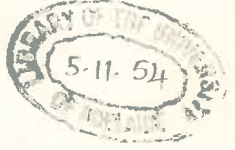




AN EXAMINATION OF CERTAIN CANCERS OF THE MOUTH
AND SOME ADJACENT STRUCTURES, WITH REGARD TO
THEIR TREATMENT BY RADIOTHERAPEUTIC MEANS, IN-
CLUDING THE USE OF MASSRADIUM AND RADIUM BEAM
THERAPY.



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AN EXAMINATION OF CERTAIN CANCERS OF THE MOUTH AND SOME ADJACENT STRUCTURES, WITH REGARD TO THEIR TREATMENT BY RADIOTHERAPEUTIC MEANS, INCLUDING THE USE OF MASS RADIUM AND RADIUM BEAM THERAPY.

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Scope of the Thesis

This thesis treats of certain cancers of the mouth and some adjacent structures and their treatment by means of radiotherapy. It is intended as a critical commentary on the work of that nature performed at the Radiotherapy Clinic of the Royal Adelaide Hospital during the years 1939 to 1943.

These years are chosen partly because I then found myself, to some extent through accident of war, in charge of the major portion of the work of this clinic. With the departure of several radiologists my scope was enlarged from that of Honorary Associate Radium Therapist to include most of the radium work, all the deep and superficial X ray, and even some radiodiagnosis. They were years of stress and difficulty, and no doubt performance and results fell short of the desirable optimum for such a clinic.

This is, in my view, all the more reason for examination and criticism of the work carried out.

The Mouth

The investigation began chiefly in connection with cases of cancer of the tongue, and on account of the difficulty of separating such lesions from those of the floor of the mouth, the tonsils and other nearby structures, was extended to include most of the carcinomata of the buccal

The Larynx

cavity. The larynx was then added, partly because epilar-
ryngeal growths impinge so closely upon the areas already under consideration, and also because such a site figures to no small extent as one suitable for radium beam therapy,

which type of treatment is discussed at some length.

A sense of dissatisfaction with our results of treatment of this region was also a reason that influenced me to include it.

Another point of interest is that much the same group of people are affected by cancer of the buccal cavity and cancer of the larynx, suggesting that much the same factors are operating to produce such disease.

Mass radi- ation

Beside the main subject of the survey, certain other cases are presented as having a bearing on the matters under consideration. In particular, there is an account of treatment by mass radium such has been attempted at this clinic, and references are made to such work elsewhere. Although most of the material deals with treatment by radium a proportion of the cases have been treated by roentgen-therapy.

Difficulties

It must be remembered that in Australia no vast masses of radium are available for the purpose of intensive treatment, nor are there the extensive physical aids that are to be found in the older and more established countries.

The total radium in use in Australia, both public and private, would probably be less than is contained in three of the beam therapy units in Britain, while the comprehensive and effective organization is also on a reduced scale.

This is not to say that no good work has been done in this country. On the contrary, much good work has been done, but the difficulties are greater, in that facilities for consultation with other radiotherapeutic clinics are negligible, except for annual conferences which have been discontinued since the beginning of war.

In England, Europe and America, one has easy access to established clinics, libraries and eminent physicists. Here, although an excellent physical service is in existence with a number of able men, it cannot yet hope to compete with some of the other side of the world. I doubt,

moreover, whether there is a well equipped radiotherapeutic library in the whole of the country.

It is not with any sense of satisfaction that cancers in these regions have been chosen for study. Even in the more famous clinics in the older countries the survival rates are not such as to produce any undue elation. Rather it is with the idea of compiling data, checking faults, and finding causes for failure that this examination has been undertaken. If some figures are relatively satisfactory so much the better. There are undoubtedly other figures that are not.

Treatment of cancer in these sites has always been difficult, and before the advent of radiotherapy was limited to surgery. Under these conditions many cases could not be treated at all, and when treatment was possible the operation was apt to be severely mutilating. In some cases surgical interference was disastrous. Radiation at least provided another possible mode of treatment.

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History of Radiotherapy.

Discovery.

The history of treatment by radiotherapeutic means does not cover a long period in time, as it was in 1895 that Roentgen discovered X rays, while a year later Becquerel announced his discovery of radioactivity. In 1899 the first radiation cure of a malignant growth, an epithelioma of the cheek, was achieved in Sweden by means of X rays.

Meanwhile many eminent people, notably the Curies and Rutherford, were working at the problem of radioactivity, and it was not long before the Curies produced purified radium.

The biological action of the newly discovered element

was accidentally brought to light when Becquerel attended a congress in London in 1901 carrying in his waistcoat pocket a tube of radium prepared by the Curies. I have not been able to discover an authoritative account of the reaction produced, but it was evidently sufficient to draw attention to the response of living tissue to the proximity of the element. The affair was no doubt regarded as a mischance at the time, and much remained to be done before radium became the valuable therapeutic agent it now is.

Application
to thera-
peutic pur-
poses.

In 1902 Danlos began clinical experiments with radium at the St. Louis Hospital, Paris, and in 1904 published his first results. Two years later the first radium centre was established in Paris, and subsequently, largely owing to the efforts of Bergonié, numerous such centres were established throughout France.

Advances.

It was not until 1907, however, when Dominici (1) published his classical work on the utilization of gamma rays in therapy that treatment on modern lines began. Dominici insisted on the necessity of filtering off the alpha and beta rays and, indeed, all but the harder gamma rays by the use of heavy screens, and stated that this method reduced damage to healthy tissues to a minimum while retaining the desired effect on the neoplastic tissue.

Later still, when radon or radium emanation began to be used for therapeutic purposes, the battle of adequate screenage had to be fought all over again, and even now in some circles there is a tendency to use lightly filtered radon for some particular purpose. Perhaps on occasion this may be able to be justified, but as an almost invariable rule when treating cancer it is desirable to filter off all but gamma rays, which cannot be done with a filter of less than 0.6 mm. of platinum or its equivalent. In the better clinics such filtrations as 0.8 or 1.0 mm. platinum are more commonly used.

Even after Dominici's publication, much of the work remained unsatisfactory and the results poor. Problems of distribution and placement of radiating sources had yet to be worked out, and estimation of dosage was inadequate, not being on a sound physical basis. Practically all the dosage calculations depended on the energy emitted at the source and not on that reaching the tissues. There was an early attempt in Belgium to calculate dosage in ergs per second, but I was informed by a London physicist that the error was apt to be as great as 300 per cent.

Early Clinics. In spite of this, such clinics as the Radium Institute of Paris under Regaud, and Radiumhemmet at Stockholm under Forssell and later Berven, with careful clinical observation had worked out an empirical dosage based on factors such as area, distance, filtration, time and summation of energy emitted. With this they were producing some amazingly good results. Centres were also functioning in Belgium, America and England, notably at Manchester, St. Bartholomew's Hospital, London, the Middlesex Hospital, London, and the London Radium Institute. This last came into being as the result of the successful treatment with radium of King Edward VII for a rodent ulcer. The Middlesex Hospital was also early in the field. As the cancer wards at this hospital were in charge of John Mayo, a member of a collateral branch of the family, from 1798 to 1817 I have a special interest in the work of this institution.

Special journals dealing with radiology, but also including radiotherapy, had begun to be published and much valuable knowledge began to accumulate.

Finzi, at St. Bartholomew's Hospital was one of the first after Dominici to suggest the use of interstitial

radium. Research began at this hospital in 1913 and included in the team were Harmer, whose work I shall have occasion to quote, Canti, whose striking films of tissue culture and the radiation effects upon such cultures will not easily be forgotten, Hopwood the physicist, and Levitt who carried out all the X ray treatments.

The first radium at the Middlesex Hospital was presented by a Mr. Gifford, a wealthy Somerset manufacturer with scientific interests and pursuits. Unfortunately for him he stated he was presenting 50 mg. of radium, believing this to be the quantity he had purchased. On examination, however, the amount was found to fall considerably short of this, and his widow informed me that it cost him £500 to bring the total to that stated.

At this hospital radium was being employed for inoperable malignant disease as far back as 1912 (2). The large quantity short time technique was adopted and both interstitial and surface methods were tried. In 1913 many cases received treatment, such cases including inoperable carcinomata of the uterine cervix, recurrences after breast operations, inoperable growths of the rectum, nose, lower jaw and ear, and also sarcomata. The tubes employed contained large quantities such as 90, 82, 40 and 22 mg. of radium bromide. It is not specified whether the weights refer to the element or the salt, but from other information I think it is probably the latter.

Some good results were obtained. In 1913 Comyns Berkeley treated a carcinoma of the cervix which had been transferred from another large hospital as unsuitable for any form of treatment. Sixty two milligrammes of radium bromide were inserted into the cervical canal, and eighty two milligrammes into the growth itself. This was left for twenty four hours. The treatment was repeated twice in the next five weeks. Four months later the patient was

in excellent health, the uterus was mobile, and no growth could be palpated. Ten years later she wrote to say she had had no further trouble.

In the same year Sir Alfred Pearce Gould treated a sarcoma of the lower end of the femur in a girl of sixteen. A section was taken and the growth described as a mixed cell sarcoma. Interstitial radium was employed, again using heavy tubes for a short time. Two further treatments were given and the limb was subsequently amputated. On examination, it showed no trace of disease. The patient was alive and well seventeen years later. It was at this hospital that Sampson Handley early began to use radium as an adjunct to surgery in the operation of radical mastectomy.

Here also was made, as far back as 1919, an early attempt at a mass radium unit or "bomb", using a simple container with two and a half grammes of radium. This was soon to be followed by the construction of larger and more complicated mass units elsewhere in the world. It was at this hospital that I worked happily for nearly two years, from 1931 to 1933, under B. W. Windeyer, a Sydney graduate, now Professor of Radiotherapy at the University of London.

Renascence of radiotherapy In 1928, after the recovery of King George V from his serious illness, a large fund was collected from the nation as an expression of joy at the happy outcome. The public conscience had recently been stirred by the cancer death rate, and so much, if not all, of this money was handed to the National Radium Commission, newly formed, for the purpose of buying radium and establishing centres all over Britain. The British Empire Cancer Campaign also came into existence and has done much to help and to spread knowledge.

The action of the Federal Government In Australia, the Federal Government, seized of the importance of the new methods, invited Burrows from Manchester to visit the Commonwealth and advise as to the

establishment of clinics and the purchase of radium. Ten grammes of radium were obtained and this has since been distributed to the various States for therapeutic use, for the production of radon, and for scientific investigation.

In Adelaide an Anti-cancer organization was formed in association with the University, and a Radium Clinic was established at first under the directorship of Dr. A. A. Lendon, and later of Dr. F. S. Hone.

It is not, however, intended to review the history of this organization so we will revert to developments of somewhat wider interest.

Physical
dosage unit

Measurement of X ray dosage had been established in terms of a unit called the international roentgen or "r", and about 1934 this was extended to include the gamma radiation of radium also. Although physically the measurements were similar, biologically this was found not to be the case.

Also work had been carried out, notably by Paterson and Parker, of Manchester, on spatial distribution of radium for treatment of different areas. This was not entirely new as some of the same ground had been covered by Regaud and Monod at the Radium Institute, Paris, but Paterson and Parker produced more formalized patterns and also graphs to work out dosage in terms of the new unit. Isodose curves were by no means new, but now they could be expressed in r. The work of Mayneord, the physicist, was very prominent throughout this period and still remains so.

Tumour
Grading

Meanwhile in another direction work had been proceeding with regard to grading of malignancy of tumours. This began with Hansemann (3) in 1893 who classified the cellular structure of tumours as ripe, unripe, or middle ripe. He also coined the term "anaplasia". About 1925 Broders brought out his grading of tumours, dividing them

into four groups, from the most benign to the most malign. Although the position of a tumour in these groups does not give full information as to prognosis and treatment, it yet has a bearing on the radiotherapeutic response in many cases.

The limitations of Surgery I have previously mentioned that before the introduction of radiotherapy treatment of cancers of the mouth was practically limited to surgery, providing that the growth was operable and sufficiently accessible. A large number were neither, and certain cancers found particularly in the region of the tonsil, either lingual or palatine, gave disastrous results with surgery. These included the lympho-epithelial tumours first described by Schminke and subsequently by Regaud, and also those styled transitional cell carcinoma by Quick and Cutler (4). Both of these respond excellently to radiotherapy.

The operations, moreover, were often mutilating although they were on occasion successful. I have myself seen a patient who had had the major portion of his tongue, including all the free portion, removed sixteen years previously. He reported with what I regarded as a fresh primary lesion of the floor of the mouth. I have always remembered that his buccal opening was a small round O, suggesting that the tongue in its functioning affects the size and shape of this orifice.

In the case of the larynx also, the extirpation of this organ is disastrously mutilating and is only occasionally possible. Shortly before he died, Butlin (5) said "Not one of my cases is living; I doubt whether laryngectomy is of any value". Other unfavourable comments are quoted by Harmer in his 1931 Semon lecture. The two Chevalier Jacksons in their book "Cancer of the Larynx" published in 1939 (6) consider cases of intrinsic carcinoma of the larynx without perichondrial involvement or perichondritis and without lymphatic metastases suitable for

their narrow field operation of laryngectomy. Where there is involvement of the perichondrium, palpable lymphatic metastasis, or extrinsic cancer they state they feel that "all such cases are better treated by irradiation". And again they refer to the "growing opinion that it is better to depend on irradiation than operation to deal with metastatic glands, present or prospective". It is therefore heartening to read of recent work in which results are becoming better with the use of radiotherapy and with preservation of the organ.

An editorial in the British Medical Journal of this year, however, shows surgery in a much more favourable light. Reference will be made to this later.

Cancer of the Lip

Before passing to the main subject matter of this thesis, I wish to refer briefly to cancer of the lip. This condition, provided that it does not involve bone or glands, is so successfully treated by radiation that I have not considered it necessary to present a detailed account of it. In my private practice in twelve years I have had no case that failed to resolve, whether treated by radium mould, interstitial radium, deep X ray or superficial X ray. Nor do I know of any case that recurred in spite of the fact that some lesions were quite extensive. At the Radiotherapy Clinic a few of the worst cases have been treated unsuccessfully either on account of the extent of the primary growth, or because of the unusually rapid involvement of glands. The majority have done very well. There is, however, one point that I wish to make. Occasionally one finds metastatic glands that have become very rapidly fixed to the mandible. I reviewed just such a case a few weeks ago. Three years ago I noticed glands fixed to the mandible in this patient and I referred him to a surgeon suggesting the removal of the glands with resection of part of the mandible. After several requests, the surgeon grudgingly consented to do the operation as a

"palliative procedure".

Certainly only three years have elapsed, but the patient shows no sign of recurrence and appears to be well and is comfortable. I think there is a chance that the disease may not recur, while at the worst he has had three years freedom from symptoms. I saw this operation successfully employed at the Middlesex Hospital in cases where there was a small mass of fixed glands and have since felt it to be well worth trying in similar cases.

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Cancer of the Larynx

When we come to examine the cases of carcinoma of the larynx treated at the Royal Adelaide Hospital in the years 1939 to 1943 the results are far from cheering. The cases, with two exceptions, were treated chiefly by deep X ray therapy. One of the exceptions was subjected to a total laryngectomy in 1940, and subsequently had deep X ray administered to the glandular areas and the laryngeal site. He remained well when last seen over four years later, but found the use of an artificial larynx somewhat alarming to some people and to children and so did not use it continuously. The results in the remaining cases were very poor. The first half of 1944 has been included not in a vain attempt to improve the figures but simply because it is hoped that with better planning of treatment results may be improving.

Coutard.

According to Coutard, (7) in twelve years he had only three years yielding good results. He considered that this was due to a large number of undifferentiated carcinomata in those good years. His general average of five years survival free from disease was 27 per cent. The best years were 50, 52 and 66 per cent respectively.

On the other hand he had seven years in which his survival rate varied between eight and twenty per cent, while in one year not a single patient survived. That year, admittedly, was a long time ago but we can, alas, only too easily equal such a performance.

When I was working at the Middlesex Hospital there was a tendency to treat these lesions with mass radium, at first in the form of large moulds at a considerable distance, such as 5.5 centimetres, and later with telecurietherapy when a radium beam unit, or so-called "bomb", was installed. Statistics of the cases so treated are not available, but early results were promising.

The work of
Lederman and
Mayneord.

However, Lederman and Mayneord, (8) writing in the British Journal of Radiology, October 1943, give the results of 15 cases of intrinsic carcinoma of the larynx treated with a five gramme unit. In nine cases the disease was eradicated. Seven were alive and well five years after treatment; one was lost sight of two years after treatment; being free from disease when last seen, and one died of intercurrent disease one year after treatment. These results are amazingly good and are a strong argument in favour of such a mode of treatment.

With these facts in mind, and in the absence of a radium unit of any sort, in December 1943 a woman with carcinoma of the larynx was treated with large radium moulds at the Clinic in an endeavour to emulate such results. Details will be given later.

Report on
Beam Therapy

In the Report on Radium Beam Therapy Research (9) issued in 1938 under the authority of the Medical Research Council, an account is given of twenty four cases of carcinoma of the larynx treated with a five gramme unit. Of these cases eight were classed as operable and sixteen as inoperable. Of the eight operable cases, six were symptom free as was one case from the inoperable group.

