Seeds of Discord: The Politics of Radon Therapy in Canada in the 1930s

CHARLES R. R. HAYTER

SUMMARY: In the early twentieth century, the therapeutic use of radon gas became an accepted medical practice. "Radium emanation" plants were established in many parts of North America to supply radon seeds to physicians. In Canada, these plants were usually established as part of state-supported cancer programs, creating concern among the medical profession, which had hitherto directed cancer treatment. This article explores how issues surrounding the ownership and distribution of radon played out in two Canadian provinces, Manitoba and Ontario. The main focus is an analysis of a computerized database created from more than two thousand radon order forms, dating from 1933 to 1940, preserved in the Archives of Ontario, which reveals interesting information about patients and the uses of radon in the 1930s, as well as discrepancies between policy and practice that illuminate the medical politics of the era. Although the radon seeds were intended for use in the government-supported central cancer clinics, they were widely distributed to practitioners throughout Ontario, and many patients received treatment for noncancerous conditions. These discrepancies are explored in the context of the struggles over cancer policy between the government and the Ontario medical profession. The article also shows how similar conflicts evolved in Manitoba. Finally, the distribution of radon is linked to the public acceptance of medical radiation despite contemporary reports of harm.

KEYWORDS: radium, radon, radiotherapy, cancer

This paper is based on previous oral presentations at the Canadian Society for the History of Medicine annual meeting, Sherbrooke, Que., June 1999, and at the annual meeting of the American Association for the History of Medicine, Charleston, S.C., 20 April 2001. The project was funded by a grant from the Hannah History of Medicine Program, Associated Medical Services, Inc. I thank the staff of the Archives of Ontario for access to the Ontario radon order forms; Christopher Rutty and Geoffrey Reaume for research assistance and help with data abstraction; and Karleen Schulze and Lawrence Paszat, of the Radiation Oncology Research Unit, Queen's University, Kingston, Ont., for statistical analysis and advice. Brent Schacter, C.E.O. of the Manitoba Cancer Research Foundation, kindly gave access to the early records of the Manitoba Cancer Relief and Research Institute, and John Linford gave his oral and written recollections of its operation. I also thank the staff of the Ontario Medical Association and the Manitoba Medical Association, who gave access to the minutes of their organizations; the University of Toronto Archives

Introduction

In the early decades of the twentieth century, the therapeutic use of radon gas encapsulated in "seeds," tiny glass or gold containers, became an accepted medical practice. The seeds produced apparently miraculous healing when applied to the skin or implanted directly into tumors. Apparatuses for the extraction and purification of radon gas called "radium emanation plants" were established in many parts of North America and supplied radon seeds to medical practitioners. The principal advantage of these plants was that the costly original supply of radium was kept in a secure location, while the gaseous by-product radon was collected and distributed for treatment. By the close of World War I, radon plants had been established at large hospitals such as Memorial Hospital in New York,[1] and seeds were being sold to physicians by commercial enterprises such as the Radium Emanation Corporation.[2]

In keeping with the greater involvement of the state in the development of health care in Canada than in the United States, Canadian radon plants were founded with government funds or formed one element of state-supported cancer control programs. After the government of Quebec donated the money to purchase radium, the first plant in Canada was established at the Institut du Radium in Montreal in 1923. Subsequent plants included those constructed in Halifax (1926) and in Saskatoon (1931)—the latter as part of the first comprehensive publicly funded cancer program in North America, the Saskatchewan Cancer Commission.[3] The plant of the Manitoba Cancer Relief and Research Institute (Winnipeg) also opened in 1931, and that of Ontario's Department of Health followed in Toronto in 1933.

---

and the National Archives of Canada; and Robert Jackson, who gave information about the history of hemangioma treatment. Jacqueline Nicholls, Keith Jones, Audrey Kerr, Richard Bennett, Lewis St. George Stubbs, Rick MacLowick, Marie DeGagne, Michael Tennenhouse, Ken Reddig, Jean Macdonald, and Leonard Israels provided advice or information. I am also grateful to Elizabeth Derraugh for kind hospitality during my research in Winnipeg.

1. Charles H. Viol, "Description of an Apparatus for the Collection, Purification and Tubing of Radium Emanation from a Radium Solution," *Radium,* 1919, *14* (1): 1–9. For the role of Memorial physicist Gioacchino Failla in the development of these plants, see Juan A. del Regato, "Gioacchino Failla," chap. 14 in *Radiological Oncologists: The Unfolding of a Medical Specialty* (Reston, Va.: Radiology Centennial, 1993), pp. 127–29.

2. Its advertisement is reproduced in E. Grigg, *The Trail of the Invisible Light: From X-Strahlen to Radio(bio)logy* (Springfield, Ill.: Charles C Thomas, 1965), p. 220.

