THE PRETORIA METHOD IN RADIOTHERAPY OF CANCER OF THE CERVIX UTERI*

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Radiotherapy of cancer of the cervix uteri by the intracavitary application of radium is so standardized in the Stockholm, Paris, and Manchester methods, and the results obtained are so good that it may appear presumptuous on my part to suggest any modification of these established techniques.

We have found, however, that infiltrating cancer of the cervix uteri presents either as a fungating mass or as an ulcerated cavity, and that the Stockholm, Paris, or Manchester applicators do not conform to these deformed anatomical features. In fact, these applicators do not fit as accurately as they should.

With due regard to the vast recorded experience of the past half century in radiotherapy of cancer of the cervix uteri, we have devised special rubber applicators of a toadstool shape that can be so manipulated that, when upside-down, they will closely cup a fungating mass and, when everted, fit snugly into an ulcerated cavity.

During the past 30 months we have treated a total of 124 patients with cancer of the cervix uteri (74 non-European and 50 European) with these applicators.

I shall now endeavour to give a short review of the literature, our own efforts at devising suitable applicators, and our experience in their use. In these efforts I am much indebted to Mr. D. J. Savage, chief medical physicist, and Dr. C. R. Jansen, clinical assistant, for their assistance and ingenuity in devising these applicators.

REVIEW OF THE LITERATURE

Roentgen discovered X-rays in December 1895, and the Curies, radium in December 1898, but it is uncertain when roentgen and radium rays were first used in the treatment of cancer of the cervix uteri, except for the fact that intracavitary roentgen therapy preceded that of intracavitary radium therapy by a few years. At the turn of the century Wertheim's radical hysterectomy for cancer of the cervix uteri reigned supreme.

O'Brien[1] in his Janeway lecture gives a masterly review of the literature and names Dr. Margaret Cleaves of New York as the first to use intracavitary radium. On 15 September 1903 she treated an inoperable cancer of the cervix uteri with 700 milligrams of radium bromide sealed in a glass tube which she had on loan from the Department of Chemistry of the University of North Carolina. Two applications of 10 minutes each were made with an interval of 3 days between the applications. In this way the 2-application method was born that has become customary throughout the world. The radium was placed in the water jacket of a vaginal roentgen tube which was closed at its distal end. The applicator was introduced into the vagina and held up against the posterior surface of the fungating mass for 5 minutes, and up against the anterior surface for another 5 minutes. The procedure was repeated in 3 days' time. After the second application, and about 10 days after the first application, the congestion and the vaginal bleeding ceased.

Morton (1903), as quoted by O'Brien, is credited with describing the first radium applicator. This applicator consisted of a celluloid test tube containing the radium capsule attached to a rod which passed through 2 corks. The corks rigidly supported the radium in the tube and closed the distal end of the tube.

Since these pioneering days an enormous literature records the progress of roentgen and radium rays in the treatment of cancer of the cervix uteri — a literature too vast to review here. Only some of the milestones will be listed.

There are 3 recognized methods of treating cancer of the uterine cervix with radiotherapy, universally known as (*i*) the Stockholm method, (*ii*) the Paris method, and (*iii*) the Manchester method. We are introducing a fourth method (*iv*) the Pretoria method.

The Stockholm Method

Gösta Forsell,[2] of Stockholm, who founded the Radiumhemmet in 1910, is rightly regarded as the father of intracavitary radium therapy for cancer of the cervix uteri. In 1914 he published his results on the first 40 cases treated with filtered radium (from 1910 to 1913). He applied 20 mg. of radium for 20 hours, often repeating the treatment 6 - 10 times at intervals of 2 - 4 weeks. By 1913 he was applying as much as 72 mg. of radium, filtered with 3 - 4 mm. of lead, for 22 hours and repeating it 2 or 3 times with intervals of 1 - 3 weeks. Since 1929 teleradium or deep X-ray therapy to the parametria has been added. This treatment follows 3 weeks after the last intracavitary radium application. This method is known as the Stockholm method.

With the help of James Heyman and later Hans Kottmeier, the Stockholm method has been perfected and has undergone little change in the past 30 years. The essential characteristic of the Stockholm method is that with a variety of intracavitary applicators, the treatment has been individualized so that the quantity of radium used and the overall treatment time for which it is applied has been varied to suit particular circumstances without deviating too far from the established pattern.

Heyman[3] writes: 'Further improvement in results cannot depend on our alteration of the routine method of brachyradium treatment. At the Radiumhemmet the Stockholm method is still used; it has been modified slightly since its adoption in 1914. Finally, there is no difference in the use of additional roentgen-ray and teleradium irradiation sufficiently pronounced to explain the improvement. There is, so far as I can see, only one acceptable interpretation: The improved results are due to superior judgement in handling the individual case, which in turn originates from increased experience.'

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This is an important point to remember. Many radiotherapists and gynaecologists who have visited the Radiumhemmet think that they can achieve the same results by applying the Stockholm method, but they forget that the vast experience of workers like Heyman and Kottmeier is not parcelled up with the applicators and the method.

