been obtained for hospitals for the purchase of radium by these means, scientific and clinical progress has been correspondingly embarrassed.

The main hope of advance in the treatment of carcinoma by radium lies in the combined investigations of the clinician, the pathologist, and the physicist, and it is in this way only, and not by startling newspaper headlines, that future clinical results are likely to improve.

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TECHNIQUE OF INTRA-ABDOMINAL INSERTION OF RADIUM FOR CARCINOMA OF THE CERVIX UTERI.

BY

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It will be many years before the public is sufficiently educated in medical matters to realize that periodic overhauls of their bodies are as necessary as for their motor cars. For a long time, therefore, there will be a large number of patients with advanced cancer, especially carcinoma of the cervix.

In discussing the problem of cancer treatment it is of some importance to consider why an advanced case of malignant disease should be more difficult to cure by radiotherapy than an early case. When dealing with "excisional surgery" it is easy to realize that if the diseased area is extensive it will be impossible with a knife to cut this out without excising portions of essential organs, with fatal results to the patient. In radiotherapy, on the other hand, it is not so easy to be certain why there is such difficulty in destroying malignant cells placed deep in the pelvis when it is so easy to destroy them if placed on the tip of the cervix. There are several possible explanations for this difference.

First, it may be the better blood supply that is found in the region of the deeper part of the growth: Strangeways and Fell found that the reaction of tissues in the embryonic chick to x rays differed considerably before and after circulation had been established.

Secondly, it is possible that the cancer resistance of the body materially helps the radiotherapy in early cases, but that in the more advanced cases no such help is forthcoming. This idea is very seriously considered in Sweden.

Thirdly, the type of cell developed in these late cases may in itself be more radio-resistant; this, however, is hardly likely, as the cells in the cervix and more exposed part of the growth are just as easily destroyed in the late stages as in the early cases.

Fourthly, there is the simple explanation that it is more difficult to apply an efficient dose to these more distant cells. It is with this simple explanation in view that I am at the present time treating a series of patients by means of intra-abdominal radium.

It is to the Brussels Radium Institute that we owe the first attempt along these lines. The technique they used in 1919 consisted in putting the patient in the Trendelenburg position, opening the abdomen, and, when the posterior layer of the broad ligaments had been incised, placing 20 mg. of radium element in a single tube at the base of each ligament. In addition to this they sometimes put needles into the uterus. The sutures from these tubes were carried out through the lower end of the abdominal incision, and the whole pelvis was packed with 6 to 8 yards of gauze. At the end of four or five days this was removed, with or without an anaesthetic. I modified this technique by using needles instead of tubes. Thirteen cases were

treated with a modified technique during 1923-24. Of these thirteen cases:

One was of the first degree and is living and well after four years.

Four were of the second degree, and of the four cases two are living after five years, although the latest report from one is not very satisfactory. Two have died, one after fourteen months and the other after seven months.

Six were of the third degree; three of these six are living after five years or more, and three have died, having lived less than one year.

Two were of the fourth degree; one is living after five years and the other died after a year and ten months.

It will be seen, therefore, that of the thirteen cases six are alive after five years, and one has lived for four years and shows no signs of the disease.

Present Technique.

The intra-abdominal insertion of radium is usually carried out about six to eight weeks after the vaginal application—that is to say, when the local external growth has disappeared and all ulceration healed. No attempt so far has been made to combine the intra-abdominal application at the same time as the vaginal, merely on the theoretical grounds that, whilst there is an infected area in the cervix and fornices, it is perhaps not wise to do anything to the abdomen and parametrium which might lower the resistance to that infection.

The patient is put into the Trendelenburg position and the abdomen opened, a general examination is made of the liver and aortic glands, in addition to the pelvic organs and the iliac glands. The intestines are packed off and the uterus is pulled forward; the parietal peritoneum is then picked up with forceps and the needle inserted, leaving only the eye of the needle protruding from the peritoneum. The suture is put through a small portion of the peritoneum below the level of the needle eye, and the knot tied over a glass bead to prevent cutting through the thin peritoneal tissue.