3. Douglas V. Cormack, "The Saskatchewan Radon Plant, 1931–1962," *Phys. Canada,* 1985, *41:* 3–5.

Canadian cancer control programs antedated the creation of universal medical care by several decades, but their creation provoked conflicts that foreshadowed later battles between the state and physicians.[4] Since radon played such a prominent part in early state-supported cancer programs, its control and distribution in these programs provides particularly useful insights into the problems of governmental involvement in health care. As this article will show, the role of radon in these programs was highly ambiguous. On the one hand, it was a symbol of technologically based, specialized, centralized treatment, and an instrument of governmental authority over cancer. On the other hand, it was a treatment that could be easily distributed outside centralized treatment centers, thus permitting the continuation of cancer care by generalists in the community and potentially undermining the power and authority of centralized cancer programs. In short, control over radon was inextricably linked with the degree of power of centralized cancer programs.

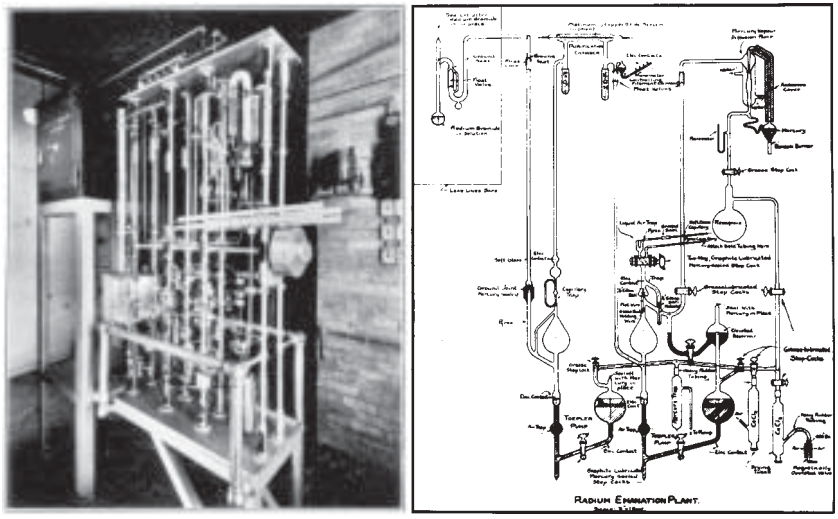
I will explore how issues surrounding the ownership and distribution of radon played out in two Canadian provinces: Manitoba and Ontario, where government-supported cancer initiatives were begun in 1930 and 1933, respectively. My emphasis will be on Ontario, where the preservation of more than two thousand radon requisitions from the 1930s permits reconstruction of the actual practice of radon therapy. As I will show, the data from the Ontario radon plant reveal discrepancies between practice and policy that arose from the politics surrounding centralization and specialization in this era. After a brief review of the scientific and medical basis of radon therapy, I will examine the control, use, and distribution of radon in Ontario, continue with a discussion of events in Manitoba, and conclude with comments on the role of public acceptance of medical radiation in encouraging radon therapy.

Radium "Emanations"

In undergoing radioactive decay, the element radium disintegrates to form radon gas, which itself emits powerful gamma radiation. If radium salts are dissolved, the solution produces a continuous output of radon gas that can be siphoned off.[5] By 1915 physicists had developed apparatuses

4. For the history of the relationship between physicians and state health insurance in Canada, see C. David Naylor, *Private Practice, Public Payment: Canadian Medicine and the Politics of Health Insurance, 1911–1966* (Kingston: McGill-Queen's, 1986).

5. For a discussion of the physics, dose distributions, and clinical applications of radon and other isotopes, see Harold E. Johns and John R. Cunningham, *The Physics of Radiology,* 4th ed. (Springfield, Ill.: Thomas, 1983), chap. 13.



Radium Emanation Plant

Fig. 1. Photograph and diagram of apparatus for the production of radon seeds installed by the Ontario Department of Health at the University of Toronto, 1933. Reproduced from pamphlet "Ontario's Program for Cancer Control," published by Ontario Ministry of Health and Labour, ca. 1933, p. 10, copy in National Archives of Canada, Ottawa, Ont., Canada, RG 29, vol. 1177, file 311-c1-14, pt. 1.

for extracting and purifying radon gas from dissolved radium (Fig. 1). Since another term for radon gas was "radium emanation," these apparatuses were often known as "emanation plants." In North America, emanation plants designed by Harvard physicist William Duane were installed at the Johns Hopkins Hospital and at New York's Memorial Hospital before 1920.[6]

Radon offered many theoretical advantages over radium. Because radon seeds were smaller than radium needles or tubes, they could be inserted more easily into body cavities or tumors. Like other isotopes used for therapy, the seeds gave a high dose of radiation to adjacent diseased tissues while sparing healthy structures. The use of radon was potentially safer than radium, because its half-life (3.83 days) is much shorter than that of the parent element (> 1,600 years); thus in a few days virtually all the radioactivity from radon will have dissipated, leaving