Kottmeier[4] writes: 'In the typical case the radium treatment is divided into two applications, with an interval of three weeks, each treatment consisting of coincident intra-uterine and vaginal applications. The filter is equivalent to 3 mm. lead.

'Intra-uterine application. The length of the applicator and the amount of radium corresponds to the length of the uterine cavity. No radium is introduced in the lower 1·5 - 2 cm. of the cervix. The amount of radium element varies from 53 to 74 mg. in the typical applicators and is intended for giving equal dosage in gamma roentgens at a distance of 2·0 cm. from the centre of the applicator.

'The vaginal application. One flat or curved box, or two or three cylinders, are used in order to cover the vaginal tumour surface and to press the lateral fornices against the lateral pelvic wall. The radium tubes are usually placed in the lateral parts of the flat box. It is important that the vaginal applicator covers the posterior part of the growth. The applicators are held in position by a tampon, which also serves to increase the distance to the rectum. The vaginal applicators, which are made of lead or monel metal, contain radium element which varies from 60 to 80 mg. (Fig. 1).

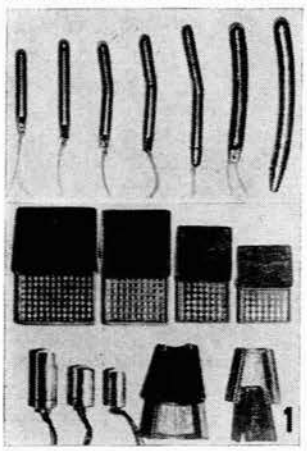


Fig. 1.

Above: Intra-uterine applicators — Radiumhemmet, Stockholm:

Length of intra-uterine applicator in cm.: 4·3, 5·2, 5·6, 6·2, 7·5, 7·4, 9·2.

Active length: 3·2, 4·4, 4·4, 5·0, 6·0, 5·0, 7·0.

Radium in mg.: 53, 62, 64, 66, 74, 250, 350.

Below: Vaginal radium applicators, Radiumhemmet, Stockholm. These can be loaded with 60 - 80 mg. of radium. (From Kottmeier 1953.)

'Irradiation time. For each of the two typical intracavitary radium treatments the irradiation time is 25 - 28 hours.

'The roentgen treatment is given through two anterior (10 x 15 cm.) and two corresponding posterior portals and is directed towards the lateral pelvic wall. In recent years the total dose has been increased. We give a maximum of 5 times 500r (skin r) to each field. Our working conditions are as follows: Thoraeus filter of 0·5 mm. copper; 170 kilovolts, 15 milli-amps; focus-skin-distance 50 - 70 cm.; halve-value layer of the radiation 0·8 cm. copper.'

According to Kottmeier, the average radium dose received at point A is less than 6,000r, at point B 1,900r, at the lateral pelvic wall 1,335r, and on the anterior wall of the rectum 3,675r.

The Paris Method

In Paris the Institute du Radium was started in 1914, but active work began only in 1918 under Claude Regaud. By then he had recruited a team consisting of Lacassagne, Coutard, Bergen, Monod, and by 1937, Baud. Regaud (1914) was the first to introduce a means of measuring radium dosage and to establish the Paris method of intracavitary radium treatment of cancer of the uterine cervix.

Lacassagne[5] writes: 'The progressive destruction of radon emination was proposed as a standard unit by Debierne and Regaud in 1914, and the dosage at the Curie Institute has always been recorded in "millicuries destroyed". This measuring is applicable to radium element as well as to radon. When radium element is used the quantities contained in each tube are so arranged as to deliver round numbers of millicuries destroyed per hour. Thus the tubes containing radium element most commonly used at the Curie Institute for treatment of cancer of the cervix uteri are put up as follows: Tubes containing 13·33 mg. radium destroy 100 microcuries per hour and 6·66 mg. 50 microcuries per hour (1 millicurie is equal to 1,000 microcuries). The Institute du Radium had by 1922 developed a technique of intracavitary radium treatment of cancer of the cervix uteri which has undergone little change since that date.'

Up to that time the unit of radium dosage was expressed either (*i*) in milligram hours, i.e. 1 milligram of radium applied for 1 hour was expressed as 1 milligram-hour, or (*ii*) in millicuries destroyed, i.e. 1 milligram of radium applied for 133·3 hours was equivalent to 1 millicurie destroyed or 1 m.c.d.

For example: 33·32 mg. of radium applied for 120 hours =4,000 mg./hrs. = 30 m.c.d.

In Regaud's Paris Method 2 applicators are used: (*i*) a uterine applicator containing 13·33 + 13·33 + 6·66 mg. tubes of radium loaded in tandem fashion, i.e. a total of 33·32 mg., and (*ii*) a vaginal colpostat and cork together containing 33·32 mg. of radium. These applicators are loaded to give a dose of 30 m.c.d. (4,000 mg./hrs.) in both the uterus and the vagina.