One case in the operable group died of intercurrent disease with no sign of cancer; the remaining cases died of cancer. Thus seven out of eight operable cases were apparently freed from the disease in question.

Fenestration

Mention must also be made of the Finzi-Harmer technique, the fenestration method developed from that employed by Ledoux and Hautant, and subsequently modified by Cade. In this procedure the thyroid cartilage is removed usually with part of the cricoid ring and the greater cornu of the hyoid bone. The internal perichondrium of the larynx is left intact, and radium needles are placed in position against it without opening the laryngeal cavity. The needles are removed after the desired dosage is achieved.

In his 1931 Semon lecture, (10) Harmer gives the results of 351 collected cases which he says were "mostly treated by fenestration". Of these 99 were alive and free from disease, fifteen for more than five years, while seventeen were alive with disease. His own cases numbered 47 at that time and 14 were alive and free from disease and four alive with disease.

I have no knowledge of such a technique having been tried in Adelaide, and I have no personal experience of it. Cutler (11) dismisses it rather summarily as being suitable only for anterior lesions, which, he says, are just as well treated by external radiation.

Concentrated radiotherapy

In a recent article (12) the last mentioned authority gives preliminary results of treatment by concentrated radiotherapy, using either deep X ray at 400 or 200 kilovolts, or alternatively a radium beam therapy unit. His results are promising and give added hope for the future. Both Cutler and Harmer suggest the use of radiation without prejudice to subsequent laryngectomy. Should it be decided not to remove the larynx, further radiation can be given, provided that the technique is planned with

such an end in view. Cutler calls for an alteration of the surgical attitude towards the treatment of some forms of intrinsic carcinoma of the larynx. He uses a radio-therapeutic test to ascertain the response of the lesion to irradiation, giving half the full course in six days and then waiting fifteen days to observe the result. If the response is considered adequate the remainder of the treatment is given by radiotherapy; if not, surgery is undertaken. His figures show 40 survivals out of 57 cases for a varying period of time up to five years. Three underwent subsequent laryngectomy and one case died of cardiac disease. It is not stated that the survivors are symptom free, but the presumption is that they are. However, the article is styled simply a "report of progress."

Cases at
the Clinic

Unfortunately the record of cases treated at the Radiotherapy Clinic of the Royal Adelaide Hospital gives no figures that can compare with any of those cited.

Twenty seven cases were treated between January 1st. 1939, and June 30th 1944. Of these, four are alive. One of these was treated by laryngectomy and subsequent deep X ray therapy in 1940. The remaining survivors were treated in 1943 and 1944.

Age dis-
tribution

The age distribution of the patients was as follows:

31-40	41-50	51-60	61-70	71-80
1	2	3	12	9

Of the twenty seven, two were female.

Incidence

Ignoring the two female cases and adjusting the proportion according to the population for each decade, the incidence of cancer of the larynx in males treated at the clinic becomes for each year equivalent to:-

Decade	31-40	1 case for 195,800 of male population.
	41-50	1 195,250
	51-60	1 94,157

Decade	61-70	1 case for	9,625 of male population
	71-80	1	7,727

As the totals of the first three groups exceed the male population of South Australia for those ages it is obvious that less than one case per year comes from each of these groups. Actually the average appears to be one case each from the fourth and fifth decades every five and a half years, and one every three years for the sixth decade.

The aggregate number of cases is small and undoubtedly does not include all cases for the State, as some are treated privately, but it does show clearly that the disease is one of later years with a rising incidence even in the eighth decade.

The population figures upon which the above calculations are based were kindly supplied by the Statistical Department of the Government of South Australia and relate to civilians only. All the above cases occurred in civilians.

Site of growth

The site of origin of the growths was in some cases very difficult to assess, particularly the late cases with extensive involvement. In an endeavour to classify them according to Lederman's nomenclature (13) the grouping is as follows:-

Endolaryngeal	16
Epilaryngeal	6
Epioesophageal	5

The survivors all belong to the endolaryngeal group.

Symptoms.

Of the twenty seven cases the chief symptom or sign complained of by the patient was

Hoarseness or aphonia	in 12 cases
Sore throat	8
Swelling in the neck	5
Difficulty in swallowing	1
Pain	1

Other symptoms or signs noticed by the patient other than the chief complaint were

Difficulty in swallowing	15
Swelling in the neck	7
Difficulty in speech or alteration of voice	6
Sore throat	5
Pain	4
Loss of weight	4
Stridor	2
Aphonia	2

A Wassermann examination was carried out in 14 cases. In all it was negative.

A history of smoking was noted in 10 cases, in the others no record was made. One man had given up smoking three years before developing symptoms. This time lag, if the two are connected, is rather reminiscent of a number of cases in a report by Sarasin (14) dealing with cancers of the mouth. A considerable number of his cases developed lesions several years after giving up smoking.

Of the four surviving cases, section showed carcinoma in three. In the fourth no biopsy was taken.

Duration of Symptoms.

The duration of symptoms before the beginning of treatment varied from three weeks to twelve months.

Beside the case treated by laryngectomy already mentioned, two others were subjected to operation. In one case laryngofissure and tracheotomy were performed, and in the other tracheotomy and attempted removal. (The first survives, the other two are dead).

Case treated with radium moulds

The last mentioned case was the one that was treated with large radium moulds. Unfortunately an attempt to remove the larynx had been made, but the disease was found to be too extensive and the patient came to us with a tracheotomy tube in place and a wound in the side of her neck. Perhaps the ultimate result might have been the same, but I have little doubt that operative interference hastened her end, as post mortem she was found to have innumerable secondary deposits in her lungs.

However that may be, a composition tracheotomy tube was substituted for the metal one, and large radium moulds were applied to either side of her neck at a distance of six centimetres. The dosage on the left side was 4300 r on the skin (25,000 mg.h.) and on the right side 4300 r (28,000 mg.h.) At the centre of the neck the dosage was 3200 r. All the available radium was used but was rather insufficient in quantity, so that the treatment time was somewhat prolonged, taking 28 days. The dosage also was probably below the desirable optimum.

Glands appeared on the right side of her neck while the left side was being treated, and the patient's condition slowly deteriorated. Without apparent pain or distress she died on February 18th. 1944.

The post mortem findings were interesting. As has already been stated, numerous secondary deposits were found in her lungs, but the larynx had disappeared and was replaced by scar tissue, and no trace of the growth was found in her neck. It is a little difficult to account for this state of affairs, as the dosage should not have been sufficient to produce necrosis, nor had there been any sign of distress. I have wondered whether the growth could have eaten away the larynx and in its turn been destroyed by the radiation. If this is true, she might have been saved had she been treated by radiotherapy alone.

The following table gives the results. Those lost sight of are assumed to be dead.

Year	Cases	Died in						Now alive	
		1939	1940	1941	1942	1943	1944		
1939	4	1	0	2	0	1	0		
1940	5		2	2	0	0	0	X	
1941	5			1	4	0	0	0	
1942	2				0	2	0	0	
1943	9					6	2	1	
1944	2	(first half)						0	2

X Laryngectomy with post-operative deep X ray therapy.

In 1943, of the nine cases treated, six died

within the year, two the following year and the remaining patient when last seen at the end of 1944 appeared to be well, had gained 22 lbs in weight, the primary lesion had healed and no enlarged glands were apparent. In previous years the dose had on occasion been insufficient, and in cases where an adequate dosage had been administered, the time had often been prolonged to an undue extent. In this year an attempt was made to see that not only was the dose sufficient, but that it was given in a reasonably short time. The fact that six cases died during the year must be ascribed to their advanced state, to the fact that hard fixed glands were present in four cases, and perhaps to the attempting of injudicious surgery in one. Certain other factors that contributed to these results will be considered later.

Dosage.

Dosage employed averaged between 4000 and 5000 international roentgens tumour dose, although a few were well below this. In a small number the tumour dose reached 6000 r, while in one it was nearly 7000 r. This last patient died the same year without much improvement. One patient who received a tumour dose of 4000 r in 43 days lived four years and nine months with considerable palliation, but eventually died of the disease, whereas another, who received the same dose in 18 days, is still alive and apparently well. He was treated, however, only two years ago.

The factors usually employed were 185 KV. constant potential, Thoraeus filter equivalent to 1 mm. of copper, half value layer 1.5mm. Gu. and 50 cm. focal skin distance.

The fields used varied as a rule from two to three. Sometime two lateral fields were used, and sometimes an anterior field was added. The fields also varied in size, from 10 by 15, to 6 by 8, and even down to a 4 cm. circle for an occasional field.

With the higher dosage, the smaller fields were always employed. A few cases were given the elaborate Coutard ritual beginning with very small initial doses for preparation of the tumour bed.

Some of the cases were undoubtedly hopeless from the start on account of the advanced state of the growth at their first appearance. In a few it was so extensive that it was impossible to determine the original site of the disease. In fifteen involvement of the glands was recorded before the beginning of treatment, and in some these glands were already fixed. One man had a mass of glands seven centimetres in diameter.

This is, of course, the normal lot of a radiotherapy clinic. Advanced inoperable cases are sent to it in the absence of other possible modes of treatment. But in spite of this our results must be regarded as very unsatisfactory.

Disabilities
of the
Clinic.

I believe that another serious cause of failure was the undue prolongation of the time of treatment. This was to some extent unavoidable owing to the congestion of cases, and also to the fact that the age of the deep therapy plant rendered it liable to recurrent breakdown, with delay of patients under treatment and increased subsequent congestion. The time of treatment in some cases was as much as two months.

A small radium unit has been constructed with the hope of dealing with some of these cases. However, it is unfortunately too weak and insufficiently flexible to be of much service. With more radium and a greater expenditure on the mechanical design of this unit it is possible that it might be of real value in the treatment of this and other conditions.

Various other difficulties have hampered the work of the department, particularly with regard to deep

X ray. In this section there are as a rule two technicians, who alternate in shifts, so that the machine is theoretically working 12 hours a day five days a week. No provision, however, is made for a relieving technician when one goes on holiday, so that for two months of the year only one shift a day is worked. As can be imagined, during this period there tends to be a considerable accumulation of cases for treatment.

Furthermore, the task of setting up a patient in position for treatment, if it be at all out of the usual routine, is a matter that is really beyond the competence of a technician. It cannot be expected that he should have the anatomic and pathological knowledge necessary for such a procedure.

In the normal course of events the registrar is available for the purpose of direction and supervision, but during the war there has been a succession of registrars, and for most of the five years under consideration these have been without special knowledge or training. It is quite impossible in a clinic such as this for the members of the honorary staff to attend to such matters, and the mere marking of the fields does not ensure that the correct angulation of the beam will be employed. In the absence of an efficient registrar, results are likely to suffer. Moreover, there are no beam directing devices such as have been described from time to time (15) nor is our plant, not being shockproof, suitable for the use of some of these devices.

The purchase of a new and more powerful machine has, however, been authorized, and it is hoped that with the arrival of this results may improve considerably.

Some isodose curves of cases, both successful and unsuccessful, and including the case treated with radium moulds, have been prepared by Mr. B.W. Worthley, B.A., M.Sc.,

physicist to the clinic, and are appended to this thesis.

Complica-
tions.

During treatment dyspnoea may occur, but has not in this series of cases been severe enough to interrupt treatment, although a number have complained of considerable discomfort. In no case has cartilaginous necrosis of the larynx been evident, nor has tracheotomy after radiation been necessary.

Several cases underwent a second course of treatment, undesirable as this may be, in a desperate attempt to palliate the condition. In none was this attempt successful. I have come to the conclusion that not only is it dangerous, which is well known, but that it is also useless. This does not, of course, refer to a planned division of dose, such as is employed by Cutler.

Since the above was written, a leading article on laryngeal cancer has appeared in the British Medical Journal (16). This throws a much more favourable light on the surgical treatment of this disease, provided that the growth has remained intrinsic. It gives a ten year cure rate of nearly 80 per cent for the early cases which can be treated by the lesser operations of laryngo-fissure or hemi-laryngectomy, and a ten year cure rate of 60 percent for the more advanced cases dealt with by laryngectomy.

Much of the work referred to in this section of the thesis is mentioned in the article in question, but later figures, then in the press, from Lederman and Hayneord are given showing for radium beam treatment that 6 out of 8 early cases were symptom free, as were 12 out of 15 more advanced cases.

Cutler's suggestion of a radiotherapeutic test is instanced, and Nielsen and Strandberg, of Copenhagen, are credited with making the same suggestion.

Broders' tumour grading is stated to provide a fair indication of the degree of malignancy, and therefore of prognosis from the surgical standpoint, although histological information as to radio-sensitivity is lacking.

CANCER OF THE TONGUE.

In the five years 1939 to 1943 fifty cases of cancer of the tongue received treatment at the Radiotherapy Clinic. The majority were treated with interstitial radium or radon, but some cases were either too advanced or the patients too frail for such a procedure and were instead treated by means of deep X ray therapy. These latter cases, as might be expected, gave poor results.

Site of
growth.

The distribution of the lesions was as follows:

Anterior dorso-lingual	27 cases
Infra-lingual	15 "
Posterior Dorso-lingual	8 "

Two of the cases were so extensive that the site of origin was difficult to assess. In these the floor of the mouth, the pyriform fossa and the lateral wall of the ^hparynx were invaded by the growth.

In 21 cases the mobility of the tongue was reduced, in 14 it was stated to be normal and in 15 no record was made.

Twenty five gave a history of smoking, one of chewing tobacco, and in 24 cases the presence or absence of this habit was not noted.

Ten cases are recorded as showing leucoplakia.

Five showed a positive Wassermann reaction on examination at the clinic, and one had previously

been positive but was negative at his first appearance. Forty one gave a negative reaction and the remaining three did not have this test performed.

Forty five were male and five female.

Age distribution.

The age distribution was as follows:

21-30	31-40	41-50	51-60	61-70	71-80	81-90
1	2	4	8	13	15	7

The youngest patient was 28 and the oldest 89.

Incidence.

Neglecting the five female cases as too few on which to base any figures, the yearly incidence of cases of cancer of the tongue in males treated at the Radiotherapy Clinic becomes equivalent to:

31-40	1 case in	89,000	of male population
41-50	1	44,185	
51-60	1	21,400	
61-70	1	10,400	
Over 70	1	3,162	

As before the figures for the first two groups exceed the totals of such groups for the State indicating that less than one case in each of these decades reports each year. Again we meet with an increasing incidence of the disease with age, the proportion approximately doubling with each decade.

That this is not the actual incidence of the disease is certain as a number of cases are treated in private practice. After questioning a number of medical men I formed the opinion that the total number of cases for the State of South Australia would be somewhat less than double the number of those recorded here.

The results are given in the following table.

Results.

Year	Cases	1939	Died in		1942	1943	1944	New alive
			1940	1941				
1939	11	1	1	4	0	0	1	4
1940	7		3	2	2	0	0	0
1941	16			2	10	2	0	2
1942	11				2	3	0	6
1943	5					0	0	5
	50							17

The figure in red refers to a patient dead of intercurrent disease after more than four years.

The above table includes as dead five patients who are probably dead. The patient who died in 1944, having been treated in 1939, showed no sign of recurrence, locally or in the glands. The cause of death at the age of 78 was given as pneumonia and uraemia. Another patient died during treatment, from bronchopneumonia.

Two patients treated in 1943 are alive with active disease still present. This, therefore, gives a total of 17 patients alive, of which number two still have active growth. There are thus apparently 15 cases free from disease.

Of these 17 survivors sections were taken in 14 and were positive. The remaining three had no histological examination, but in one of these the disease is still active and the patient is going down hill.

The following table gives the results according to site:

Anterior dorso-lingual	10	survivors out of 27	
		patients	
Infralingual	5	do.	15
Posterior dorso-lingual	2	do.	8

One in each of the latter groups shows active disease.

The cases treated with interstitial radiation number 38, the remaining 12 having received deep X ray therapy instead.

Results of tongue cases treated with interstitial radiation.

Year	Cases	1939	1940	1941	1942	1943	1944	Now alive
1939	11	1	1	4	0	0	1	4
1940	6		2	2	2	0	0	0
1941	10			1	5	2	0	2
1942	7				0	2	0	5
1943	<u>4</u>					0	0	<u>4</u>
	38							15

This table includes one patient alive with active disease. Fourteen cases out of a total of 38 are apparently well.

Dosage.

Dosage of this group of patients varied somewhat, being from about 6500 r to 8000 r. This scale of dosage applied to both successful and unsuccessful cases. The length of treatment varied from four to eight days and there appeared to be no correlation of success and time factor within these limits. One case that was first treated with deep Xray was left with a small residuum in the tongue. This was given 4000 r by means of interstitial radiation. He has since remained well for over two years. The dosage in milligramme hours showed a wide variation according to the size of the lesion, being from 1400 mg.h. to nearly 4000 mg.h.

Technique.

The technique of interstitial radiation was usually carried out by a number of vertical planes in the tongue, with the marginal dosage sometimes buttressed by an additional plane in the cheek. The active length of needles in the posterior portion of the tongue has usually been at least 4 cm. In recent years cross needles linking the planes have been used less frequently. There appears to be a certain discrepancy in Oddie's figures for dosage for plane implants and for a block of tissue by volume implants. The latter dosage seems to be on a reduced scale, so that our physicist has calculated dosage according to planes, taking a point midway between any two planes, and computing the dosage from adjacent and distant planes. By this means one is assured that any point within the block of tissue receives a minimum dosage of the figure chosen. Certainly there must be hot spots, but that is inevitable with any interstitial method, and this is a lesser evil than underdosage within the dangerous area. I think that further work needs to be done on so-called volume implants.