6. Grigg, *Invisible Light* (n. 2), p. 223.

containers of the gas inert and safe. More importantly, the use of radon rather than radium protected the costly radium against loss or theft. In the early years of radium treatment, there were many unhappy experiences with accidental loss of valuable (and dangerous) containers of radium.[7] The use of radon allowed the radium supply to remain secure while the radon was distributed widely for treatment. These advantages were summarized by Memorial Hospital physicist Edith Quimby: "the precious radium could be kept in a safe, with no danger of loss, theft, or breakage, while adequate activity could always be available in the form of radon."[8] In addition, radon possessed greater flexibility as a form of treatment since the gas could be subdivided and concentrated into smaller quantities than radium salts.[9]

Once radon was produced, how was it applied to patients? During the early years of radium enthusiasm, there was a vogue for the inhalation of radon gas, which was thought to have stimulating and restorative powers. It was administered either by small portable devices or in large rooms called "emanatoriums."[10] However, this form of radon delivery was of dubious benefit and could not produce the high localized radiation doses required to cause the destruction of a tumor. Working in collaboration with Duane, Memorial Hospital surgeon Henry Janeway developed a way of collecting the radon in tiny lengths of glass capillary tubing that could be inserted directly into diseased tissue. This technique theoretically delivered a high dose of radiation to the cancer while sparing the healthy tissues outside. Janeway investigated the use of these "seeds" in the treatment of a wide variety of human cancers and found particular success in eradicating cancers of such accessible sites as the mouth, lip, and tongue. The seeds could also be laid directly on the surface of a tumor and were used in this way to treat bladder cancers. In 1917 Janeway and his colleagues publicized the results of this technique in his book *Radium Therapy in Cancer.* As his fellow Memorial surgeon James Ewing recollected, "The sensational character of this advance can hardly be

7. For an example, see F. H. Cross, H. Miller, and L. E. Mussell, "An Unusual Radium Accident," *Brit. J. Radiol.,* 1951, *24:* 122. A collection of amusing and often hair-raising anecdotes about losses and recovery of radium is contained in Robert B. Taft, *Radium Lost and Found,* 2d ed. (Charleston, S.C.: Walker, Evans and Cogswell, 1942).

8. Edith H. Quimby, "The Background of Radium Therapy in the United States, 1906–1956," *Amer. J. Roentg.,* 1956, *75:* 443–50, quotation on p. 444.

9. G. H. Henderson, "An Installation for the Preparation of Radium Emanation for Therapeutic Use," *Proc. & Trans. Nova Scotian Inst. Sci.,* 1926–30, *15:* 14–19.

10. Richard F. Mould, *A Century of X-rays and Radioactivity in Medicine: With Emphasis on Photographic Records of the Early Years* (Bristol: Institute of Physics, 1993), p. 186 and picture on p. 193.

realized by one who had not lived through the trying period when superficial healing of . . . carcinomas was regularly followed by recurrence and death."[11] In subsequent years this technique was developed and improved, particularly by the replacement of glass by gold containers (the gold offered better filtration of superficial rays). Thus by 1920 the use of radon seeds was considered a standard method of administering radiotherapy.

Because of the complex physics and chemistry involved, the establishment of radon plants often required close collaboration between cancer programs and local university physics departments. In Manitoba, a Cancer Relief and Research Institute (MCRRI) was created by provincial legislation in April 1930. On the recommendation of the head of the University of Manitoba Department of Physics, Professor F. Allen, the Institute hired Dr. P. A. Macdonald as radium physicist in June 1930.[12] Macdonald was subsequently given sweeping executive powers to run the Institute, which included authority to issue radon to local physicians.[13] One of his first tasks was to erect a radon plant using the radium that had been bought through a loan guaranteed by the government. After a proposal to erect the plant in the Provincial Jail was rejected on the basis of its proximity to "Provincial Police and Female prisoners," space was assigned in the basement of the Medical College building.[14] Despite controversy over possible harm to other occupants of the building, the radon plant was installed in this location in early 1931.[15] Following the example of Montreal, the Manitoba authorities engaged Memorial Hospital physicist Gioacchino Failla to construct the plant, which was producing radon at a rate of 70 millicuries a day by April 1931.[16]

In Ontario, the establishment of a radon plant was but one in a series of recommendations of a Royal Commission established in 1931 to examine the usefulness of radiotherapy and to advise the government on cancer control.[17] As it implemented its cancer program, the Ontario

11. James Ewing, "Early Experiences in Radiation Therapy," *Amer. J. Roentg.,* 1934, *31:* 153–63, quotation on p. 155.

12. Manitoba Cancer Relief and Research Institute (hereafter MCRRI), Board Minutes, 12 June 1930 (held in office of CEO, Manitoba Cancer Treatment and Research Foundation, Winnipeg, Manitoba, Canada).

13. MCRRI, Executive Committee Minutes, 11 May 1931.

14. MCRRI, