large units a greater percentage depth dose can be obtained by increasing the focal skin distance when using x rays at 200 kV. This latter has become a practical policy with the advent of newer types of tube, which give a larger yield of x rays.

One important consideration in depth doses is that it is extremely easy to pay too much attention to the expression "percentage depth dose." The vital thing is what doses may be given to the carcinoma cells at various depths in the body, and the percentage dose calculated in terms of a single exposure of x rays may well give the impression that the figure resulting is rather absolute in character. This is far from the case, for if we begin to think of total depth doses we see that the total dose which can be given to a group of cells at a depth in the body not only depends upon the number of ports of entry, but also upon the actual intensity of the radiation employed. This arises from the fact that the reaction of the skin (the bogy of the therapist) is a function of the intensity of the radiation employed, of the time intervals, as well as the total dose. It is many years since experiments showed that it was possible to reach a limiting, though useful, intensity of radiation which the skin could more or less indefinitely support. It has been left to the genius of Coutard, making use of this condition in x -ray practice, to show that he can give a large cumulative dose to groups of malignant cells at a depth in the body without even a severe skin reaction by giving daily small doses of radiation.

Future Organization

The present time is one which finds many institutions installing new x -ray apparatus and discussing the administrative needs of therapy departments. The decisions reached are very important ones, for they will influence the treatment and prospects of life of thousands of patients. The radiologist has to decide between treating his patients with x rays at 200 kV and adopting prolonged treatment, and alternatively making the hazardous jump to half a million volts or more, knowing beforehand something of the technical difficulties involved, the limitations and hindrances inevitably associated with a beam whose direction or inclination may have to remain unchangeable, and that such experimentation is very costly.

It is evident that the general tendency of the more successful centres of radiotherapy is to increase the period over which treatment is given, and this extension of the time may well cause very big changes in the way in which this kind of work should be organized. If patients are to be under daily treatment for periods ranging from sixty to ninety days, it is questionable whether the organization of general hospitals, with the exception of those with special interests in cancer, is particularly fitted for such an exacting demand. It looks as though x -ray treatment in the future may have to be organized on the lines of sanatorium treatment.

In any case the problem is evidently becoming so big, so complicated, and so full of essential but intricate detail that the organization of this service for the country requires well-considered schemes, so that advantage can be taken of existing knowledge, and large sums of money and individual toil shall not be wasted in unproductive effort.

FATAL CASE OF JAUNDICE

BY

R. M. LITTLEDALE, M.R.C.S., L.R.C.P.

After reading the article on leptospiral jaundice in the *Journal* of March 30th I am prompted to publish this case. Here also the aetiological problem was very difficult; in actual fact it was never solved. The case occurred on a small poultry farm in the country, consequently the facilities for bacteriological and other examinations were not such as one would get in a general hospital. Such tests as were carried out were done by Dr. Ponder and his staff at the Maidstone laboratory, and I should like to take this opportunity of thanking them for the help and advice which they gave me in this case.

Case Record

The patient, a strong, well-built man of 44, was first taken ill on February 24th, 1935. He then complained of joint pains and a sore throat; he went to bed, but did not send for me till the 26th. When I first saw him he was complaining of pains in his back and in the larger joints, a general feeling of lassitude, and a sore throat. Headache was present, though not severe.

On examination his throat and tongue gave the appearance of a scarlatinal infection. Examination of the chest and abdomen revealed no abnormality, and no rash was discernible. Temperature was 102.4° F. Urine was clear and contained no albumin or sugar.

On the 27th, after the patient had passed a very restless night, the clinical picture was much the same. A few rales appeared at the base of the right lung; the temperature fell to 99.2°, and respirations increased to 30. On the 28th, after a slightly more restful night, the patient became markedly jaundiced. (Here it may be of interest to add that he was jaundiced—diagnosed at the time as catarrhal—in 1921.) Examination of the abdomen revealed slight tenderness over the gall-bladder area, but neither liver nor gall-bladder was palpable. Rectal examination showed no abnormality.

The right lung base presented impairment of resonance and tubular breathing. Temperature was 100.4°, and respirations 32. Stools were dark brown and of a normal consistency. Urine contained bile, but no albumin or sugar.

On March 1st the condition remained much the same; the temperature dropped to 98°, and respirations to 24. On March 2nd the patient said he felt better. Jaundice had increased. The apex beat now became very irregular—about seven or eight normal beats followed by a period of auricular fibrillation and then back to normal rhythm again, and so on. Signs of pneumonic consolidation for about two inches above the diaphragm on the right side were now fairly well established. Temperature was 97.6°, and respirations 24. On March 3rd, after a night of delirium, the patient was very euphoric. The jaundice had now become an intense bronze, and the mouth was exceedingly sore and dry. The condition of the heart had improved slightly—digitaline cristallisée, 1/240 grain, was given four-hourly—but was still irregular. The consolidation was spreading across to the base of the left lung. Still there was no physical abnormality detected in the abdomen, beyond a slight resistance of the upper right rectus. The stools were black, but this was undoubtedly due to the administration of an iron mixture at the onset of the illness. Temperature was 98.2°, and respirations 28.

On March 4th no sleep was obtained with medinal; the pulse became feeble, but less irregular. Cardiazol 1 c.cm. was