Lacassagne[5] writes: 'The vaginal radium tubes are about 2·0 cm. in length; usually three tubes are used; two of these contain 13·33 mg. of radium element each. The third tube usually contains 6·66 mg. of radium element. The platinum walls of each of these tubes are 1·5 mm. thick. The corks enclosing them have a 5-mm. wall. This serves as a secondary filter and remains a distance from the mucous membrane. The two 13·33 mg. tubes in their respective corks are mounted

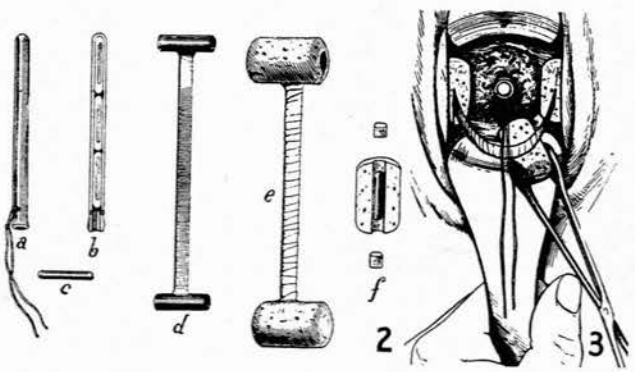


Fig. 2. Material for intracavitary radium therapy for cancer of the cervix uteri — Paris method: (*a*) Blind-end rubber catheter for 13·33 mg., 13·33 mg. and 6·66 mg. of radium in tandem from above down. (*b*) Radium tubes in place. (*c*) Radium tube. (*d*) Metal sheath of vaginal colpostat. (*e*) Vaginal colpostat. (*f*) Radium tube in cork cylinder of colpostat.

Fig. 3. Paris method. Intracavitary placement of colpostat, central cork, and intra-uterine applicator for radium therapy of cancer of the cervix uteri.

on a watch spring which has a tendency to push the corks towards the region of the parametria. This little arrangement is called a colpostat. The radium tubes and corks are placed vertically in the vagina so that only radiation from the ends of the tubes reaches the bladder and rectum. This is important as these two organs are rather sensitive. The third tube in its cork is inserted against the cervix parallel with the other tubes. The corks and uterine catheter are maintained in position with packing (Figs. 2 and 3) for 120 hours.

'Transcutaneous irradiation. As stated earlier, transcutaneous radiotherapy and intracavitary curietherapy are combined whenever the carcinoma is not strictly limited to the cervix. It is also used in carcinoma of the cervix (even in group I), when irradiation through the natural body passages cannot be carried out under satisfactory conditions.'

In terms of the r-unit, the radium dose received at point A would be about 6,700r, at point B about 2,000r, at the lateral pelvic wall about 1,450r, and on the anterior wall of the rectum about 4,400r.

The Manchester Method

With the establishment of the r-unit in 1937, the old empirical methods of dosage determination in terms of milligram-hours and millicuries destroyed were gradually replaced by the r-unit, especially by Paterson and Parker[6,7] of Manchester. The experience of more than 25 years of intracavitary radium therapy was made use of in determining the equivalent in the more scientific r-unit.

The r-unit immediately stressed the importance of radium filtration and the need for a defined point in the pelvis for dosage specification. Margaret Tod and Meredith[8] of Manchester introduced points A and B in the pelvis for dosage specification, and Tod[9] the optimum dosage.

The relation of milligram-hours to r-unit is modified by the amount of filtration used. Table I gives the relation:

TABLE I. RELATION OF MILLIGRAM/HOURS TO R-UNIT WITH REGARD TO THE FILTRATION USED

Radium filtered with:	*1 mg./hr. at 1·0 cm. distance*	*4,000 mg./hrs. at 1·0 cm. distance*	*4,000 mg./hrs. at 2·0 cm. distance. Point A*	*4,000 mg./hrs. at 5·0 cm. distance. Point B*
0·5 mm. Pt	8·4r	33,600r	8,400r	2,545r
1·0 mm. Pt	7·6r	30,400r	7,600r	2,300r
1·5 mm. Pt	6·7r	26,800r	6,700r	2,000r
2·0 mm. Pt	5·8r	23,200r	5,800r	1,430r

From all available data Paterson[6] considered the relative tolerance levels in terms of the r-unit for the organs and tissues of the pelvis on a basis of 8 days' continuous radium irradiation to be as follows:

Dose to wall of uterus	30,000r
Dose on vaginal mucosa (vault)	20,000 - 25,000r
Dose to recto-vaginal septum	6,000r
Dose to point A	8,000r

The Manchester method is a modified Paris method with important changes. Vaginal rubber ovoids replace the corks of the colpostat described by Regaud. The shape of the ovoid follows the distribution in 3 dimensions of the isodose curves round a radium tube of 1·5 cm. active length, the shape thus ensuring a homogeneous dose over the whole surface of the ovoid.

The introduction of two points A and B for dosage specification is an important feature of the method. These imaginary points are defined as being 2 cm. and 5 cm. lateral to the central canal of the uterus, and 2 cm. up from the mucous membrane of the lateral fornix in the axis of the uterus. In practice measurements are made on anteroposterior and lateral radiographs taken immediately after the radium is inserted. The lower end of the radium tube in the cervical canal is level with the lateral fornices as indicated by ovoid position. Point A can be found by measuring 2 cm. up from the lower end of the last intrauterine tube and 2 cm. laterally in the plane of the uterus. Point B is 3 cm. lateral to point A at the same level.