Some of the survivors in this series of cases

had quite advanced lesions when presenting for treatment, as for example a man treated in 1939 who had a mass measuring 4.5 by 3.5 centimetres involving the right border of the tongue, the dorsal and infra-lingual surfaces and the pharyngeal portion of the tongue. He was treated with interstitial radium and dissection of the glands of the neck. Biopsy from the tongue showed cancer, but the glands did not reveal any deposit. He was well in 1944.

Dissection of the glands of the neck was carried out in only 13 cases. Eight of these survived, but in only one of these did the glands show metastases. In the nine remaining survivors the operation was not performed, either on account of the age of the patient, or because of associated disease such as pulmonary tuberculosis, diabetes, cardiac disease or other complaint. One tuberculous patient, treated in 1939, had a growth which the pathologist described as a very actively growing squamous cell carcinoma. After his interstitial radiation he received deep X ray to the neck and remains well in 1945. I have wondered whether this growth should not have been classified as belonging to Quick and Cutler's group of transitional cell epidermoid carcinoma. Four other patients also received roentgentherapy to the neck. One survivor underwent both operation and radiation.

No patient in this group was treated with interstitial radiation to the glands. I used this method on many occasions in England in the years 1931 to 1933, both with and without surface radiation in the form of moulds. I still believe that dissection is the best procedure, if possible. Failing that, from what I have read I imagine that irradiation with Radium beam therapy would be the next best method.

Symptoms.

The chief symptom or sign complained of was

Sore tongue	in 23 cases
Lump in the tongue	16
Earache	4
Sore throat	1
Difficulty of speech	1
White spot on tongue	1
Lump in roof of mouth	1
Rough patch on tongue	1
Swelling in the neck	1

Symptoms and signs noted by the patient other than the prime complaint were:

Pain	in 10 cases
Salivation	6
Difficulty of speech	6
Swelling in the neck	5
Dysphagia	5
Lump in the tongue	4
Earache	4
Pain in the jaw	2
Roughness of tongue	2
Reduced mobility	1
Sore throat	1

It is interesting to note that although in 21 cases the mobility of the tongue was reduced, in only one did the patient complain of it. Also that in six cases patients noticed enlargement of the glands of the neck before reporting.

Duration of Symptoms.

The duration of symptoms was given as

Up to 3 months	in 28 cases
4 to 6 months	9
6 to 9 months	2
1 to 2 years	8
Unstated	3

Two patients had previously suffered from cancer of the lip, one 35 years previously. He was not stated to be a smoker, but I think it can be accepted as probable.

Another patients who did not survive or even complete treatment gave a family history of a brother dying of cancer of the tongue. Yet another had two brothers die of cancer, in one case of the throat and in the other of an internal organ, while two further cases reported one or more immediate relatives as dying of cancer. Not much notice can be taken of the number so recorded as such details are sadly lacking in the reports.

Cases treated
with X ray.

As stated previously, twelve patients did not receive any interstitial radiation, either on account of age, extent of the lesion, or because of associated disease. These were treated with deep X ray therapy. In this group was a man of 86. He had a large mass involving the tip of the tongue, which on section showed a quietly growing carcinoma. The factors employed were the same as for the larynx which have been already given, with the exception that the fields consisted of an intra-oral one direct to the growth, supplemented by an external submental field. The tumour dosage was 4000 r and was given in 25 days. The mass became much smaller, but did not completely resolve so six weeks later the anterior portion of the tongue was removed, leaving him, however, quite a useful organ. He received no treatment to the glands of the neck. He remains well over two years later. Whether this is due to the nature of the growth or the treatment received it is difficult to say.

Of the remaining eleven patients, ten are dead and the other case shows active disease and his condition is deteriorating. The survival period for the ten cases varied from one month to 20 months after treatment, the average being 7.8 months. The sole defence for these results is that the patients selected for this treatment were the most advanced or the most decrepit cases. In some the dosage may have been inadequate by modern standards but in the majority it was very considerable, even up to 7000 roentgens tumour dose. The greatest discrepancy was the undue prolongation of the time of treatment. This has already been emphasised in connection with treatment of carcinoma of the larynx but will bear repetition. With the arrival of a modern plant much of this difficulty should disappear.

A case treated
with radium
beam therapy.

I must confess that I have not personally seen very good results from the treatment of carcinoma of the tongue with deep X ray. On the other hand with the use of teloradium or radium beam therapy I have seen results that were dramatic. Some twelve years ago I remember treating a man at the Middlesex Hospital with a one gramme unit. He had been very inadequately treated with radium needles at a country hospital and came to us in a deplorable condition. He had a large cavity in the left side of the dorsum of the tongue, measuring 2 by 2 centimetres and 1.5 centimetres in depth. Around this was an indurated mass extending from the anterior third of the tongue to the posterior third and to the lateral wall of the pharynx. There was also a large mass of fixed glands, 5 centimetres in diameter, on the left side of his neck. These had broken down and were discharging freely through a sinus. Further enlarged hard glands were present down the whole length of the deep cervical chain. He was in great pain.

I debated whether it was of any use to give treatment, but because of his pain decided to do so. He was treated with the mass radium unit, and received a total dose of 102,000 mg.h. through a number of ports.

The radium was at a distance of 5 cm. from the skin, the filtration was 1.5 mm. platinum, and the ports consisted of circles of 5 cm. diameter, giving an area of approximately 19 sq. cm.

Treatment began on 17th October, 1932, and was completed in 18 days.

Five weeks later there was considerable reaction of the tongue, the pharynx and the skin. By then the sinus in the neck had healed.

On 2nd January, 1933, he had improved greatly in health. He was free from pain and had put on

weight. The tongue was perfectly mobile and completely healed, although two or three small indurated nodules were still present.

The tongue was free from pain on palpation, the mass in the neck had disappeared and the sinus remained healed. I am unable to give the final result in this case, as I left for Australia some weeks later. It is, however, unlikely that the disease was eradicated. Nevertheless, it was an amazing improvement.

At the time I do not think there were any results of treatment of the tongue by means of X ray to compare with this.

Concentrated
radiotherapy.

However, in the period 1938 to 1943 Max Cutler (17) has treated some 38 cases with external radiotherapy. He used X rays of either 400 or 200 KV. or ^{R₂} radium beam therapy. In the tables the source of energy is not stated, and he appears to have used them as alternative methods of treatment.

He gives the following results:-

Carcinoma of the tongue.

Early	13%
Advanced	39%
Very advanced (with adenopathy)	48%

Cutler's
results.

Year	Cases treated	Alive at the end of				May 1943
		1939	1940	1941	1942	
1938	5	0	0	0	0	0
1939	2	2	0	0	0	0
1940	8		6	4	2	2
1941	16			14	10	10
1942	6				5	4
1943	1					1
	<u>38</u>					<u>17</u>

Two survivors had subsequent hemiglossectomy.

These figures are very promising for treatment of tongues from an external source of radiation. The results are not yet equal to those of interstitial

radiation at the best clinics, and no five year survivors are yet shown. But 87 per cent of the cases were advanced, and nearly 50 per cent had glandular enlargement. For such a mode of treatment I consider the figures hopeful.

Our own figures for almost the same period are not much better except for the year 1939 when of the eleven patients treated - by interstitial radiation - four have survived free from disease for more than five years, and one died just short of five years from intercurrent disease with no sign of cancer.

The main advantage on favour of Cutler's technique is that these patients were not subjected to the painful procedure of interstitial radium, which in the tongue must tax their endurance.

I have long been anxious to discover and employ some method of treatment which would avoid such extremes of discomfort. In certain areas within the mouth so-called contact therapy can be employed, using a Chaoul or Philips machine. There are, however, severe limitations to the areas that can so be treated, and in any case such treatment is not usually suitable for a tongue. If Cutler's technique fulfils its promise it would be of great advantage to patients suffering from this painful disease. It may, moreover, enable us to deal with those extensive cases where the area affected is too great to offer hope of cure by the insertion of needles. I have no doubt that concentrated radiotherapy is uncomfortable enough, but it is probably better than needles in the tongue.

A small
radium
unit.

I have for years urged the acquiring of a mass radium unit for the treatment of lesions of the throat, having a lively memory of such cases treated at the Middlesex Hospital. The case I have recorded is but one of many, but one of the more striking. As already

stated, a small compromise unit has been constructed here, but is neither powerful nor flexible enough to meet the demands, nor is it safe from the point of view of the operator. Furthermore, an organisation needs to be built up so that such a unit is used in a room adjacent to a special radium ward, where the staff is trained and accustomed to the use of such an appliance. The somewhat haphazard methods of application so far employed do not give much hope unless the procedure can be radically altered. As one of the few men in Australia who has used such an apparatus, I speak with some conviction.

Later in this paper I shall discuss the use of heavy radium moulds, such as I described some twelve years ago. Apart from the rather unsatisfactory radium collars, I believe that my paper of 1933 gave one of the earliest descriptions of such methods to be published in Australia. In this belief I may, of course, be mistaken, having then been out of the country for a number of years.

I could quote many cases treated by me personally in England either by mould or by beam therapy, but I have no wish unduly to labour the point. At the proper stage in this thesis I shall discuss cases treated by me in Australia by means of heavy moulds, but will now pass on to tongue treated in my private practice.

Of the cases treated by me in the last ten years I cite 16 that were either proved histologically or were clinically beyond doubt. I exclude a proved case in a woman treated within the last few weeks as being too recent.

These sixteen cases include all that were treated that I know to have died. Eight were male and eight female.

Cancer of
the tongue
treated in
private.

Treated with interstitial radiation.

15

- 1935 3 cases
1 woman, positive section, remains alive and well, December 1944.
1 died of cancer 1936
1 died 1937 of a tongue condition stated to be infective, but almost certainly cancer, and pneumonia.
- 1936 1 case
Lesion resolved. Operative death after block dissection of glands.
- 1938 3 cases.
1 alive and well 1944.
1 died 1938 of cancer.
1 died 1939 of cancer.
- 1939 1 case
A woman, positive section, alive and well December, 1944.
- 1940 1 case
Positive section. Died June 1944 of cerebral arteriosclerosis without recurrence in tongue or glands.
- 1941 2 cases
Both positive section
One died of cancer 1942.
One alive and well 1945.
- 1942 2 cases.
One positive section.
Both alive and well, December, 1944.
1944. 2 cases
Both women, both positive section.
Both alive and well, 1945.

And one case treated by means of deep X ray.

- 1942 A man of 88, who was thought to be unfit to undergo any surgical interference. He died of cancer in 1944. There was, however, very considerable palliation.

The following table gives the results of those treated with interstitial radiation.

Results.

Year	Cases	35	36	37	38	39	40	41	42	43	44	Alive and well, December, 1944.
1935	3	0	1	1	0	0	0	0	0	0	0	1
1936	1		1	0	0	0	0	0	0	0	0	0
1938	3				1	1	0	0	0	0	0	1
1939	1					0	0	0	0	0	0	1
1940	1						0	0	0	0	1	0
1941	2							0	1	0	0	1
1942	2								0	0	0	2
1944	2										0	2
	<u>15</u>											<u>8</u>

Thus three out of eight cases have been well

for over five years. Of the total group, one death was from intercurrent disease after four years, the tongue remaining well, and one death was post-operative. Eight out of sixteen cases are alive, and none shows any sign of disease. The case treated with X ray was regarded as too advanced for anything but palliation.

The two women treated in 1944 are both of interest. The first one, aged 38, developed a small white surface growth on the right side of the dorsum of the tongue. This grew in size, and was sectioned, the report being squamous epithelioma. It was after this that I first saw her.

She was completely edentulous, wearing full upper and lower dentures. After interstitial radiation the growth resolved and has so far shown no sign of recurrence. She has, however, drawn my attention to a small white spot on the left side of the dorsum well away from the irradiated area which has appeared since treatment. It is at present entirely superficial and does not look very impressive, but she assures me that the first lesion began in exactly the same way. I am watching it carefully. Since writing the above I have examined her tongue several times. The new lesion shows no sign of advancement, but rather a regression.

Cancer of
the tongue
in a young
pregnant
woman.

The other patient was a young woman of 30 years and eleven months, four months pregnant with her first child. This patient complained of no symptoms whatever, but the lesion was detected by her own doctor, Dr. Donald Steele, during a routine examination. Section was positive.

When I saw her first the growth measured 2.5 by 2.5 centimetres, and involved the whole thickness of the left border of the tongue somewhat behind the tip. Her teeth were natural and very clean and well kept, without obvious caries but with some fillings. She had never smoked and her Wassermann reaction was

negative. There was no sign of any leucoplakia.

Two teeth in the lower jaw opposite the lesion had tilted slightly medially and this seemed to be the only possible source of irritation.

She was treated with interstitial radiation and the mass resolved. She has since had a dissection of the glands of her neck which showed no deposits. Treatment did not appear to interfere with her pregnancy and she looked very well. Her appetite remained excellent throughout, and she complained that when the needles were in her tongue she could not eat as much as she wanted to. She has now given birth to a healthy daughter, and the tongue so far remains excellent without sign of recurrence. There is a certain amount of scarring with slight atrophy at the site of the growth, but there is no evidence of activity either here or elsewhere. This is not the youngest patient I have treated but it is the only case of carcinoma of the tongue I have seen in a pregnant woman. Curiously enough, the medical attendant of the other woman treated in 1944 has informed me that, following some gynaecological treatment undertaken after the resolution of the tongue lesion, this patient has also become pregnant, again a first pregnancy.

Sex
Ratio.

It is difficult to say why my cases should show such a high proportion of women. At least seven of the eight had never smoked and neither had one of the male cases.

Ill-fitting
Dentures?

Seven patients had been edentulous for considerable periods, three of them for 15, 22 and 40 years respectively. My last patient, not included in these records, was also a woman who had been edentulous for many years and had never smoked. I suspect ill-fitting or badly constructed dentures as a source of chronic irritation.

Even at such a large cancer clinic as that at the

Middlesex Hospital both the proportion and the absolute numbers of women with cancer of the tongue were very small.

Wassermann tests were not regularly performed in the case of my private patients. No positives were recorded, but there was one man who gave a history of a gumma of the tongue. He was sent to me merely for insertion of radium and a section at that time showed the presence of an epithelioma. After treatment, the growth disappeared for a time, but recurred and caused his death the following year.

The duration of symptoms before treatment was stated to be of different periods up to a year. One woman, mentally unstable, gave a history of three years, but I could not regard her statements as reliable.

The age distribution was as follows:

30	to	40	3
41	to	50	1
51	to	60	3
61	to	70	3
71	to	80	4
81	to	90	2

This shows that the difference from the figures of the Radiotherapy Clinic is not only in the sex ratio, but also in the age distribution. At the Clinic 70 per cent were over 60 years of age, in my figures only 56 per cent were above this age. Admittedly my total is too small from which to draw any conclusion, but the age difference is definite, while the sex difference is striking. Women are generally supposed to pay more attention to oral hygiene than men, and the prosperous members of both sexes more than the poorer section of the community. If this is a factor in the production of tongue cancer, one would expect more cases to occur in men than women and in the poor than the rich. This is as a rule true, so that I expect my group of cases is not a fair sampling of the community.

Age
distribu-
tion.

However, I shall deal somewhat more fully with possible factors in the production of mouth cancer later in this thesis.

Dissection
of the
Glands.

On reviewing the tongue cases generally I was surprised to find how rarely a block dissection of the glands of the neck had been performed. At the Clinic it has for years been accepted as a rule that all cases of cancer of the tongue, whether exhibiting palpable glands or not, should have such an operation if their physical condition were sufficiently good to withstand it. Crile's block dissection, as subsequently modified by Roux-Berger, has been regarded as the operation of choice. Admittedly many of these patients were old people and unfit for such a procedure, while others were suffering from such diseases as to preclude major surgery. In others again the condition was too advanced locally or in the glands to provide any justification for dissection, and in some of these, owing to fixation of the glands surgery was impossible. Nevertheless, 13 dissections out of 38 cases - if we limit the number to those treated with interstitial radiation - seems a rather small proportion.

Another point calling for comment is the inadequacy of the records. Leucoplakia, such an important precursor of cancer, is only noted on ten occasions, while the personal and family histories are sketchy or absent.

Certainly the years cover a period of war, a period of great stress with changing staffs, both honorary and clerical, and a constant succession of registrars. I do not think, however, that all the blame is attributable to this. Those of us who continued the work as members of the honorary staff must accept some of the responsibility. The fact that for three years or more I was heavily loaded with almost all the radium work, and all the deep therapy does not altogether absolve me.

But to check carefully the histories of 86 patients - which number I have seen at a single session - would have taken more time than was then available.

The consultative committee, at this period, had ceased to function, and often consisted of one medical man, or on occasion perhaps two. This committee, when properly used for consultative opinions in doubtful cases, can be of real value, but in those days medical men were too few and too busy to attend. Now that it is functioning in part it is at times of great help, although I consider it undesirable, unnecessary and uneconomic to take up its time with such cases as uncomplicated skin lesions, simply because the patients are new patients.