The needles are placed at a distance of 1 to 1½ cm. from each other, starting at one sacro-iliac synchondrosis and ending at the corresponding joint of the opposite side. In addition four, or possibly more, needles are placed in front of the broad ligaments in the hope of eradicating the disease from the obturator glands. The ends of the ligatures are tied together and pushed down into the pouch of Douglas. The abdomen is sewn up completely and the radium left *in situ* for seven days. At the end of this time the abdomen is again opened and the radium removed.

An objection to this technique is the second laparotomy at the end of a week, but up to the present it has been felt that in order to keep them in position the needles should be sutured to the peritoneum, which makes it impossible to pull them out. In addition to this they are often placed at an angle to the line of traction, and damage might be done if pulled out blindly. Dodd of the Westminster Hospital has modified this technique by using radium needles in catheters placed retro-peritoneally so that they can be withdrawn through stab incisions. In addition he combines this with excision of the glands.

Immediate Results.

The first case chosen in this series was a patient (second degree) in whom it was considered there was a reasonable chance of the treatment being of some value, and the operation took place in October, 1927. Three or four months were allowed to elapse in order to see if there were any untoward symptoms before attempting the technique again. At the end of this time the patient was found to be extremely fit. During the year 1928 twelve other cases were treated in a similar manner. Of these, three were diagnosed as being first degree, two were of the second degree, two of the third degree, and five were of the fourth degree.

Of the first degree patients there is little to be said except that on opening the abdomen one of these was found to have enlarged obturator glands. The operation was done in September, 1928, but in December a letter stated that she did not feel very fit, and she died in February, 1929. Another, operated on in June, is very

well at the present time. The third, operated on in July, 1928, has vague pains, but appears to be doing well. The two patients diagnosed as second degree are both doing well.

Of the third degree patients one, operated on in March, has died recently. This patient is of particular interest because when she had her vaginal application it was noticed that there was a swelling in the region of the right kidney. At the intra-abdominal operation it was found that this swelling was due to a hydronephrosis, which seemed to be caused by the pressure of the growth round the ureter. In spite of this the patient wrote in December, saying, "There is no doubt my health generally is greatly improved. I feed regularly and have regained much of my lost weight."

Of the fourth degree patients one had a slight degree of intestinal obstruction and masses of glands were found in the pelvis; a colostomy was performed and radium was inserted. She has since died, and there is no evidence that the radium improved her condition.

Another late case was admitted in April, 1929. The patient was so anaemic that a blood transfusion was carried out before putting the radium in per vaginam. She had an ulcer of the cervix two inches in diameter, involving the fornices. Two months later the vagina had completely healed and an intra-abdominal operation was carried out. Glands were found near the aorta, which felt hard and were probably malignant. In December there was marked induration in front of the rectum, but the patient was extremely fit considering her original condition. In another very advanced case the patient was treated in May and was found to have pus in Douglas's

pouch. Radium, however, was inserted, and there is little doubt that this was an error of judgement, as, in spite of drainage, the patient got general peritonitis and died as a result of the operation.

The next patient in this series was operated on in September and found to have large masses of glands, some the size of a walnut. It was realized that it was not possible to effect a cure, but it was thought that if those near the uterus were diminished in size it might reduce the amount of pain at a later date. The needles were therefore concentrated on those glands. In December the mass of glands did not seem to be diminished and the patient was obviously not so well.

The last of the fourth degree patients was treated in December. Considerable adhesions were found in the pelvis but no markedly enlarged glands. There was, however, much induration in both the broad ligaments. Following the removal of the radium there was a certain amount of wound infection, but this cleared up and the patient left hospital in fair condition.

It will be seen, therefore, that of the 13 cases 9 are living, but it is too early to say much about their condition.

Conclusions.

Since it has been proved beyond doubt that radium will entirely eradicate carcinoma in the cervix and vagina it is logical to try and extend the influence of the radium to the growing edge of the tumour by means of intra-abdominal radium. The cases so far treated show that this method is not attended by any undue risk to the patient, and the small series treated in 1923-24 show sufficiently good results to justify us in investigating further this line of treatment.

RADIUM TELETHERAPY: EXPERIENCE WITH A TEMPORARY "BOMB."

BY

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Few medical men are unaware of the excellent results of radium treatment of primary growths and accessible glandular metastases by needles and seeds, but only those constantly employing these methods are fully awake to their limitations. If local and accessible manifestations can be successfully treated with gamma rays, so also should the inaccessible lesions; and therefore until the difficulties of producing α -radiation of a sufficiently high frequency have been overcome radium teletherapy must be provided.

It is well to follow the line of thought that has led to the technicalities of teletherapy. Whatever be the view taken as to the mode of action of gamma rays on normal or cancer cells, the treatment is substantially the same. An attempt is made to dose the cancer adequately without overdosing the patient, and to this end the cancer is irradiated more intensely than the rest of the body whenever possible. The dosage, measured as it is in milligram hours or millicuries destroyed, is a measure of available energy of which as a rule only a small proportion is absorbed by the cancer, and a larger by the surrounding tissues. The cancer itself can be adequately dosed by widely varying values of intensity and time, but the patient stands the best chance of recovery only when those values are suitably chosen. The usual method of placing needles or seeds interstitially provides economically a more intense irradiation in the growth than in the surrounding tissues; it is also possible in a large measure thus to provide the optimum intensities, but it has been found that local applications are by no means always sufficient, and in practice an attempt is made to irradiate more generally from over the lesion by the so-called "surface application." This system, employing radium at a short distance from the skin, usually about 15 millimetres, is elementary teletherapy. Surface application is usefully employed only when the lesion is close to the skin. To extend the system to the treatment of deeper manifestations Sluys of Brussels uses radium similarly at a distance of 5 cm. from the skin, and in teletherapy proper the radium is employed at distances as great as 16 cm.

This has given rise to the belief that gamma rays penetrate to a greater depth when the source is farther from the surface. It is of course quite erroneous; but greater distance does enable us to irradiate usefully to a greater depth, for the reason that the necessary intensities can then be maintained without producing destructively high skin and upper-layer intensities.

The intensity of irradiation is reduced in proportion to the square of the distance from the source, and also by absorption in the tissues. Evidently, then, the intensity near a needle is very much greater than it is at a distance. For this reason, while the intensity between two needles may be insufficient for the desired reaction, radium necrosis may yet be produced close around them, even when all but a minute percentage of beta particles are excluded. An average of the effective minimum intensities employed with needles is approximately that intensity which is produced at the surface of a sphere of 1 cm. diameter when 1 mg. of radium is placed at its centre. This intensity is here called the "standard needle intensity." It is likely that where, as in teletherapy, the practical difficulties of placing the needles accurately enough to maintain this value are entirely eliminated, then half this intensity produces the same reactions; and experience shows that this intensity must be available at the greatest depths.

A concrete example will serve to compare the four radium arrangements mentioned.

The lesion is supposed to be two inches in diameter and three inches in length, the longitudinal axis being at a depth of 10 cm. To maintain the standard needle intensity with the usual needle technique from 30 to 40 mg. are required. Using surface application to produce half this intensity, 600 mg. would be required; with the radium at 5 cm. from the skin some 1,000 mg.; and if skin-radium distance is increased to 16 cm. the amount would have to be more than 2,600 mg. to maintain that intensity. The economy of the interstitial method is obvious.

The relation between the intensity at a depth and that at the skin is known as the "relative depth intensity." This value for the above lesion, employing needles, is from 24 to 32; employing surface application 1/170; radium at 5 cm. 1/16; and radium at 6 cm. 1/5.6. It is assumed that in the three latter methods only a single point source is employed in each case. It is impossible with them to irradiate the lesion more intensely than the surrounding tissues; indeed, the reverse is the case, but it has been