The intra-uterine applicators are made in 3 lengths: 6·0, 4·0, and 2·0 cm., and the ovoids in 3 sizes: 2, 2·5 and 3 cm. in diameter. A special feature of the method is that any combination of uterine and vaginal applicators can be used without changing the dose at point A. Washers or spacers hold the ovoids apart in the vaginal fornices. The object is to keep the ovoids forced laterally towards the parametria to irradiate any malignant spread to these parts. The ovoids are placed vertically in the vagina so that the ends of the radium tubes point towards the bladder and rectum, thereby lessening irradiation in these directions. Instead of 5 days' or 120 hours' continuous radium irradiation, the radium (using a 6·66 mg. radium unit) is applied in 2 applications of 72 hours each with an interval of 4-7 days between the applications (Fig. 4).

After treating 4,000 patients in 15 years by the Manchester method using 6·66 mg. as their radium unit, Tod and Meredith[10] suggested in 1953 that a modification of this system should lead to even better results, and so they introduced a revised cervix dosage system in which they recommended that the unit of radium should be 2·5 mg. Table II shows the dose in 'r' received at points A and B in 24, 72, and 144 hours for this unit, correctly placed in ovoids and uterine tube.

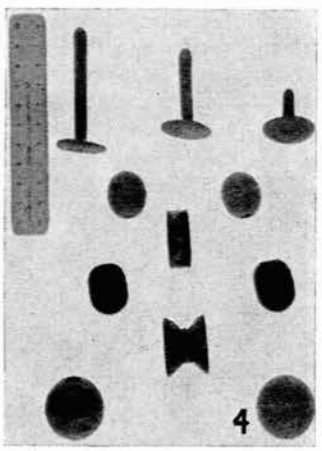


Fig. 4. Manchester method. Three lengths of intra-uterine rubber applicators (top row) with 3 sizes of paired vaginal rubber ovoids with spacer or washer for introduction between the ovoids.

TABLE II. DOSE RECEIVED IN R-UNITS AT POINTS A AND B (FILTRATION = 1·0 MM. PT.)

Unit of radium	*Dose at points:*	*Dose in r-unit in 24 hours*	*Dose in r-unit in 72 hours*	*Dose in r-unit in 144 hours*
2·5 mg. ..	A	1,366r	4,098r	8,196r
	B	414r	1,242r	2,484r

They write as follows: 'We believe that the dose delivered at point A should not be less than 7,000r and seldom more than 8,000r for an overall time of exposure from 10 to 17 days. It can be given either as an almost continuous treatment or as two or three discontinuous exposures. This dosage is near the limit of tolerance, but takes no undue risks'.

If the 2·5 mg. unit of radium is placed in the vaginal ovoids and uterine tubes in the following proportions, the

dose at point A is kept constant, irrespective of the size of the ovoids used (Table III).

TABLE III. PROPORTIONS IN WHICH RADIUM IS PLACED IN VAGINAL OVOIDS AND UTERINE TUBES

Ovoids	*Diameter*	*Units*	*Total radium*
Large	3 cm.	9	2·5×9=22·5 mg.
Medium	2·5 cm.	8	2·5×8=20·0 mg.
Small	2·0 cm.	7	2·5×7=17·5 mg.

Uterine tubes	*Diameter*	*Units*	*Total radium*
Long	6·0 cm.	6	2·5×6=15 mg.
		4	2·5×4=10 mg.
		4	2·5×4=10 mg.
Medium	4·0 cm.	6	2·5×6=15 mg.
		4	2·5×4=10 mg.
Short	2·0 cm.	8	2·5×8=20 mg.

At the Manchester Radium Institute the unit now normally employed is 2·5 mg. of radium which delivers a dose of 8,000r in 2 applications of 72 hours each with an interval of 4 days between the applications. This dosage of 8,000r to point A is administered when radium alone is used for treating cancer of the cervix uteri that has been classified as stage I or stage II. When radium is used in conjunction with deep X-ray therapy for treating stages III and IV, the radium dose at point A is reduced to 6,500r and a dose of 3,000r is added to the parametria by means of deep X-ray therapy administered in 24 exposures through 4 anterior and 4 posterior fields of 10 x 4 cm.[2]

THE PRETORIA METHOD

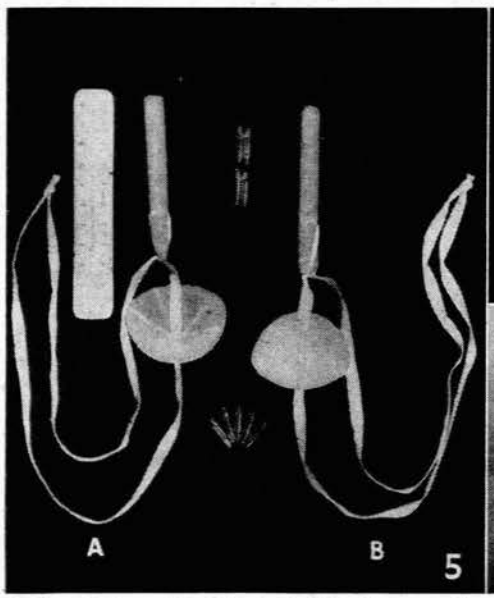
Our experience led us to believe that certain improvements could be brought about by modifying the best in the 3 methods of radium therapy just outlined.

In the first place we felt that the applicators did not conform to the deformed anatomical features caused by cancer of the cervix uteri. We had found that the large majority of patients presented with either a fungating mass or an ulcerated cavity. Therefore, any vaginal applicator should be so shaped that it could either cup a fungating mass, or fill an ulcerated cavity. Moreover, the vaginal and uterine applicators, once placed in position, should be firmly fixed together so that their positions relative to each other and to the parts to be irradiated remain constant throughout the period of continuous irradiation.

Secondly, we felt that it was most desirable to complete the radium treatment in 1 application only. The need for 2 or more applications with intervals of rest between the applications seemed to us an unnecessary complication. Repeated applications increased the hazards of exposure of the staff to ionizing radiations. Moreover, the reaction and spasm caused by the first intracavitary radium application invariably caused difficulty with the subsequent accurate insertion of the second intracavitary radium.

Thirdly, we felt that the radium dosage should be concentrated on the primary lesion, and the spread to the parametria should be controlled by teleroentgen or telecobalt therapy. We have therefore planned our treatment along these lines. We do not believe in forced packing to push the vaginal radium into the parametria. We believe this causes ischaemia of the parts compressed and therefore increases radioresistance of the very parts we wish to treat.

Fourthly, we believe in using only one size of intracavitary radium applicator, and if the uterus and vagina cannot accommodate this applicator, the case is not suitable for intracavitary radium therapy and should be



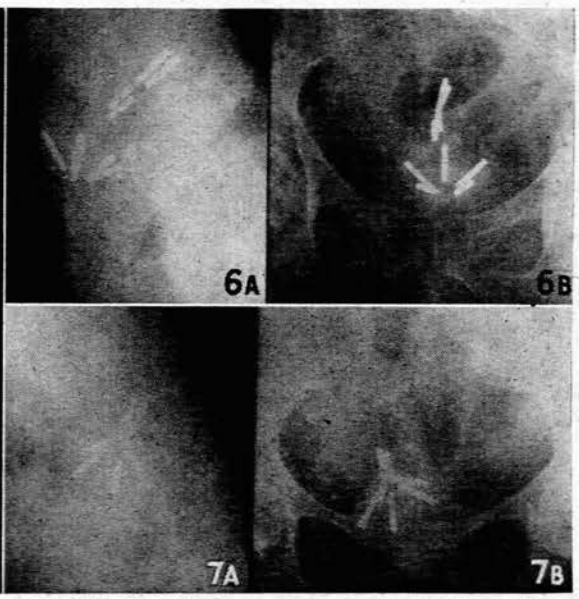


Fig. 5. Pretoria method. Rubber intra-uterine and vaginal applicators can be drawn together, either with the concavity upwards to cup a fungating mass (A), or with the convexity upwards to fill an ulcerated cavity (B), by the simple expedient of pulling the tape attached to the distal end of the uterine applicator through the central hole of the vaginal applicator until these two applicators are firmly fixed.

Fig. 6. Pretoria Method. Intra-uterine and vaginal applicators drawn together to cup a fungating mass. (A) Lateral view. (B) Antero-posterior view.

Fig. 7. Pretoria method. Intra-uterine and vaginal applicators drawn together to fill an ulcerated cavity. (A) Lateral view. (B) Antero-posterior view.

treated by transcutaneous irradiation alone. This we feel is a very important point that is not sufficiently appreciated. Intracavitary radium inserted into a narrow and inelastic vaginal passage is the most frequent cause of radiation injury to pelvic tissues and organs.

By a method of trial and error we eventually evolved our present vaginal and uterine rubber applicators. These are cast from polyvinyl chloride, and then baked in an oven as directed to retain a rubbery consistency.

The complete applicator, when fixed together, looks like a toadstool. Radium is loaded into the stem and this serves as the uterine applicator. It is 1·0 cm. in diameter and 7 cm. in length, of which 4 cm. is loaded with radium tubes, 20 mg. + 20 mg. radium in tandem fashion. The convex-concave head of the toadstool serves as the vaginal applicator. The head can be introduced into the vagina either with its convex surface upwards to fill an ulcerated cavity or with the concave surface upwards to cup a fungating mass. By means of a piece of tape attached to the uterine applicator, it can be firmly fixed to the vaginal applicator by drawing the distal end of the tape through a central hole in the applicator. The radium is loaded into the head in radial fashion like 5 spokes of an umbrella with their ends meeting on one side at the centre, while their other ends are spread out equidistant from one another and point to the circumference. Each spoke represents 10 mg. of radium. The radium is filtered by 1·0 mm. Pt (Figs. 5, 6 and 7); total radium: 90 mg.