Outlook.

Consideration of the tongue cases suggests that with treatment in reasonably early stages before glandular metastases are apparent the chances of controlling the primary lesion are good, and that with block dissection of the glands the prospects of eradication of the disease are hopeful. In the later advanced cases with glandular involvement the outlook is very poor. The site of the growth is also of importance, the most hopeful position for cure being the anterior dorso-lingual portion.

The choice of the best time for the dissection of the glands has been much debated. The method employed at the Radium Institute, Paris, was to operate within 48 hours of removal of the radium from the tongue before the development of any reaction. This was constantly done at the Middlesex Hospital without apparent ill-effects. In Adelaide, as a rule, the surgeons have preferred to wait until the reaction has disappeared, but on one or two occasions when I have persuaded the

surgeon to perform the immediate operation no harm has resulted. I believe that this is the time of choice.

Preparation
of the mouth.

Before the insertion of needles into the tongue we have endeavoured to take the utmost care to render the mouth as healthy as possible, by the extraction of carious teeth, the sealing and cleaning of others, and by the observance of oral hygiene generally. It has been our practice to wait at least a fortnight after such extraction before proceeding with the treatment. While the needles are in position the mouth is douched frequently, usually with some non-irritant fluid such as a weak aqueous solution of sodium bicarbonate, which helps to wash away the stringy mucus. The patients are made to sit up as soon as possible, even before the needles are removed.

Feeding is a matter of difficulty, especially if there is much swelling of the tongue. I have found that many patients will gratefully accept ice cream, and they sometimes manage this better even than fluids.

Most of our cases have had radium implantation of the tongue performed under general anaesthesia, usually intra-tracheal ether. On a few occasions an intravenous anaesthetic has been employed, while once or twice in the past I have used double mandibular block anaesthesia.

Following a general anaesthetic the patients are as a rule given carbogen inhalations to stimulate the respiratory function and lessen the risk of pulmonary infection to which they are particularly susceptible.

Our histological reports have in the past been rather uninformative and little has been stated, as a rule, but the diagnosis epithelioma. On two or three occasions only, as far as I can discover, has

any comment been made as to the activity or group of the cancer. The degree of keratinization has not usually been recorded.

One point that has caught my attention with regard to epitheliomata occurring in deeply fissured tongues is their liability to develop necroses in the fissures, and also the frequency of recurrence. Cases are, however, too limited to make much of this.

For the purpose of comparison and to complete the figures for tongues, I give results for all the preceding years in which the Radiotherapy Clinic has been working.

Year	Cases	'29	'30	'31	'32	'33	'34	'35	'36	'37	'38	'39	'40	'41	'42	'43	'44	Now alive
1929	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1930	5		1	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1931	11			3	3	0	0	1	1	0	0	1	0	0	0	0	0	0
1932	4				1	0	0	1	1	0	0	0	0	0	0	0	0	1
1933	8					1	3	0	0	1	0	0	0	0	0	1	1	1
1934	6						2	2	1	0	0	0	0	0	0	0	0	0
1935	14							2	3	2	1	1	1	1	0	0	0	2
1936	10								1	5	0	0	0	0	1	1	0	1
1937	17									7	3	2	0	0	0	0	0	3
1938	5										0	3	1	0	0	0	0	1
	83																	9

To complete the tally of cases treated more than five years ago, the figures for 1939 are repeated.

1939 $\frac{11}{94}$

1 1 4 0 0 1 $\frac{4}{13}$ 4

The figures in red represent cases dead of intercurrent disease more than three years after treatment, while the oblique line divides those who survived more than five years from those who did not.

Untraced cases.

A certain number of cases are untraced, their particulars age given below.

Year treated	Untraced.
1929	0
1930	0
1931	2 untraced, both alive in 1940, untraced since.
1932	0
1933	0
1934	1 untraced, alive in 1937, untraced since.
1935	1 untraced, alive in 1943, untraced since.
1936	1 untraced, alive in 1940, untraced since.
1937	2 untraced, 1 untraced since 1937. 1 alive in 1941, untraced since.
1938	0
1939	0

Of these 7 cases, three survived more than five years. With the exception of one case, all lived till at least the third year after treatment.

The mode of treatment of patients during the years 1929 to 1938, and the results of such treatment, are now briefly summarized.

Cases treated with radium only.

Total	39
Survived five years	9
Now surviving	5
Untraced	5

These were lost sight of as follows:

- 1 in the year of treatment.
- 1 three years after treatment.
- 2 four years after treatment.
- 1 nine years after treatment.

This last case is included in the total surviving five years.

Cases treated with deep X ray only.

Total	16
Survived five years	0
Now surviving	0
Untraced	0

Cases treated with radium and deep X ray.

Total	24
Survived five years	7
Now surviving	3
Untraced	1

This patient was last seen nine years after treatment, and is included in the total surviving five years.

Cases treated with diathermy, excision, or both.

Total	3
Survived five years	3
Now surviving	1
Untraced	1

This patient was last seen eight years after treatment, and is included in the total surviving five years.

One patient was untreated.

No patient treated with deep X ray only survived more than a year, although two are stated to have died of intercurrent disease. This group, however, comprised those with advanced lesions.

Dissection of glands.

Of the 94 cases, there was a dissection of the glands in 46, and in at least five of these the dissection was incomplete. 14 of these survived five years. Of the 48 who had no operation on the glandular area 9 survived five years.

Survival Rate.

Thus 23 patients out of a total of 94 in the eleven

years survived more than five years, which gives a rate of 24.4 per cent. Of these, seven have since died, one of cancer, and three are untraced, at 9, 9 and 8 years after treatment.

As the expectation of life at the ages at which these patients were first seen would not be very great, I think these results must be regarded as fairly satisfactory. If my five year results are added to these, we get a total of 102 cases, with 26 survivors for more than five years, a rate of 25.4 per cent.

CANCER OF THE FLOOR OF THE MOUTH.

Relatively few cases of carcinoma of the floor of the mouth have been treated in the period under review, there only being nine cases in which there was not gross involvement of the tongue. The division between this group and the tongue proper is perhaps arbitrary, but there are differences, chiefly in the more frequent involvement of the mandible and in the more frequent use of moulds for treatment. Therefore, in this paper Regaud's lead of grouping them together has not been followed.

All but one of the cases were males, and in the four in which a Wassermann test was performed the results were negative. Two are stated to have been heavy smokers when presenting for treatment, and one had previously been so. The ages varied from 50 to 82.

The ages in decades were as follows:

50 to 60	61 to 70	71 to 80	81 to 90
2	4	2	1

The duration of symptoms was given as follows:

1 month	in	1 case
2 months		2 cases
3	"	1 "
4	"	2 "
10	"	1 "
12	"	1 "
3 years		1 "

Age distribu- tion.

Duration of symptoms.

Symptoms.

The primary symptom complained of was

Lump in the floor of the mouth	2	cases
Sore lower jaw	2	"
Sore beneath tongue	2	"
Swelling of the lower jaw	1	"
Swelling of the neck	1	"
Sore in the mouth	1	"

Stage of growth.

In five cases the growth was fixed to the mandible. Glands were palpable in six cases, being much enlarged in two. Biopsy was positive in six cases, in the remaining three no section was taken, but all these cases died.

Mode of treatment.

Four patients were regarded as too advanced or too weak for radium treatment and were treated with deep X ray. Their ages were 67, 70, 76 and 82. All died.

Of the remainder three were treated with radium moulds, either intra-oral or intra-oral and submental. Two remain well.

The two remaining patients received interstitial radiation. One is alive and well.

Dissection of glands.

Block dissection of the glands of the neck was performed in three cases. In one the glands showed deposits and the patient died. The other two survived.

Table of results.Results.

Year	Cases	Died in					Alive and well.
		1939	1940	1941	1942	1943	
1939	2	1	0	0	0	0	1
1940	0						
1941	2			0	0	1	1
1942	5				1	3	1
1943	9						3

Thus three are alive and well out of nine treated, one having survived five years, one three years and one two years after treatment. These figures do not appear to differ widely from those reported from other clinics. Once the disease is extensive with mandibular involvement and deposits in the glands the chance of cure is remote. In our group no case with either survived.

Five cases involved the mandible when first seen, and in one case the right side of the bone was extensively eroded. Six showed glandular enlargement, in three considerable. One case with moderately enlarged glands survives, but the glands showed no deposits.

In connection with cancer of the lip I have mentioned the possibility of successful removal of portion of the mandible with a small attached glandular mass. This was not attempted in any case in this group, nor did any appear to be suitable for such a procedure.

Theoretically such a case might occur, but as a rule in primary involvement of the floor of the mouth with mandibular invasion the condition is too extensive to warrant much hope of success. Nevertheless I think that it should be kept in mind as a possible mode of treatment.

No superficial X ray apparatus capable of intra-oral use was available during the years under consideration, so that treatment was limited to radium, either interstitial or on a mould, or deep X ray. On one or two occasions surgical diathermy was used in an attempt to palliate recurrences.

Much of what has been said in relation to cancer of the tongue applies to this group of cases also and so no further comment is made.

Small necroses of the jaw have occurred in some cases, but these have been infrequent with the use of heavily screened needles, those usually employed having a filter of 0.3 mm. Pt.

One or two cases developed submental infection, but this was rarely serious.

Dosage.

For the radium cases dosage varied from 6500 to 8000 r. given in 8 to 10 days, and for the X ray cases 3000 to 5000 r. given in 3 to 4 weeks.

CANCER OF THE TONSIL.

The next group of cases consists of carcinoma of the tonsil. Lymphosarcoma has been excluded as a different and, as a rule, a more systemic disease. It was not thought that any useful purpose would be served by combining the figures.

Of the ten cases none was described as either lympho-epithelioma or transitional cell carcinoma. One patient was female.

Age distribution.

The age distribution seems to show a shift toward the older groups in comparison with other mouth cancers, 60 per cent being over seventy. The total is, however, too small to have much significance.

41-50	51-60	61-70	71-80	81-90
2	0	2	5	1

All cases except three were recorded as smokers, several being heavy. In the three cases no record was made.

A Wassermann reaction was negative in each of the four cases in which this examination was made.

The results of treatment, given below, are truly deplorable. However, as Berven (18) points out cancer of the tonsil is one of the most malignant forms of growth, and most resistant to treatment, either surgical or radiotherapeutic.

Table of Results.

<u>Results.</u>	Year	Cases	1939	1940	Died in		1943	1944	Alive and well.
					1941	1942			
	1939	2	2	0	0	0	0	0	0
	1940	1		0	0	0	1	0	0
	1941	1			0	0	0	1	0
	1942	5				3	2	0	0
	1943	1					0	0	1
		<u>10</u>							<u>1</u>

The patient treated in 1941 died suddenly three years later. He had had an attack of influenza and was saying goodbye to his soldier son when he dropped dead. No active growth was apparent at the time.

The patient who presented in 1940 had previously had the right half of his tongue removed, presumably

for cancer, some eighteen years before. About five years after this, the glands of the neck had been dissected and showed deposits of squamous cell carcinoma. This was before the establishment of the Radiotherapy Clinic, and there is no record of any radiation treatment. On examination in 1940 he showed thickening of the base of the tongue on the right side, enlargement of the right tonsil, and redness of the left tonsil also. Sections showed epithelioma both of the right tonsil and of the left pillar of the fauces. He was treated with deep X ray and received considerable benefit. The condition, however, recurred and he died three years later.

It is possible that this case was really a recurrence of cancer of the tongue and should therefore be included in that group.

Another patient died of bronchopneumonia before the reaction had developed, probably as a result of the anaesthetic and operative procedure. Yet another died suddenly, apparently from a heart condition, but with active growth still present. A fifth case, treated in 1942, showed no sign of growth the following year, but developed urinary retention possibly from prostatic trouble. He was then either 77 or 78 years of age and is stated to have died of bronchopneumonia while still suffering from symptoms of retention.

Thus only one patient remains alive, although two died of intercurrent disease without evidence of cancer.

Mode of Treatment.

Five patients were treated with interstitial radium. The survivor, the only female, belongs to this group. She was 72 years of age when treated, and section showed squamous cell carcinoma. She received no treatment to the glands, and no further irradiation to the tonsil. She was well without sign of disease in December, 1944.



The remaining cases were treated with deep X ray. Seven were very advanced, two patients being barely able to open their mouths. Six had enlarged glands, some quite large.

In nine cases a section was taken and was reported as carcinoma in all, usually as squamous cell carcinoma.

Symptoms.

The chief symptom complained of by these patients was

Swelling of the tonsil	in	3	cases
Difficulty of swallowing		2	
Sore throat		2	
Earache		2	
Swelling of the neck		1	

Dysphagia and pain were severe in many cases, and earache was a common symptom.

Duration
of
Symptoms.

The duration of symptoms before treatment varied from 6 weeks to 6 months. In one case the patient's medical attendant noticed the growth before the patient himself complained of any symptoms.

Dosage.

Dosage with radium was usually 6500 r in 6 to 8 days, while cases treated with X ray received a tumour dose of 3,000 to 4,000 r in three to four weeks.

Why these results should be so bad it is hard to say. As with other mouth cancers, the patients are often old men in poor physical condition, bad subjects for surgical interference. Also many came to the Clinic with the condition already considerably advanced.

Coutard.

In spite of this Coutard (19) as long ago as the years 1920 to 1926 achieved a 23 per cent five year survival rate for such cases treated with deep X ray.

Berven.

Berven, (20) writing in 1929, stated that at Radiumhemmet deep roentgentherapy and buried radium had been employed with only palliative results and that the technique had then been altered to a combined method using first radium beam therapy - what he styles "radium at a distance" - then surface application of radium against the tumour by means of his special clamp, and finally implantation of radium needles into the tumour remnants.

Not all our results have been as poor as those shown in the table given in this section, as I can remember treating a man at the clinic in 1936 who survived six years and eventually died of intercurrent disease when nearly 80. I believe there were other successful cases also, although not many. These, however, lie outside the quinquennium I have elected to study.

I am driven to the conclusion that our technique is in need of improvement. Possibly something on the lines adopted by Berven, with intensive external irradiation, followed by internal surface or interstitial radiation of the tumour remnants, or else by the use of Cutler's concentrated radiotherapy.

CANCER OF THE PALATE.

Seven cases of cancer of the palate were treated, two being female. The age distribution was as follows:

Age.

31-40	41-50	51-60	61-70	71-80
1	1	1	3	1

Site.

Four cases involved chiefly the hard palate and three the soft palate, two of these with extension to the tonsillar area and the pharyngeal wall.

Two were stated to be smokers. In the other cases no record was made of this. Two cases gave a history of cancer in near relatives, in one case the mother having died of cancer of the throat.

Three patients remained well and free from disease in 1944, one was untraced, and the remaining three were dead.

Results.

Year	Cases	Died in						Well 1944
		1939	1940	1941	1942	1943	1944	
1939	2	0	1	1	0	0	0	0
1940	1		0	0	0	0	0	1
1941	0							
1942	3	1 untraced			1	0	0	1
1943	1					0	0	1
	7							3

Six cases were proved microscopically, including the three survivors.

Mode of Treatment.

Both patients treated in 1939 had very extensive lesions. One of these was treated primarily with a radium mould, and subsequently with deep X ray, dissection of the glands of the neck, and finally with removal of the right maxilla. The growth was not checked and he died 17 months after the beginning of treatment.

The other was treated first by means of deep X ray and a residuum in the tonsillar region then received interstitial radium. The glands of the neck were dissected. In 1940 this patient showed no sign of his original trouble, the mouth and palate remaining perfectly well. He, however, developed symptoms suggestive of cancer of the prostate, was lost sight of and is thought to be dead. The neck glands of both these patients showed secondary deposits.

Two of the survivors were treated with intra-oral radium moulds, and the other with intra-oral deep X ray.

The untraced patient was also treated with deep X ray and when last seen not very long after treatment no growth was evident.

Symptoms.

The chief symptom noticed by the patient in this group of cases was the presence of a lump in the roof of the mouth.

Duration of Symptoms.

Duration of symptoms varied from 6 weeks to 12 months.

Dosage.

In the successful cases, dosage was 5,000 r and 8,000 r respectively in those treated with radium moulds, given in eight to twelve days, and 3,000 r with one intra-oral field for the patient treated with roentgentherapy given in 15 days. This patient, however, had previously had the lesion excised.

THE BUCCAL ASPECT OF THE CHEEK.Age.

The last site to be discussed is the buccal aspect of the cheek. Four cases were treated, and all were male. Their ages were 42, 67, 71 and 77. A Wassermann test was taken in two cases and was negative in each. Three cases were proved by biopsy.

Results.

Results were as follows:

Year	Cases	Died in				1943	1944	Alive 1944
		1939	1940	1941	1942			
1939	1	0	1	0	0	0	0	0
1941	1			0	0	0	0	1
1942	2				0	0	0	2
	4							3

One patient treated in 1942 had active growth present in 1944.

Mode of Treatment.

Two patients were treated with interstitial radium and deep X ray, one with interstitial radium only, and one with deep X ray only. The two last are alive and well, while of the others one is dead and the other had active growth still present in 1944. This was, however, in my opinion the result of bad management of the case. Dosage with radium was usually 6,500 r, given in an average time of 6 days excepting the case now to be mentioned.

The patient treated in 1939 was stated to have a very actively growing squamous carcinoma. He was treated with interstitial radium, the dosage being recorded as 11,700 r. He subsequently received deep X ray therapy, but died 13 months after the beginning of treatment with active growth and necrosis both present. In spite of the virulence of the growth I consider this irradiation too heavy.

The patient alive with active growth gave a history of an accident five years previously in which the cheek was injured by a tooth. When seen in 1942 he had a growth involving the cheek and attached to the mandible posteriorly. He was treated with interstitial

radium (6,500 r) and deep X ray. Considerable improvement took place but the growth did not completely resolve and further interstitial radiation was given in December 1943. The ulcer then healed leaving a scar attached to the mandible. In the latter part of 1944 some activity was suspected although there was little to be seen or felt. A biopsy showed squamous carcinoma and he was referred to a surgeon for removal of a small portion of the mandible and dissection of the glands of the neck. When I last saw this man about May, 1945, he had only had a removal of a portion of the cheek followed by a plastic operation. He then showed no sign of growth.

I discussed the case with the surgeon, but as the cheek looked healthy I made no request for further interference at present.

There are several comments to be made about the treatment of this patient. Looking back I feel that the best procedure would have been to remove a small portion of the upper margin of the mandible at the site of attachment first of all, and then to insert radium needles to the affected area. I believe that this would have eradicated the disease without need for further treatment of the primary site.

A word also needs to be said about the microscopic findings in the later stages. Before now I have had a report of active growth when to all appearance necrosis only was present. I am thinking in particular of a lip case which received heavy deep X ray radiation. A late necrosis - two years after treatment - followed, and was alleged to show active growth in a biopsy. Nevertheless it was left untreated, and healed within a month or two leaving a good scar. What is more, it has remained healed and apparently well for about three years. I believe that radiation makes things very difficult for

the pathologist by producing a considerable alteration of the tissues, and I think that histological reports on tissue that has been irradiated, particularly some considerable time previously, should be accepted with a certain amount of reserve. I have a high opinion of our pathological reports, but I think there are cases where it is difficult to be certain. In this cheek case, if active growth remained it should have been present in the bone also. Nothing has yet been done to the bone other than the irradiation it received, and the patient now appears to be well. It will be interesting to follow the progress of this case.

Although the three surviving patients are recorded as having small palpable cervical glands, none have so far had the glands dissected.

Symptoms.

The chief symptom complained of in every case was the present of a sore on the inner surface of the cheek. In all except the patient with a history of accident the growth was opposite the articulation of the teeth.

Three were recorded as heavy smokers. Leucoplakia was present in two cases.

Duration
of
Symptoms.

The duration of symptoms was given as

1	week
3	months
12	months
10	years.

The last three all gave positive sections.

The patient who stated the duration of his symptoms to be a week was found on examination to have a flat growth 4 centimetres in diameter, with central ulceration and heaped up edges and peripheral nodules. He was treated with deep X ray and the lesion resolved. He has since remained well for over two years. His Wassermann reaction was negative. There can be little doubt that

his growth must have been present for very much more than a week. The other patient who went to the other extreme and complained of symptoms for ten years must, I think, have had an antecedent leucoplakia which attracted his attention.

This group is too small to be of much statistical value, but the results are fairly satisfactory.

Apart from the case with a "very actively growing carcinoma", and it was almost fungating through the cheek when he first attended, all patients are alive. As far as can be judged from this small group, these growths do not appear to metastasize rapidly.

It is not proposed to discuss other sites in relation to the buccal cavity as the material available is too limited. As it is, some of the groups have dealt with such small numbers that little can be inferred from them.

Telecurietherapy, mass radium or radium
beam therapy.

The idea of mass radiation using a considerable quantity of radioactive material placed within a container is by no means new. It probably developed from the use of heavy moulds or packs, but has certain advantages over these older methods. To begin with, there is far more effective limitation of the radiation to the area under treatment, so that numerous parts or fields can be used, and there is greater protection for the patient generally and for the operator working the apparatus. As one who has in the past made a great number of heavy moulds I can stress the importance of this latter point.

The skin areas of the patient adjacent to that being treated are protected by the thick walls of the unit, constructed of some dense metal, such as lead. In one unit that was used at the Westminster Hospital, London, the thickness of the wall in contact with the patient was much reduced by using gold for this portion. This made for greater ease of application, especially for awkward corners.

History

Kronig (21), at the Freiburg in Brisgau Frauenklinik, seems to have been the first to put the idea into practice. In 1912 he made what he called a "cannon" containing a large amount of mesothorium. This he used to irradiate women for parametrial involvement in cases of cancer of the uterine cervix, using a number of different ports. He, however, gave up the method as uneconomic as it immobilized half his entire supply of mesothorium for the treatment of a few cases only.

In 1915 Lysholm, of Stockholm, revived the idea and constructed an apparatus that was not only improved mechanically, but gave a greater measure of protection as well.

Both of these early pieces of apparatus consisted essentially of a lead cylinder containing the radioactive material. In that of Lysholm the radium was placed in a piston which could be moved up and down in relation to the

opening, thus varying the radium skin distance. The lateral walls consisted of lead two centimetres thick which absorbed 75 per cent of the gamma rays emitted by the quantity of radium in use. Exposures lasting two hours at a time were given to each area, but by a system of pulleys and counterweights, some degree of movement was possible for the patient during this rather long treatment.

In 1919, as has been related, a simple container was constructed at the Middlesex Hospital, London, in which was placed two and a half grammes of radium. One authority (22) gives the amount as just under five grammes, but I am nearly sure that this refers to the weight of the salt, not the element, as it is elsewhere described as two and a half grammes. A long rod was attached to the container, and served to regulate the direction of the emergent beam. This appliance was known within the hospital as the large "Q" radium, and was first used in October, 1919. Its employment was continued until April 1921, and 168 patients were treated. Beneficial results were noted in a number of cases, especially great temporary improvement in inoperable breast cancers, but the results as a whole were not thought to justify continuation of this method of treatment.

Following this many different units were constructed. In France in 1924 Mallet conceived the idea of a machine which would give simultaneous radiation at several ports. It was constructed for him by Danne. It consisted, in effect, of a curved arm of metal supporting three lead boxes containing radium. The curve was an arc of a circle, so that the beams from the three boxes converged to a central point. The apparatus seems to have been used chiefly for carcinoma of the uterine cervix, and apparently first three anterior ports and then three posterior ports were used. The boxes were to some degree adjustable, and the beams were intended to converge upon the site of the disease.

Even more complicated units were constructed, as for

example that of Sluys-Kessler, in which 13 different foci were directed towards the site to be irradiated.

However, a better known and more famous unit was that of Regaud Ferroux at the Radium Institute of the University of Paris. This was a massive block of lead supported by an overhead structure, with pivots or gimbals for angulation. It contained four grammes of radium, subsequently increased to eight grammes, and was largely used as a source of external radiation for cases of cancer of the cervix, to deal with the parametria, following the usual intra-cavitary treatment.

At Radiumhemmet, Stockholm, a three gramme unit was in use. This was designed, I think, by Sievert, who later made use of pneumatic transference of the radium to and from the unit head for the greater protection of operator and patient. He was, I believe, the first man to conceive this idea and carry it out.

Other units worthy of note were that of Failla at the Memorial Hospital, New York, and that of Cheval and Mayer at Brussels. Both these had means of retracting the contained radium behind a heavy lead screen within the unit, thus increasing the safety of those using it.

That of Cheval and Mayer was also notable in that two apertures or treatment ports were provided, so that with two beds, one placed below the unit and one above, two patients were treated at one and the same time.

Another point of interest in connection with this unit is that, in 1932, it was broken up and the radium brought to London, having been purchased, so I understood, by the National Radium Commission. It was there divided into four lots of one gramme of radium element each and thus provided the radioactive source for each of four one gramme units which were distributed to certain London Hospitals, namely, the Royal Cancer Hospital at Fulham, the Westminster Hospital, the Middlesex Hospital and University College

Hospital. The Westminster unit was shortly afterwards increased to two grammes.

It was with the one gramme unit at the Middlesex Hospital that I gained my experience of such a mode of treatment.

Establishment of beam therapy research.

In the fourth decade of this century great advances were made and by 1933 Radium Beam Therapy Research (23) was instituted on a considerable scale. The Governing Body included Sir William Bragg as chairman, and Lord Dawson of Penn and other notabilities. The cost of research was met by grants from the Royal College of Surgeons, the Royal College of Physicians and the British Empire Cancer Campaign, with donations from other bodies and individuals. A very large quantity of radium was lent by the Union Minière du Haut Katanga.

At first the cases treated were limited to cancer of the mouth, tongue, pharynx and larynx, but later the field was somewhat widened.

The research was begun with a five gramme unit. Later a second unit of the same intensity was added, but with much greater protection.

The need for physicists.

The close co-operation of physicists was needed and was utilized. Grimmett was in charge of this side. Much has been done by them with regard to protection of the staff, accuracy in positioning, and assessment of dosage. So much advance has been made that the modern beam therapy unit is perfectly safe from the operator's point of view. The radium is contained in a heavy lead safe, and after the unit head has been placed in exact position in relation to the patient, the operator leaves the room, and by the throw of a switch the radium is pneumatically transferred to the unit head and treatment begins. A warning light shows that the radium is in position.

The first five gramme unit was not of the pneumatic type, but the second was, and since then almost exactly similar units have been installed at the Royal Cancer Hospital, the Middlesex Hospital, the General Hospital, Birmingham, the Western Infirmary, Glasgow, and the Royal Infirmary, Edinburgh.

A directional caliper was developed to ensure that the beam was directed in the exact position. Soft tissue skiagrams, as instituted by Coutard, were of great help with regard to tumours of the pharynx and larynx.

A model treatment head was devised and constructed for the purpose of aiding calculations of dosage. This avoided making calculations with the patient under the actual machine, which was undesirable for several reasons. With the aid of a graphical calculator designed by Dr. J. Read, these estimations were greatly accelerated.

It is not intended here to review the whole report on Radium Beam Therapy Research. The facts stated have indicated the approach to the problem. A few figures from the report will be given before passing on to the attempts made at the Radiotherapy Clinic at the Adelaide Hospital to use what were for us large amounts of radium.

Before giving the figures, one point is of interest.

Treatment
of glands

In this research in Britain the attempt was usually made to treat the primary growth through the lymphatic gland area. In no case was a block dissection of the glands performed. In operable cases the response to radiation was satisfactory and a block dissection is stated not to have been indicated. When the response of the nodes was poor they were always inoperable from the beginning. In some cases where glands disappeared but recurred, it was felt that this was due to an uncontrolled primary growth which provided a reservoir of cancer cells from which the glands were filled.

In many cases glands disappeared and did not recur, which result is not easily achieved even with other methods of radiation.

Of the 366 cases dealt with in the report only 34 or 9.3 per cent were operable, and besides this many were of a type which had not previously given good results with other types of radiation.

Summary

A brief summary of results of treatment in the years of results 1934 to 1938 will now be given.

Carcinoma of the tongue, anterior two-thirds.

7 operable cases	5 symptom free
19 inoperable	3 "

Five others died of intercurrent disease showing no sign of cancer of the tongue, giving a total of 13 cases apparently freed from the disease.

Posterior third of the tongue.

1 operable	1 symptom free
48 inoperable	12 "

Six patients died of intercurrent disease with no sign of cancer at the primary site or in the glands, giving a total of 19 cases apparently freed from the disease.

Floor of the mouth

4 operable cases	all symptom free
20 inoperable	5 "

Alveolus.

None operable	
12 inoperable	5 symptom free.
Seven died of cancer.	

Cheek.

None operable.	
7 inoperable	2 symptom free.
Five died of cancer.	

Soft Palate.

2 operable	1 symptom free
12 inoperable	5 "
Two died symptom free of intercurrent disease.	

Hard palate.

3 operable	all symptom free.
6 inoperable	3 "

Tonsil

2 operable	Both symptom free
41 inoperable	16 " "

Two died symptom free of intercurrent disease.

Larynx.

8 operable	6 symptom free
16 inoperable	1 " "

These are some of the results of treatment with a five gramme radium beam therapy unit up to the year 1938. I have not included figures of cancer of the maxillary antrum or certain other sites, as in the years under discussion our cases have been too few to serve as any basis for comparison.

As Windeyer (24) has pointed out, statistical results do not give the whole picture. No account is taken in tabulated results of any amelioration of symptoms, easing of pain, prolongation of life or other improvement if the patient eventually dies of cancer.

The survival rates in the Beam Therapy Report are not for a five year period, as the research in question was begun in 1934, and the report was issued in 1938. The findings of the Governing Body were conservative and impartial, but it was considered that the method should be continued, and the fact that six new five gramme units were obtained and installed is a sufficient indication of the feelings of the committee.

Reference has already been made to the work of Lederman and Mayneord with regard to treatment of cancer of the larynx by this method, and the remarkable results they achieved.

For many years I have urged that the Radiotherapy Clinic should endeavour to acquire a radium beam therapy unit of some sort to give certain types of case a better chance of survival, but to a small organization the cost is prohibitive. Nevertheless, I hope that some benefactor may see his way clear to give such a unit as, in my opinion, it would be the means of saving a number of lives that are

at present lost. Our home-made unit is, as has been stated, too weak and too unmanageable to be of much value.

Heavy
Radium
Moulds

Having thus cleared the ground by showing the reasons for my belief in the value of treatment by mass radium I will now pass on to a number of cases that I have treated with heavy radium moulds in an attempt to deal with certain difficult conditions. Some of these have no relation to mouth cancer, but are included to give a relatively complete account of the method and its results. This does not pretend to be a complete list of such cases as some may have been used before I was associated with the clinic. I give no account of "radium collars" as in my opinion the radium on such applicators made here was mounted at an insufficient distance to be of much benefit. Rather the reverse was true, as a number of cases developed a superficial necrosis of the skin and subcutaneous tissue of the neck, and one or two even of the mandible. In those days there was no "roentgen" to tell what dosage the tissues were actually receiving.

I have made very many heavy moulds for the neck on the other side of the world, but these were usually at a distance of approximately five centimetres, although for some special sites it was reduced to three centimetres. In those latter cases the dosage -- recorded in milligramme hours or millicuries destroyed -- was reduced to a figure that experience had shown the skin would stand.

The following cases are very far from being an unbroken list of successes. On the contrary, only one or two were successful, but these successes were in cases that in my opinion could not have been adequately treated by any other means at our disposal.

Cases

1. To begin with I wish to refer to a case of retinoblastoma of the eye, treated in England. A boy, aged one or two years, was brought to the Middlesex Hospital after one eye had been removed on account of this disease. As is said to occur in 25 per cent of cases, the other eye was then found to be affected, so Windeyer made a Columbia paste mould and treated the remaining eye with radium at a distance of about four centimetres. I can remember Windeyer telling me that insertion of radium needles into the orbit was disastrous. I have not the records of the case, but the child did very well, the growth disappeared, and I heard seven years later that the boy remained well with perfect vision. Another such case was treated at the same hospital equally successfully a few years later with radium beam therapy, using the one gramme unit.

In 1936 just such a case was brought to me in Adelaide. The boy - they are usually boys - was exactly one year old and the right eye had been removed before it was discovered that the left eye was affected also. I believe that it is the habit of the growth to appear in one eye before the other is obviously involved. In an endeavour to follow out the technique that had been successful within my knowledge, I constructed a Columbia paste mould three centimetres thick and mounted 127 mg. of radium element on it. This the child wore intermittently for 67 hours, giving a total of 8509 mg.h. and a skin dosage of 2900 r. A modest skin reaction followed. In a month's time the growth had changed colour, becoming dark grey and smaller. Two and a half months later the opht^halmic surgeon reported that the growth was still present. Vision was still good. It was here I made my mistake, as I then proceeded to apply a further larger dose of radium, this time 3300 r. A strong skin reaction ensued, with epilation of eyelashes and eyebrow. When two months later the surgeon reported that the growth was still present the child was sent to the Radiotherapy Clinic at the Royal Adelaide Hospital, where it received

further treatment in the form of deep X ray.

In 1944 the boy still had his eye, but there was much corneal opacity and very little sight.

I believe that if treatment had been suspended after the first mould that this child might have lived and retained his sight. The dose was probably on the small side but this type of growth is rather radio-sensitive. The appearance of the mass had certainly changed greatly and even though it had not disappeared it is likely that complete resolution in such a situation would take a long time. Largely because this case was not a success I think it well worth recording, so that others may avoid the errors that I made. One of the troubles of these rare lesions is the difficulty of accumulating sufficient experience to enable one to choose the right factors for treatment.

2. The next case is that of a boy of four months with a swelling in the right temporal region. This was reported in the Medical Journal of Australia and a reprint is attached to this thesis. Briefly the history is as follows:

A mass appeared on the right side of the head when the child was three months old. This grew rapidly and skiagrams showed bony outgrowth suggesting osteogenic sarcoma. He was treated with a radium mould with a total of 12,000 mg.h. at a distance of three centimetres, over an area 6 by 6 centimetres, giving 4,200 r at the skin surface. The time of treatment was 132 hours.

A section was taken eight weeks later and was reported as fibrosarcoma by three pathologists.

A brisk reaction followed the application of the mould and the tumour slowly disappeared taking about six months to resolve completely. He has remained well for five and a half years, and skiagrams show no bony abnormality.

3. The third case is that of the woman with extrinsic carcinoma of the larynx, described in the section dealing

with cancer of that site. As previously related, she died with numerous secondary deposits in her lungs, but no trace of growth in her neck.

4. The fourth case is that of a man of 63, a very heavy smoker, who developed glands in the neck in 1943 and came to the clinic six months later with a mass of fixed glands on the left side of his neck. One gland had been excised, and microscopic examination showed squamous carcinoma. On account of his heavy smoking and the nature of the growth the pharynx and larynx were regarded as the most likely sites for the primary growth. Despite an intensive search of his mouth, pharynx, nasopharynx, and the larynx, and numerous skiagrams of oesophagus, stomach and lungs, no primary lesion was found.

Heavy radium moulds were applied to each side of his neck, first the left and then the right, at a distance of 4.5 centimetres. The total milligramme hours were 35,000 on the left, and 30,000 on the right, giving a skin dosage of 5,300 r and 5,610 r respectively. The central line of the neck anteriorly received 3,690 r and the left glandular area at least 5,000 r. The time of application for the two moulds was 32 days.

Two months later the masses in the neck had practically disappeared, and the patient was gaining weight.

Four months later there was a recurrence at the lower end of the left sternomastoid muscle, but situated more anteriorly, and in August radium needles were inserted into this.

This mass was reduced in size, but later a fluctuant swelling formed which eventually broke down leaving a discharging sinus. The patient died in March 1945, and post mortem he was found to have a large growth of his left pyriform fossa.

This case reminds me forcibly of some remarks made by

Eric Pearce Gould at the Middlesex Hospital. Speaking of growths of the pyriform fossa, he said that it was remarkable how almost invisible lesions in this area gave rise to massive secondary deposits. It was his opinion that radiation, by prolonging the life of the patient, gave time for the primary growth to become manifest. Previously, he thought, the patient died long before the lesion could be detected. This case certainly seems to bear out his contention, as in the early stages he was repeatedly examined without success, while at his death no-one could have missed the growth.

5. The next case was that of a young woman of 35, who had an enlarged right tonsil for twelve months. This was removed at the end of May, 1944, and section showed rather a confused picture. She came to us in June, and then had a large hard movable gland in the right submaxillary region, and an indurated area in the tongue adjacent to the right tonsillar bed.

She was treated with a large radium mould of an area of 100 square centimetres at a distance of 4.5 centimetres. The total was 35,000 mg.h. and the dosage 5400 r to the skin. The time of application was 12 days. The following month needles were inserted in the appropriate area of the tongue and the tonsillar bed.

She had a brisk reaction, but then improved greatly, gaining over 13 lbs. in weight. The glands were then dissected, and from the examination of these, the pathologist reported the growth as an endothelial sarcoma.

The tongue did not entirely resolve, and in May 1945, further interstitial radiation was given to the whole of the posterior third of the tongue. The local condition appears to have improved greatly, and the induration which was previously apparent is greatly reduced. No further glands have appeared.

6. A woman of 69 was admitted in July, 1944, with a swelling of the left side of her neck. It had been present for twelve months.

Her previous history was somewhat obscure. Both she and her mother had suffered from simple goitre, hers occurring at the age of 15. Her account was that she had been given something to rub on it, and that it had then disappeared. She had also had a small lump removed from the buccal surface of her left cheek five years before presenting.

A gland was excised, and microscopic examination showed solid carcinomatous masses of possible thyroid origin.

On examination she had a large mass occupying most of the left side of her neck with very numerous glands extending into the posterior triangle. The left lobe of the thyroid was said to be involved in the mass, the right lobe and the isthmus to be free.

A Mantoux test was negative.

Skiagrams showed no bony metastases, and no deposits were visible in the chest.

No other primary source was discovered. She was treated with a large radium mould at 4 centimetres distance. The dosage was 5,400 r on the skin (40,000 mg.h.) Time of application - 128 hours in between two and three weeks. A brisk reaction followed and the glands disappeared rapidly, being barely palpable three weeks later. She had now, however, developed glands in the left axilla and in the left inguinal and iliac regions.

Treatment of these areas was begun with deep X ray without apparent effect. The masses in the groin and iliac fossa grew very rapidly until there was a huge mass involving the upper third of the thigh, with vascular obstruction and necrosis, combined with secondary infection.

The necrosis was apparently due to interference with the blood supply as it developed before radiation of these areas was complete. Treatment was discontinued and the patient died a week later.

7. The next case has been somewhat more successful so far. A man of 60 from a distant country area had a squamous epithelioma removed from his right temporal region in January, 1944, the raw surface being covered with a skin graft.

He was told to report in a month, but instead went home, returning only in October with a mass of glands in the right preauricular region. He also complained of an unpleasant taste in his mouth of a few months' duration.

On examination the site of excision and graft looked very healthy. Below this there was a mass of glands in the preauricular region, at the angle of the jaw, and behind the ear some glands were about to fungate. The parotid was involved in the glandular mass, no doubt accounting for the unpleasant taste of which the patient complained.

The glands were not entirely free, and Dr. Jose considered that they were not operable.

Before a mould was applied three days later the glands behind the ear broke down.

A large mould was made and applied, the radium being at a distance of 3.5 centimetres. The area was 100 square centimetres, and the dosage 8,000 r to the skin (40,000 mg.h.) Time, 148 hours in 13 days.

A brisk reaction and epidermolysis followed. This gradually subsided and the skin healed, including the sinus behind the ear. Within two months of treatment the patient volunteered the statement that the unpleasant taste in his mouth had gone. When last seen in May, 1945,

he remained well although the lower part of his ear had suffered a little from the radiation, having received a dosage of 10,000 r.

8. Within the last few months a young man with an osteogenic sarcoma involving the left temporo-mandibular region has been treated with a large radium mould, the skin dosage being 8,000 r in 15 days. He also had a very brisk skin reaction, but this has healed although there is some scarring. He still has a bony mass, but it is too early to form any idea as to the result of the treatment. He made no complaint at any stage of treatment or reaction, and I believe he is back at work.

One or two even more recent cases have been similarly treated.

This list does not purport to include all cases treated at this clinic with heavy moulds, but I think it includes the greater part of them, that is, moulds of considerable area and with the radium mounted at a distance of three or more centimetres. Further details of these moulds are given later.

Numerous moulds have been made for smaller areas, but it is only in recent years with the increasing use of superficial X ray for skin malignancies that sufficient radium has been set free to attempt the use of these larger moulds.

Disadvantages of large moulds.

Large moulds are not in themselves ideal. Their manufacture is tedious and time-consuming, and mounting the radium inevitably exposes the constructor to more than the tolerance dose of radiation.

Moreover, the nursing staff, and to a less extent adjacent patients and others are exposed to undesirable radiation. The moulds themselves are often cumbersome and tiring for the patient to wear, and unless very carefully made, are apt to get out of position. The patient can rarely tolerate them for more than twelve hours a day.

Their correct adjustment calls for considerable skill and knowledge on the part of the nursing staff.

What is more, one cannot choose a series of ports through which to irradiate a deeply seated tumour. The number is usually limited to two, as for example, on either side of the neck. In the process of treatment the adjacent skin usually receives a quite appreciable dose. Thus in some of our cases in which moulds were applied to the neck, the skin below the clavicle developed a moderately brisk erythema.

Comparison
with beam
therapy.

There can be no comparison, either for effectiveness or for safety, between a radium beam emanating from a mass unit and that from a mould. With a mass unit only the port chosen is irradiated to any appreciable degree, whereas with a mould there is a general irradiation in all directions.

Protection has already been mentioned but its importance should be stressed. As one who has made very many large moulds I can testify to the necessity of this. Adequate protection is impossible without a carefully designed radium unit.

The mould cases reported here vary from apparent complete success to undoubted failure. The only modes of treatment in these cases open to us were deep X ray or radium moulds. My belief is that the results were not the worse as a result of the method used. Such experience as I have ^{had} tends to make me think that with the more resistant lesions radium is the more effective agent of the two.

I have no illusions that the possession of a radium beam therapy unit would enable the clinic to save all cases of mouth cancer. I do, however, believe that a greater percentage would be rescued from a miserable death and would continue to be useful members of the community.

That this is possible is supported by Lederman and Mayneord's results.

Possibilities It may be that with newer and more powerful deep X ray
of deep plants, and the more accurate positioning rendered possible
X ray by such plants being shockproof, which our present machine
 at the clinic is not, combined with the use of appliances
 for beam direction, better results than were formerly possible
 may be achieved. Perhaps Cutler's technique will give us results
 that at present we dare not hope for, but I have yet to read of any
 results of X ray therapy of carcinoma of the larynx that approach
 those of Lederman and Mayneord achieved with radium beam.

Beam therapy units are not without their disadvantages. Their
 immensely high cost, and the length of time of each treatment are
 two of these. As against the high cost of purchase one may point
 out that running costs are negligible, and that depreciation is
 merely that of variation in value of the radium within it. If the
 price of radium falls, then, of course, the unit loses in value.
 In recent years, however, the price of radium has risen.

Nevertheless I feel that there should be at least one place in
 the Commonwealth where the services of a modern radium beam therapy
 unit should be available to the public. Perhaps it should be placed
 in a large city where there is the greatest density of population,
 such as Sydney or Melbourne. On the other hand, a more central
 position might be more desirable.

In Sweden radiotherapeutic work is concentrated at three centres,
 and the appropriate cases are transferred from any part of the
 country at the expense of the government. The great distances of
 Australia might make such a plan unworkable here.

This thesis, however, is not intended to be merely a plea for
 radium beam therapy. I think it desirable that such treatment
 should be available, but if equal results

can be achieved with deep X ray therapy, so much the better. X ray machines are cheaper, are largely made in Australia, and tap almost unlimited power in the electric supply mains. Much, therefore, can be said in their favour. But I do plead for the use of adequate external irradiation for the treatment of the more inaccessible mouth cancers. It may be that I have been unfortunate in not having seen this effectively done by means of X ray.

Contact X ray, no doubt, has its place in treating certain superficial and accessible lesions within the mouth and may be more extensively used in the future. Its advantages lie in the rapidity of application and in the limited volume of tissue affected. I do not, however, think that it has any place in treatment of cancer of the tongue. For the palate and certain other sites it may be quite applicable. I have no personal experience of the Chaoul or Phillips machines and therefore do not propose to discuss such treatment. *For the same reason super-voltage therapy is not discussed.*

Volume Dosage

I have so far said nothing about the volume dose received by the tissues when irradiation of one form or another is undertaken. A considerable amount of investigation has of recent years been carried out with regard to this problem, and physicists now evaluate the total energy received by the body in terms of the mega-gramme roentgen ^{or the mega roentgen c.c.} ~~c.c.~~ A certain amount of hesitancy is apparent in the literature with regard to the terms "volume dose" and "integral dose".

I have discussed this phase of the work with our physicist at the clinic, and he has worked out the approximate volume dose for several different types of treatment,

taking the term to mean that given above, namely the total energy received by the body. The results of some of his calculations are given below.

- | | | | |
|----|---|-------|---------------|
| 1. | A large tongue implant, | total | 3.8 m.r.c.cs. |
| 2. | X radiation of the larynx with 3 fields | total | 5.7 m.r.c.cs. |
| 3. | Single plane implant to the cheek | total | 0.4 m.r.c.cs. |
| 4. | Small mould to the hard palate. | total | 0.9 m.r.c.cs. |

And for the purpose of comparison only the following two are added.

- | | | | |
|----|---|-------|----------------|
| 5. | X radiation of the pelvis for carcinoma of the cervix | total | 31.6 m.r.c.cs. |
| 6. | Intra cavitory radium treatment of uterine cervix | total | 8.7 m.r.c.cs. |

I do not propose to go further into this matter, but it is interesting to note that the energy received by the body during irradiation of the larynx by X ray and in treatment of a large lesion of the tongue with interstitial radium are of the same order.

Also the last two figures go far to answer a question asked by a gynaecologist at a recent meeting, as to why the patient may be so much more upset by X radiation of a pelvis in comparison with the insertion of radium into the uterus and vagina.

One point only remains to be mentioned, and that is that the beam therapy report shows clearly, as might be expected, that the systemic effects of radium beam therapy are found to be less with a reduction in volume of living tissue irradiated. This, as is well known, holds true with roentgentherapy also.

I have recently come across an article by Nuttall (25) dealing with the intra-oral radium treatment of cancer of the mouth. This is from the Holt Radium Institute, Manchester, and deals with a large number of cases. He makes many good points although on occasion I find myself in dis-

agreement with him.

Technique of Treatment

Speaking generally, I agree with Nuttall that where possible, a mould is preferable to implantation of needles. He does not suggest this for the tongue, and indeed in such a site with a constantly moving organ the extension of the growth is usually more than is visually apparent, especially with regard to depth. Thus implantation is usually needed,* and I find that in the posterior portion I prefer to use needles of considerable active length, not less than 4 centimetres. These are inserted vertically, and several planes are employed.

For lesions of the dorsum of the tongue I do not as a rule care to rely on horizontal implantation of needles for the same reason as that given before, that the lesion is deeper than it appears to be.

For the tip of the tongue I have had failures with interstitial radium, necessitating the subsequent use of surgery, although not in the five years under review apart from the case treated with roentgentherapy.

I do not care for his suggestion of the use of radon seeds. I have seen many cases of skin lesions treated with lightly filtered radon seeds, and I have not regarded any as entirely satisfactory. The caustic effect is undesirable and indiscriminating, and where the seeds are left as a permanent implant I have noticed that there is usually permanent discomfort as well. I have not used them for the tongue at all, being content to follow the teaching of the French school in this regard. I can, however, believe that seeds are more convenient for awkward positions.

* This needs amplification. A mould needs distance and a considerable quantity of radium to give an effective dose at depth. This makes it impracticable for most tongue lesions.

I have not, in Australia, used the technique sometimes employed by Monod of inserting needles for four days horizontally, and then removing them and re-inserting them vertically for another four days.

For the floor of the mouth and the alveolus I agree with Nuttall that moulds are preferable when possible. These may be single, of the dental type, or where the lesion is deeper a submental mould may be added. I am not, in this paper, considering the question of antral invasion at all. That has been admirably dealt with by Windeyer (26) among other writers, and our cases are too few to provide any original comments.

With regard to the palate I am in agreement with Nuttall that moulds are best for the hard palate, and that lesions of the soft palate are suitably treated by implantation, though here, as elsewhere, I believe that adequately filtered radiation is better than seeds.

I have not in recent years employed moulds for the buccal surface of the cheek. I nevertheless think the method sound if the mould is well fitting and can be kept in place. My cases have been treated with implanted needles, and the results have been fair.

With regard to the fauces, I have used implantation for the few cases I have had to deal with, while lips have usually been treated at the clinic by interstitial radiation, or by means of a mould if the gingivolabial sulcus and the alveolus are involved. In my private practice I have been using for some years X radiation for lips, even on the buccal aspect, provided that the lesion does not involve the sulcus and alveolus. For a considerable time I used moulds for all lips, but since using roentgentherapy the results achieved seem to have been equally good, with much less bother to patient and operator, and with the advantage that there is no necessity to send the patient to hospital.

The second part of Nuttall's paper is not available as apparently all copies were sunk in transit.

Construction of Moulds

While on this aspect of the subject I should like to refer in more detail to the moulds used at the clinic. The large external moulds have usually been made of Columbia paste, chiefly because of the absence of a satisfactory alternative during recent years. This makes a rather heavy and cumbersome mould, so on one or two occasions a Columbia paste base plate has been used, with a hollow paste support to mount the radium and achieve the necessary distance. This has the effect of reducing the weight considerably. The area of these moulds has usually been about 100 sq. cm. and the filtration always 1 mm. of platinum or its equivalent. The charge carried has been in the neighbourhood of 300 mg. Ra. el. and the time of application for each mould has been between two and three weeks. The intermittent application of the mould obviously increases the number of days occupied in treatment. The addition of tubes of radon to the radium on the mould has in recent cases decreased the number of days to about 14.

The distance at which the radium has been mounted has varied. The earlier cases were mostly at a distance of 6 cm. or somewhat less, but our physicist has calculated that the best depth effect is achieved with the radium at a distance of 3.5 to 4 cm. Any increase above this merely adds to the time necessary without markedly improving the depth dose.

The intra-oral moulds have almost always been of the dental type, and have been constructed at the Dental Hospital adjacent to the Royal Adelaide Hospital. The staff there is accustomed to the manufacture of such appliances,

and the results have been very satisfactory. These moulds are very familiar to those concerned with cancer of the mouth and need no description. We have, however, been increasing the thickness of the lead roof and walls of the box in the mould containing the radium in an endeavour to reduce the radiation effect on that portion of the mouth not undergoing treatment. In one or two we have been able to increase the thickness of the lead to 1 cm., when such effect outside the area treated becomes almost negligible. Unfortunately, this makes rather a heavy mould to carry within the mouth, and is rarely possible.

The question of radium implantation has already been considered in the section on tongues.

The question of Biopsy

It has been often suggested that the taking of a biopsy entails an added risk to the patient with regard to the dissemination of the disease. As far as the carcinomata are concerned, I have not found this borne out in practice.

The usual routine at the clinic in the case of lesions of the mouth, is to take a biopsy at the time of the radium implantation, although in certain cases of doubt it may be taken previously. I have seen no ill results that could be traced to this practice. Certainly it is difficult or impossible to say that glandular metastases would not have developed had a biopsy been avoided, but the vast majority of cases who showed deposits in their glands had them at their first appearance at the clinic before the beginning of treatment. One man whose biopsy showed a "very actively growing squamous carcinoma" is now well over five years later. He suffered from pulmonary tuberculosis and his glands were not dissected although they were irradiated.

The Importance of Palpation.

Before passing to the next matter, I should like to stress the importance of palpation in the examination of the mouth. I have seen before now a senior member of the honorary staff of a London hospital miss an epithelioma of the tongue by relying on visual examination. On putting a finger in the mouth, the mass was obvious. This matter of palpation is not limited to tongues, as an experienced examiner once he has gained the confidence of the patient, can palpate not only almost the whole tongue, but the tonsils, the lateral wall of the pharynx, and can sometimes reach down well into the pyriform fossa. The whole secret, apart from gentleness, is to keep the examining finger close to the tongue and away from the fauces. The sensation of induration when found, is almost unmistakable, while other lesser points may help in diagnosis.

Factors that may be concerned in the production of mouth cancer.

At this point it may be suitable to consider briefly the factors that may help to produce this group of cancers.

Of these, age is important, as the figures, both those given here and those in other writings, demonstrate. Although some cases occur in the relatively young, and in the literature, even in the very young, the majority of cases occur in people of more than middle age. Our tables show a rising incidence even up to the eighth decade.

Sex is also of importance as far as more cases occur in males. It is hard to believe that there is a sex-linked liability to such disease present in men and absent in women, so that an examination of the different habits of men and women is required.

In this connection I do not think that smoking can be exculpated. Certainly a vast number of men smoke and there

are in comparison relatively few cases of cancer of these sites, but many of my patients, both public and private, were heavy smokers. As a smoker myself this saddens me, but we have too many examples of the carcinogenetic properties of combustion products to dismiss the probability of such being the case. Tar and soot cancer are two that spring quickly to the mind, and in the case of mule spinners and retort workers we are dealing with carcinogenetic hydrocarbons in oils that have been subjected to heat treatment. Kangri burn cancer has probably a different mechanism.

With regard to women, I do not think that the vast number of them have smoked sufficiently long to affect the figures much as yet. Years of smoking appear to be necessary to produce this disease. With the deterioration in quality of tobacco during the war I fear the possibility that a greatly increased incidence may follow some years after the conflict is over.

Smoking is obviously not the only factor, as an appreciable group of patients have never smoked, but I am inclined to think that its potentiality for causing cancer is not limited to the sites discussed. May it not be a factor in cancer of the stomach and oesophagus?

Syphilis has frequently been named as a forerunner of cancer, and there is no doubt that this is at times true. It is certainly apt to be followed by leucoplakia, which is an important precursor of cancer. However, in our cases the proportion of those showing a positive Wassermann reaction, or giving a history of this disease, was too small for it to be regarded as a major contributory factor.

The condition of the teeth, whether showing dental caries, sharp and irritating edges, or a generally unclean condition, or perhaps all combined, I do consider of real significance. After studying the records of my private patients I am forced to the conclusion that dentures, presumably ill-fitting, can be a fruitful source of trouble.

If smoking is added to irritating conditions such as any of these, I imagine that the likelihood of cancer is greatly increased.

Other tongue cancers have developed in the smooth tongues associated with achlorhydria, and in the fissured tongues of chronic glossitis. One or two have been in women with microcytic anaemia.

Amalgams of different metals used in dental stoppings have been cited as a possible cause of mouth cancer. It has been shown that a potential difference of a few millivolts may exist in relation to these. This does not sound very different from normal electrical impulses that are present in the body, but perhaps the constancy of the voltage, the fact that it is always present, may be enough to produce an abnormal stimulation of the cells. Considering the very great number of amalgam fillings that must be present in probably millions of mouths one would expect a greater incidence of the disease if this were at all a powerful factor. On the other hand we must remember that a very small percentage of the enormous number of smokers actually develop cancer of the mouth.

Heredity may have a bearing on the matter, but our records are too inadequate in this respect to furnish any information. One or two of our patients at least have had near relatives with cancer of the throat or nearby structures, and several more have mentioned relatives with cancer of other organs. Little significance can be attached to this in view of the paucity of investigation of the remaining cases.

A few cases have given a history of a sequence of growths in the same patient, such as a lip followed by a tongue, or a tongue by a tonsil. This is by no means un-

common, and has been dealt with by various writers, including Sarasin, whose article on this subject has already been cited.

I cannot leave the subject of heredity, and the apparent transmission of a cancer tendency from one generation to another without briefly referring to the work of Bittner and his remarkable experiments with mice. After the immediate transference of mouse litters of a high cancer strain to foster mothers of a low cancer incidence he found that not only did these litters have a greatly reduced incidence of cancer, but that so did the subsequent progeny of these litters without further fostering. In other words, by one act of fostering he converted a high cancer strain to a low cancer strain. To explain this he postulated a "milk factor" These experiments have been confirmed by numerous other workers (27). Perhaps some such factor may be operating in man also.

With regard to cancer of the larynx, the important factors again appear to be age and sex, with such irritants as tobacco smoke, though according to the two Jacksons this is less important here than in cancer of the tongue. They also refer to irritation and inflammation and "the very important element of frustrated repair". (28).

Heredity also may play a part, but on the whole it appears that cancer may sometimes occur as one form of response to reiterated slight damage to the tissues.

Planning of Treatment.

The treatment of the lesions dealt with in this thesis calls for a planned attack with the most appropriate weapons at our disposal, whether radiotherapy alone, or in conjunction with surgery. This entails

Early and accurate diagnosis

Investigation and charting of the

extent of the lesion and glandular involvement as far as possible.

The necessity of as clean an area as possible for treatment. This may be achieved within the mouth by the sealing and cleaning of teeth and the extraction of others if necessary. Such extractions should always be performed before radiation, as after treatment extraction is likely to be followed by necrosis. If it is the larynx that is being treated, the use of a very low initial radiation dosage in accordance with Coutard's technique, may be tried.

Collaboration with the surgeon or other specialist so that the whole procedure, both radiation and surgical, is planned as an integral whole.

Decision as to whether the primary lesion is to be treated entirely by radiation, or whether to give portion of the dose, as in Cutler's technique for the larynx, and then to wait to see the response before deciding whether the treatment should be completed by radiation or by surgery.

Treatment as early as possible as is consistent with the above principles.

Administration of the dose within a definite pre-determined time. This dose should be planned to be lethal to the tumour, and not to allow of repetition.

The utmost use of physical aids for accuracy of dosage and positioning.

Adequate attention to drainage areas, by dissection of glands if possible, or if not, by irradiation.

The use of skiagrams, including soft tissue skiagrams.

Adequate follow up.

No repetition of treatment unless the likelihood of necrosis is small or unimportant. This of course varies with the organ being treated. In the case of the larynx,

necrosis is very serious, whereas a small necrosis of the tongue or mandible may be relatively unimportant.

Organization of the Department.

Besides these main principles, there are such matters as the general organization of the department. At present the Radiotherapy Clinic of the Royal Adelaide Hospital is suffering from very serious disadvantages other than that of antique machinery. There are no radiotherapeutic wards, with the result that patients are scattered throughout surgical and medical wards. This makes supervision difficult, and has the added disadvantage that the nursing staff looking after such cases has had no special experience in this direction. There is no doubt that special wards and a coherent department are badly needed, with wards, treatment and mould rooms, small theatre, clinic room and in fact all the necessary units of such a department housed in one block with convenient access. All this, no doubt, is envisaged for the future, but in the meantime work is hampered by the lack of such facilities. The war has interfered with the development of the department, but until such time as this can be fulfilled, work must be carried out under difficulties.

Summary and Conclusion.

A consideration of the facts disclosed in this thesis reveals a number of points of interest, of which perhaps the first is the relative adequacy of radium treatment, as compared with the relative inadequacy of deep X ray. This has not quite the significance that appears on the surface, as it has been the practice of the clinic to treat the more hopeless cases by the latter method thus adversely loading the figures. Furthermore, most cases of cancer of the larynx were treated with deep X ray, and the majority of these cases were very advanced with metastatic deposits.

The good results of treatment of this disease in other clinics are very largely with cases of intrinsic carcinoma, and although a considerable proportion of our cases are described as endolaryngeal in origin, in many the growth had passed beyond these limits. With regard to carcinoma of the tonsil, according to Berven, and indeed to other writers, these growths are difficult to treat successfully.

However, the fact remains that lesions of the tongue, floor of the mouth, palate and cheek were treated with modified success, whereas lesions involving the tonsil or larynx were treated with very little success whatever. Some tonsillar cases were treated with radium, and here I feel that I am to blame in prescribing a dose probably insufficient to eradicate the disease. Nevertheless, I had previously had good results from similar dosage.

Beside these points certain defects are evident, and these can be roughly divided into defects of organization, defects of equipment, and defects of treatment. To some degree these are interlinked, as deficiencies of the first two groups are at least in part responsible for those of the third.

1. Defects in organisation.

Under this heading can be included such matters as the lack of a complete radiotherapeutic department, with special radiotherapeutic wards, operating theatre, treatment, mould and clinic rooms, and in fact all the basic essentials of such a department. This subject has already been discussed, but it may not be realised that frequently there are great delays in bringing patients for deep X ray treatment, as much as half an hour being lost with consequent disarrangement of the timetable. Moreover, as a natural corollary of this state of the department, there are no members of the nursing staff, either in the wards or in the theatres, with special experience of this mode of treatment or of the patients' requirements.

The lack of a relieving deep X ray technician has also been a very serious detriment, as the limitation of such treatment to one shift a day for two months of the year, while one or the other of the technicians is away on holiday, has curtailed the number of treatments possible to an undesirable extent. Even when two shifts are being worked, the theoretical maximum is never reached for reasons of hospital management and routine. In spite of this the reduction to seven hours a day imposes a severe limit to the number of cases that can be accepted for treatment, especially with an old machine with a relatively low output.

During the war years there has been insufficient collaboration between the department and other branches of the hospital owing to the heavy stress placed upon surgeons, physicians and all members of the staff. This, however, is a temporary disability which should disappear. In the same category is the lack of a trained registrar which has been experienced for the same reason, and which has also been seriously felt.

2. Defects of equipment.

These are chiefly confined to the deep X ray department, on account of the old type of machine, and the lack of aids to beam direction. Certain positions, also, are impossible because the plant is not shockproof. However, this situation should be rectified before long when the "250 Maximar" is installed.

3. Defects of treatment.

As already stated, these are in part due to the other deficiencies, congestion of cases from one cause or another producing delay and prolongation of treatment, while setting up in exact position is difficult under present conditions.

It is hoped that defects of treatment from other causes, such as lack of judgment on the part of the radiotherapist, will become infrequent as time progresses.

Defects of the records should be less likely to occur with the present registrar, who has undergone a considerable amount of training.

The radium work, on the whole, has been conducted with reasonable efficiency, and the experimental work with large moulds is devoid neither of interest nor result. In the absence of a beam therapy unit further investigation in this direction seems to be well worth while.

Cutler's concentrated radiotherapy is another method of treatment that will certainly be tried, but the attempt may have to await the new machine.

The co-operation of the physicist has been excellent throughout the whole time I have been associated with the clinic, and his advice has been most helpful. I have no criticism whatever to make in this direction.

In conclusion, I wish to thank Dr. F. S. Hone, Honorary Director of the Radiotherapy Clinic of the Royal Adelaide Hospital for permission to use the facts and figures relating to the cases at the clinic for the purpose of this thesis.

90.

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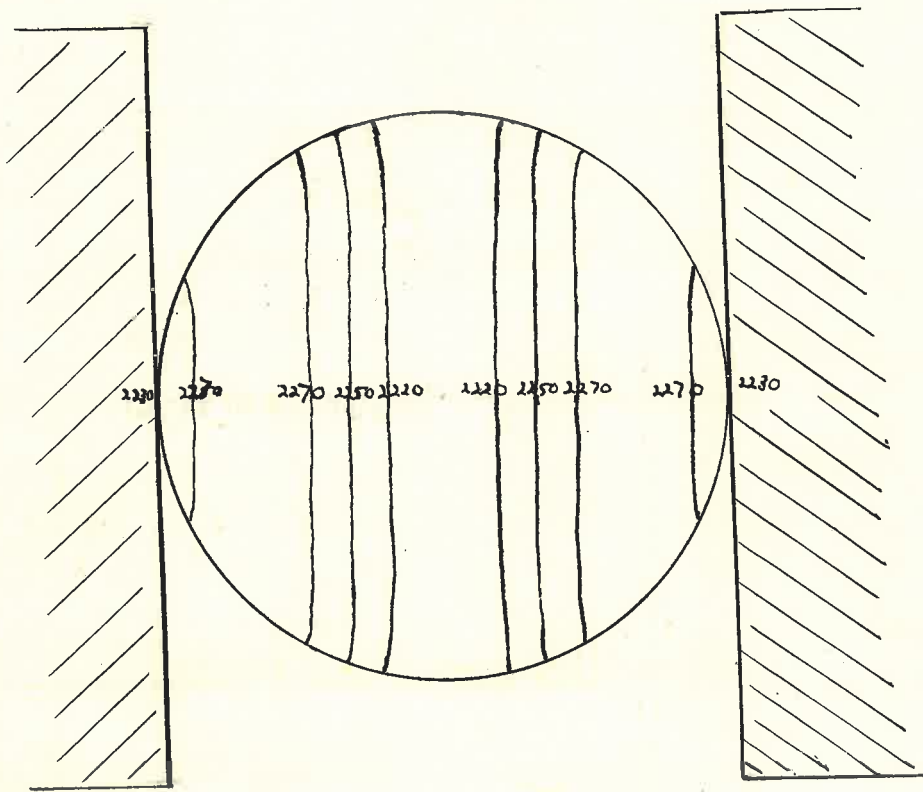
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Isodose curves

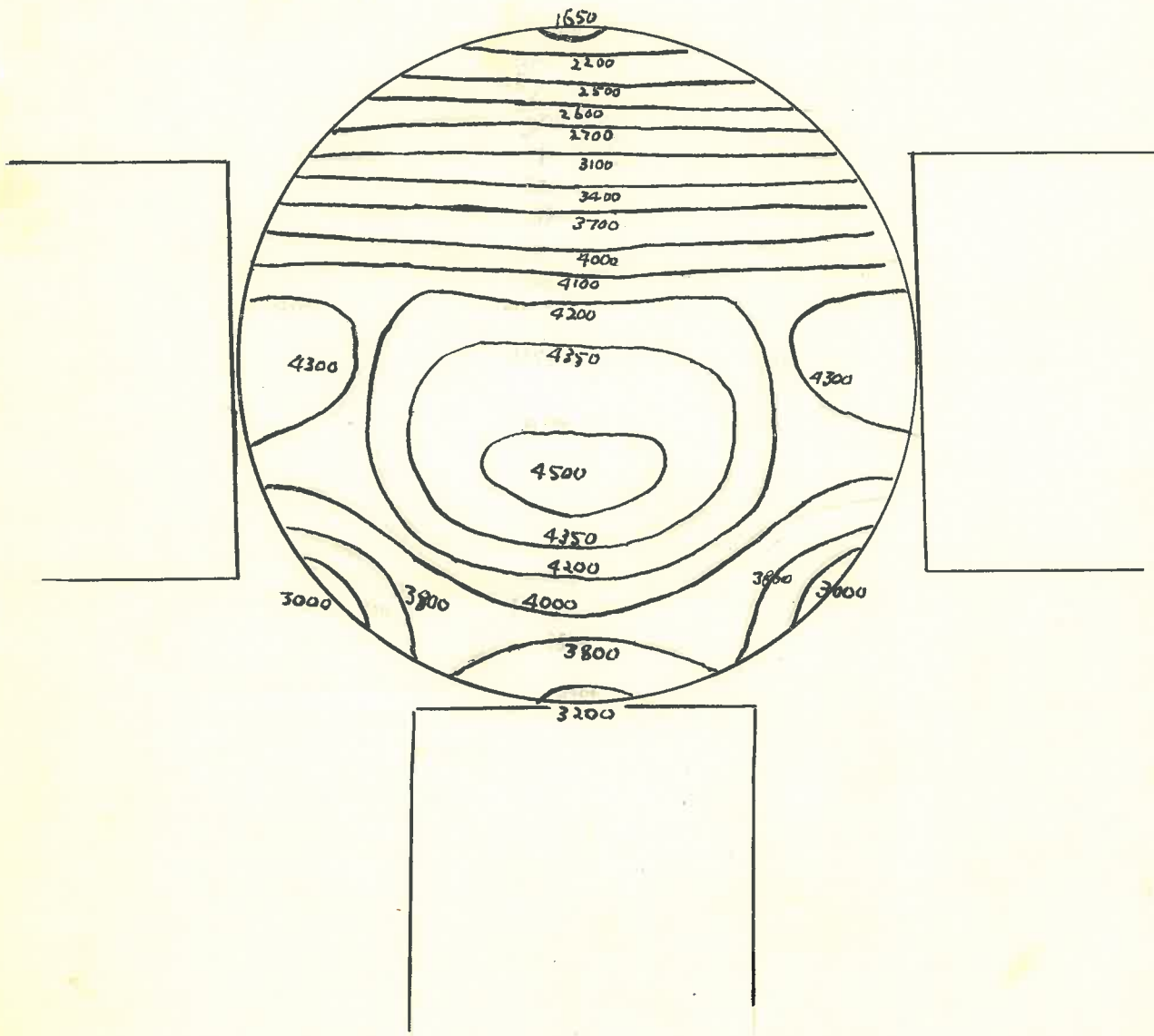
of the treatment of four patients
for cancer of the larynx, three by
means of deep X ray, and one by
radium moulds.

HODGKINSON 6623 Squamous cell carcinoma
Rt & Lt laterals 10x15/50 HVL 1.5mm Cu
1500r each 12.6.40 to 23.6.40



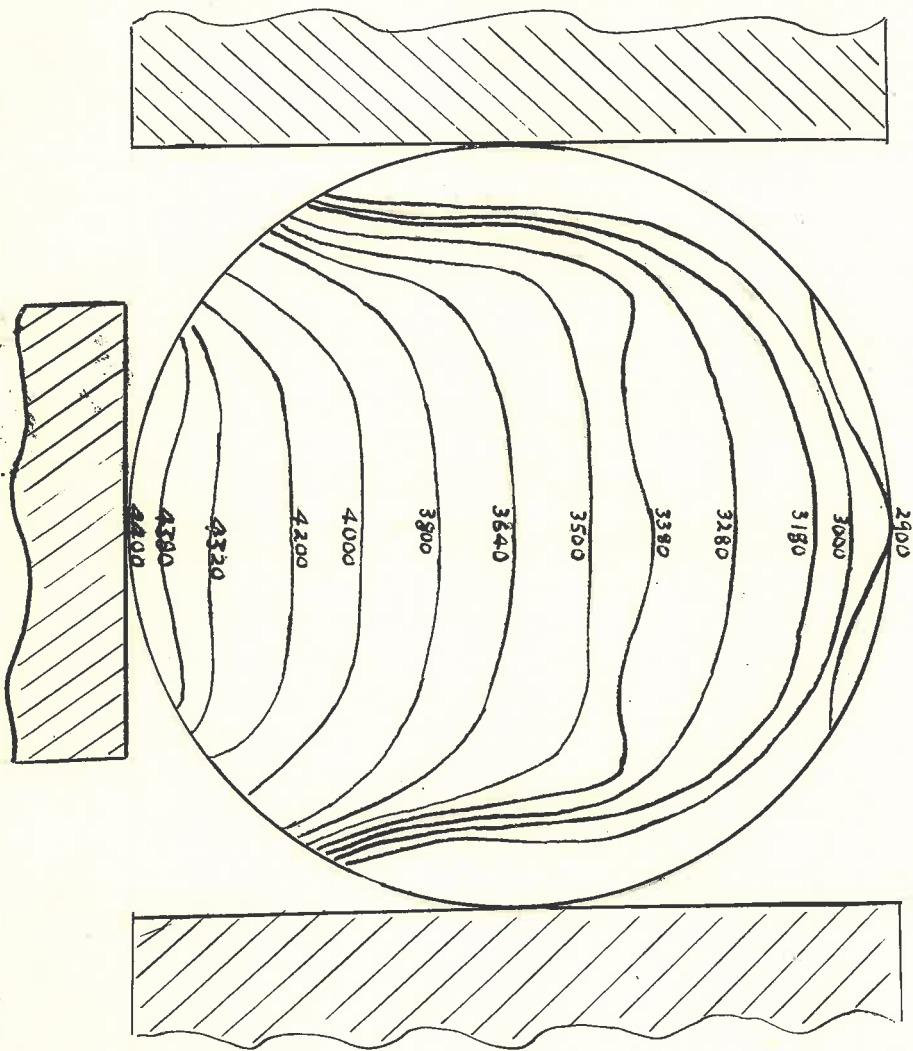
Carcinoma of the larynx. Laryngectomy.
Post-operative X ray. Survived,

ENRIGHT 9219 Carcinoma larynx
Rt & Lt laterals 6x8/50 H.V.L 1.5 G
3000r each
AP 50/50 2000r.
7.6.44 to 7.8.44



Carcinoma of the larynx. Treated with deep X ray.
Survived.

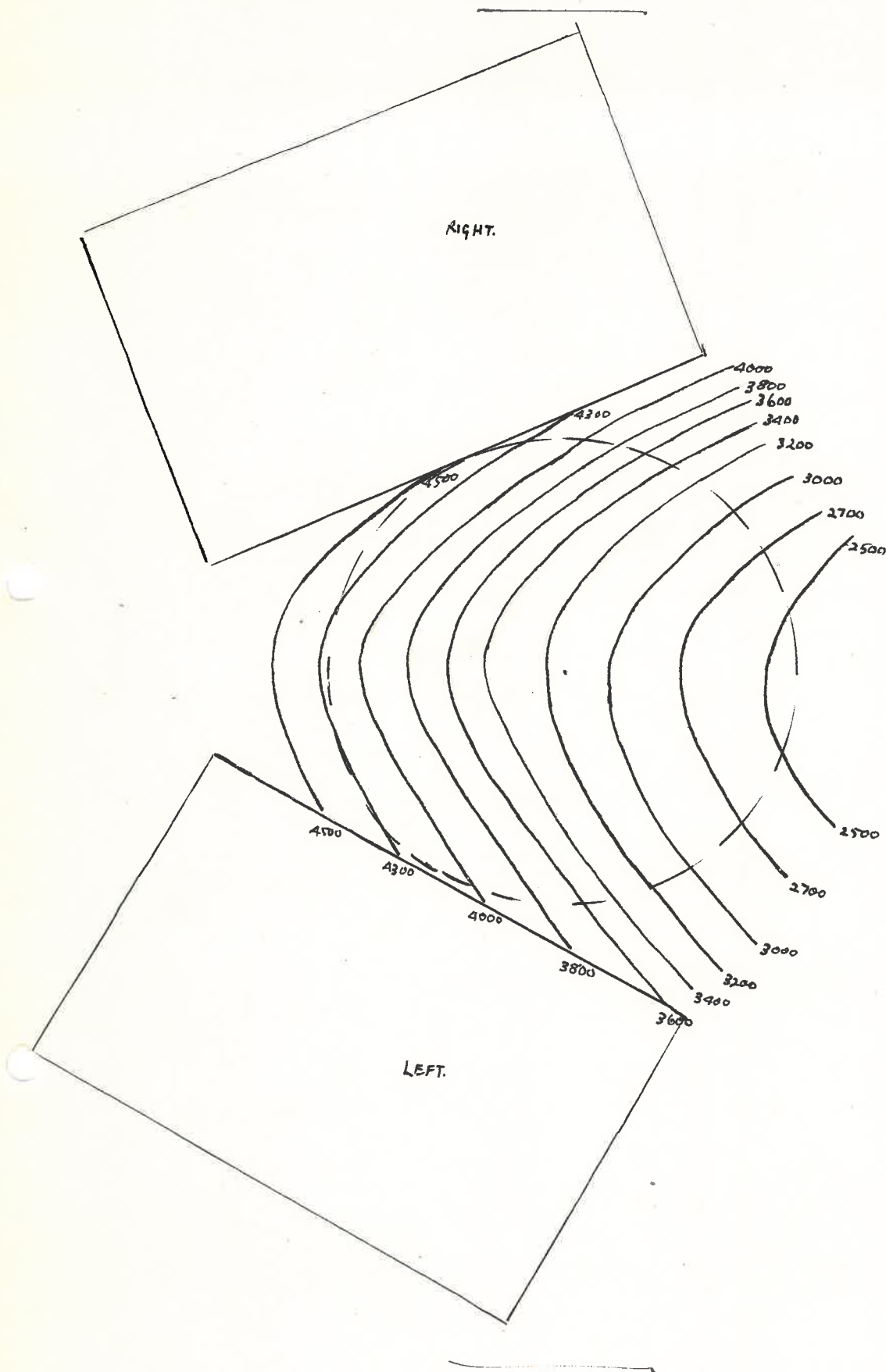
Carcinoma of larynx
HAWNS 8629



Carcinoma of the larynx,
Treated with deep X ray. Survived.

R and L laterals 10x15/50 HVL 1.5mm Cu.
AP 60/50 2000r Do each field
221-4372 10-12-43

Mrs Johnston 8864
 Treated 18.12.43 to 15.1.44 with two radium moulds.
 Left side 270 mgs for 93 hrs } Area of both 75 sq cms and radium skin distance 6 cms.
 Right side 270 mgs for 108 hrs }
 Neck 8 cms thick.

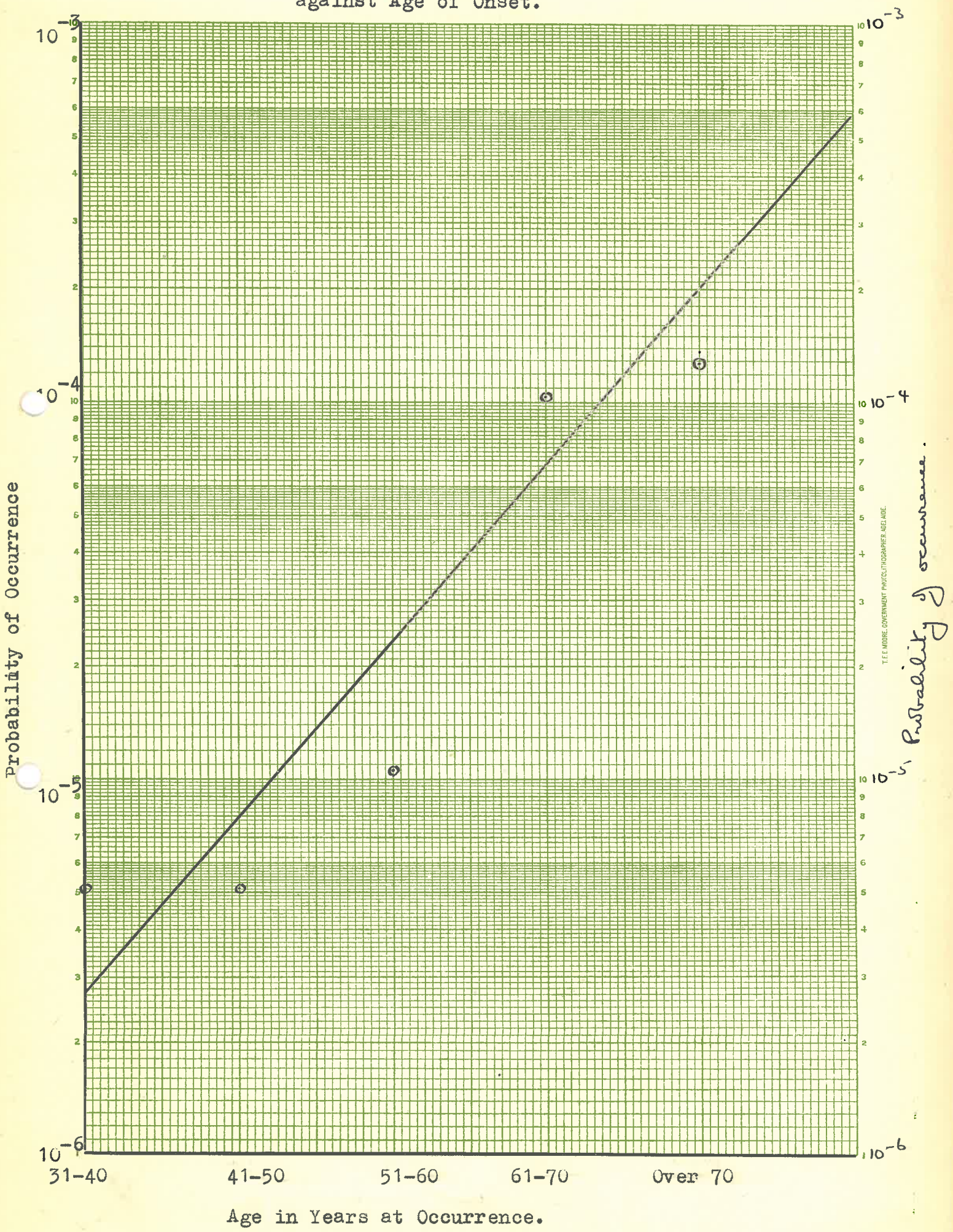


Carcinoma of the larynx. Treated with heavy radium moulds. Death in three months.

Logarithmic graph

of the incidence of cancer
of the larynx in the male
population of South Australia,
probability being plotted
against age.

Graph of Probability of Occurrence of Carcinoma of the Larynx
against Age of Onset.



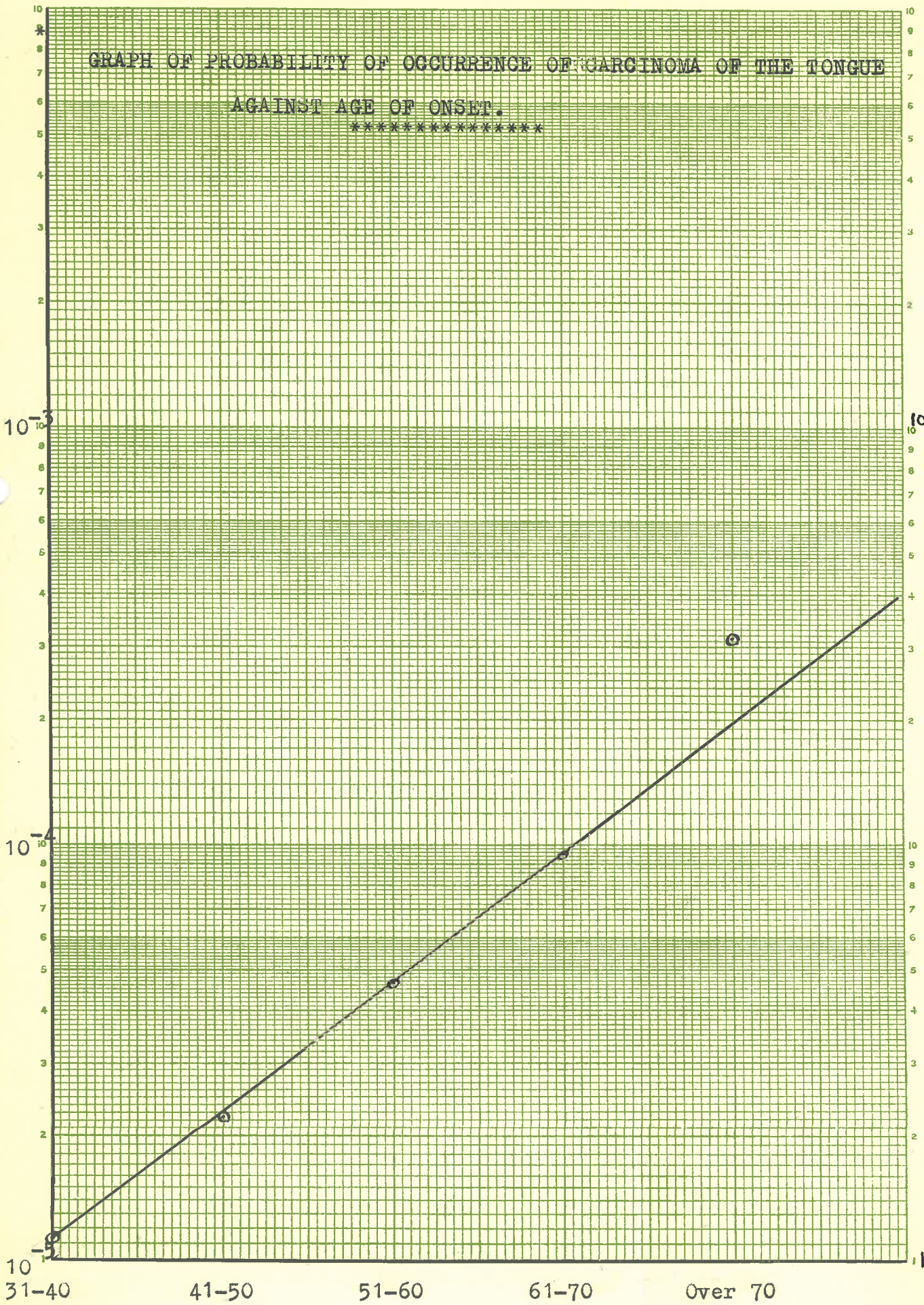
T. E. MOORE GOVERNMENT PHOTOGRAPHIC SERVICE

Probability of occurrence.

Logarithmic graph
of the incidence of cancer
of the tongue in the male
population of South Australia,
probability being plotted against age.

GRAPH OF PROBABILITY OF OCCURRENCE OF CARCINOMA OF THE TONGUE
AGAINST AGE OF ONSET.

PROBABILITY OF OCCURRENCE



Age at Occurrence in Years.

T. E. MOORE GOVERNMENT PHOTOGRAPHIC SERVICE

Probability of occurrence.

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NOTE:

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