Provided the case is suitable for intracavitary radium therapy, these applicators are very easy to introduce and to fix together. A minimum of packing is required. As the dose is calculated with due regard to the radiosensitivity of the mucosa of the rectum, there is no need for packing the rectum away from the applicator. The applicators are introduced under a general anaesthetic and only one application is needed. The radium is left in for 72 hours' continuous irradiation, and this gives a dose of about 6,000r at point A, and about 1,800r at point B. The mucosa on the anterior wall of the rectum receives about 6,000r. As malignant spread occurs almost as commonly to bladder and rectum as to the parametria, it is important that these parts should receive an adequate carcinoma-lethal dose which is 6,000r in 72 hours.

The course of intracavitary radium therapy is followed a week later by a course of teleroentgen or telecurie therapy for all 4 stages. The deep X-ray therapy factors are as follows: 250 kilovolts, 16 m.A., 50 cm. F.S.D., filter 2·0 mm. Cu and 1·0 mm. Al. H.V.L. = 1·5 mm. Cu and a tumour dose of 3,000 rad is given in 3 weeks through 8 fields 10 x 4 cm. each; 4 anterior and 4 posterior fields directed towards point B with the central area (irradiated by the intracavitary radium) protected with lead from further deep X-ray therapy.

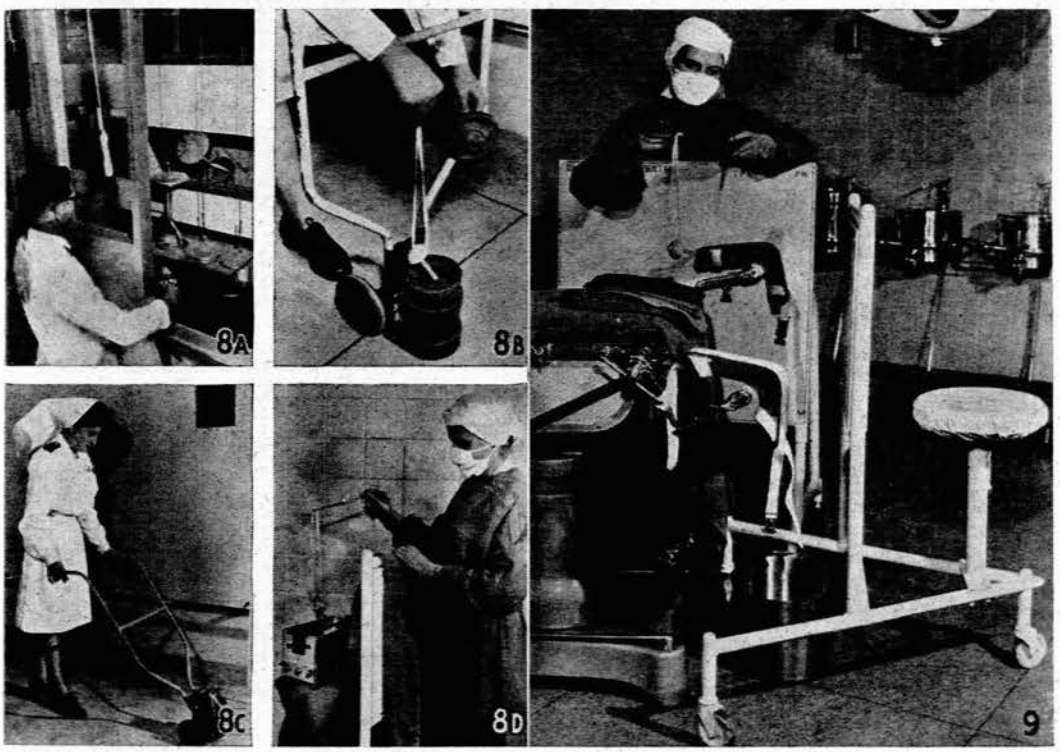


Fig. 8. (A) Radium store and loading bench. The radium applicator is being loaded with radium from the pit-holder. Note mirror at an angle to give a view of radium in pit-holder. (B) Loaded radium applicator being transferred to lead cylinder on radium push-cart. (C) The radium is being conveyed from radium room to operating theatre. (D) Radium applicator is being placed into sterilizer in corner of theatre, with 2-inch lead screen between radium and sister.

Fig. 9. Lead shields. One with stool for the doctor inserting the radium applicator, and one for the sister. The radium applicator is held in position to show that adequate protection is afforded by the 2-inch-thick lead screens.

RADIATION PROTECTION

Adequate protection of the staff handling the radium is an important essential in the application and management of radium therapy. This is a fact that has not been fully appreciated in the past and needs stressing now, so that every precaution will in the future be taken whenever mobile sources of ionizing radiation are used in the treatment of cancer of the cervix and corpus uteri.

In the Department of Radiotherapy at the Pretoria General Hospital we have a special radium room where the radium is stored, and where applicators are loaded. The photo-

graph of the radium room reveals the essential features (Fig. 8 A).

The bench consists of a solid block of concrete, with pits at the far wall-end into which the radium is sunk and stored. These pits are so constructed that when the applicators have been loaded for use they can be stored in these pits until required. Three lead barriers (between the operator and the radium sources) each 15 x 15 x 4 inches are suspended from the roof, and run on a rail so that they can be moved into any required position. The bench is divided into 2 parts. On the left the radium applicators returned after use, are received and dismantled, and the radium is cleaned and stored. On the right new applicators are loaded, sterilized, and stored ready for use. The applicators are re-sterilized in the operating theatre.

When the radium is required in the operating theatre, it is placed in the tubular lead container (with wall thickness equivalent to 2 inches of lead) of the radium push-cart, and conveyed to the operating theatre. The long handles of the push-cart and the low position of the lead container increases the distance between the person pushing the cart and the radium source. This distance ensures additional protection to the person conveying the radium from radium store to theatre (Fig. 8 B and C).

When the radium reaches the theatre it is immediately dropped into the sterilizer which is placed in a corner of the theatre behind a lead screen 2 inches thick (Fig. 8 D). There it is left until required for insertion. The theatre sister (who holds a diploma in radioprotection) assists the gynaecologist and radiotherapist in the application of the radium. She works behind a 2-inch-thick lead screen and similarly the doctor inserting the radium applicator also works behind a 2-inch-thick lead screen with suitable stool and wheels attached (Fig. 9).

When the radium has been inserted the patient is quickly conveyed to the ward where she receives nursing care in wards specially constructed to ensure adequate protection to the nursing staff. These wards consist of 2-bedded wardlets with the beds placed in the corners, so as to give increased distance between the centres of the 2 beds (the position of the radium in a patient undergoing therapy for cancer of the cervix).

An overcouch-table with lead protection on the sides is then wheeled into position; it serves as an absorber of gamma radiation and gives added protection to the nurses who have to attend the patient. Under the bed is a 2-inch-thick sheet of lead on wheels which is attached to the bed and which moves along with the bed, remaining constant in position for every new position the bed is pushed into. This absorbs any gamma radiation that might penetrate the floor and irradiate personnel in the ward below. If the ward is on the ground floor with nothing below, such protection is not necessary. Our ward is on the top-floor and, therefore, such undercouch protection is necessary, but then we need no roof protection because there is nothing overhead. See photographs of the bed with protection in position (Fig. 10).

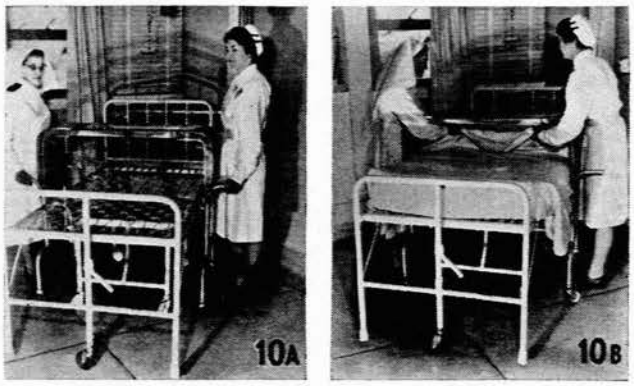


Fig. 10. (A) Over-couch table on wheels with 2-inch lead protection, and under-couch sheet of lead 2 inches thick on wheels and fixed in position to the bed. (B) Demonstration of how the bed is made up behind the protection afforded by the over-couch table.

TABLE IV. PATIENTS TREATED FROM JANUARY 1959 TO JUNE 1961—30 MONTHS *

Stage	*Race*	*Number*	*Fungating mass*	*Ulcerated cavity*	*Symptom-free*	*Residual Ca.*	*Alive*	*Dead*
I	European	18	16	2	14	4	18	—
	Bantu	6	5	1	6	0	6	—
II	European	25	18	7	19	6	25	—
	Bantu	30	17	13	26	4	29	1
III	European	5	3	2	4	1	5	—
	Bantu	31	14	17	13	18	27	4
IV	European	2	0	2	0	2	0	2
	Bantu	7	5	2	0	7	4	3
Total	European	50	37	13	37	13	48	2
	Bantu	74	41	33	45	29	66	8
Grand Total	Together	124	78	46	82	42	114	10

* 124 Patients with cancer of the cervix uteri treated by radiotherapy: Pretoria method. (50 European and 74 non-European.)

When the radium applicator is removed from the patient, either in the operating theatre or in the ward, it is immediately placed in the tubular container of the radium push-cart and conveyed to the radium store, where it is received, taken out of the container, the applicator dismantled, and the radium cleaned and stored.

ANALYSIS OF OUR CASES

During the past 30 months from January 1959 to June 1961, we have seen a combined total of 235 European and non-European patients with cancer of the cervix uteri in the Department of Radiotherapy. Out of this total, 124 patients (50 European and 74 non-European) were treated by the Pretoria method.

All our patients are seen in consultation with the gynaecologists and a treatment schedule is planned before treatment is commenced. We are much indebted to Prof. F. G. Geldenhuys, Head of the Department of Gynaecology and Obstetrics at the Pretoria General Hospital and University, and his staff for their willing and keen cooperation in treating these 124 patients by the Pretoria method. All cases were proved histologically to be 'squamous-cell carcinoma' of the cervix.

Out of a total of 105 European patients, 50 were treated by the Pretoria method. These were not selected cases. It is too early to say whether they have fared better or worse in comparison with a similar group treated by other means. Their ages varied between 85 and 21, and all were married.

Out of a total of 130 non-European patients with cancer of the cervix uteri, 74 were treated by the Pretoria method. They were not selected cases. Their ages varied from 78 to 25, and all had had children.

An analysis of these cases revealed the following data (Table IV):

Out of a combined total of 124 patients with cancer of the cervix uteri treated by the Pretoria method during the past 30 months, 82 are alive and symptom-free, 32 are alive with residual cancer, and 10 are dead with evidence of residual cancer at the time of death. Of these, 78 presented with a fungating mass, while 46 presented with an ulcerated cavity. The impression was gained that the fungating mass responded better than the ulcerated cavity. All these patients were treated with combined therapy — intracavitary radium followed by deep X-ray therapy to the parametria. The reactions on the mucous surfaces were about the same as seen with the Manchester method, where combined therapy is used. The reactions are well within tolerance limits, and, if anything, they are less severe compared with the other 3 methods. In future one may consider increasing the radium dose by another 500r to point A if the 5-year survival results should so dictate.

At present we feel confident that the method has stood the test of trial, and our experience so far gained is most encouraging and leads us to believe that the Pretoria method is a good contender for pride of place in treating cancer of the cervix uteri by radiotherapy.

SUMMARY

The Pretoria method in radiotherapy of cancer of the cervix uteri is a modification of the best of the 3 older methods of treatment, namely, the Stockholm, Paris, and Manchester methods.

Since infiltrating cancer of the cervix uteri presents either as a fungating mass or as an ulcerated cavity, a rubber applicator for introduction into the uterus and the vagina is cast from polyvinyl chloride and baked in an oven. The combined applicator looks like a toadstool. The stem acts as the uterine applicator, while the concave-convex dome can be inserted either with its concave surface upwards to cup a fungating mass, or with its convex surface upwards to fill an ulcerated cavity. When in position, the uterine and vaginal parts of the applicator can be fixed together so that their positions remain constant relative to each other and to the tissues to be irradiated.

The applicator is loaded with radium so that 20 mg. + 20 mg. of radium are placed in tandem fashion in the uterine applicator, and 5 x 10 mg. of radium are placed like the spokes of an umbrella in the concave-convex dome of the vaginal applicator, with their ends converging on the axis, and their other ends spreading out equidistant from one another at the circumference.

Only one intracavitary radium application (under a general anaesthetic) is made, and the applicators are left in for 72 hours to give a predetermined dose of 6,000r at point A, and 1,800r at point B. About 6,000r reaches the mucous surface of the anterior wall of the rectum behind, and the posterior wall of the bladder in front. As malignant spread not only occurs into the parametria, but also reaches the bladder and rectum, we felt that these organs should also be irradiated to the limit that the normal cells in these areas will tolerate. We do not pack the rectum away from the applicator. We introduce only one size vaginal applicator, and if this does not fit, the case is unsuitable for intracavitary radium therapy. We believe that the introduction of smaller applicators into a narrow inelastic vaginal cavity is the cause of irradiation injury to surrounding parts.

The intracavitary radium is followed by transcutaneous conventional deep X-ray therapy or telecobalt therapy to a tumour dose in 3 weeks of 3,000r with the former and 4,000r with the latter to point B in the parametria. This form of transcutaneous therapy follows a week after the radium therapy. The whole course (radium + transcutaneous therapy) is generally completed in 5 - 6 weeks.

During the past 30 months we have treated a total of 124 patients with cancer of the cervix uteri (74 Bantu and 50 Europeans) with the Pretoria method. It is too early to assess the final results, but we have been encouraged by the response so far. Those still living with residual cancer, and those who died with residual cancer still present, form 34% of the total. This is less than the usual percentage of unresponsive cases found in any series of cancer cases involving the cervix uteri treated by any modern method.

The Pretoria method in the treatment of cancer of the cervix uteri by radiotherapy offers a simple, single-application-method of intracavitary radium followed by conventional deep X-ray therapy or telecobalt therapy.

Stress is laid on the importance of adequate protection against gamma radiation for the staff handling mobile sources of ionizing radiations, especially radium, and

photographs are submitted of the manner in which such protection has been brought about in the Department of Radiotherapy at the Pretoria General Hospital.

My thanks are due to Dr. E. L. Jacobs, senior radiotherapist, and to Drs. A. G. Sandison and J. V. van Zyl, clinical assistants in the Department of Radiotherapy, for their keen interest and help in treating these patients by means of the Pretoria method; and also to Mr. Theo Marais, chief clinical photographer, for the photographs. In particular I wish to thank Dr. P. N. Swanepoel, Superintendent of the Pretoria General Hospital, for his continued interest and assistance in the radiation protection that has been brought about in the areas where mobile sources of ionizing radiations have to be handled by the staff, and for his permission to publish these results.

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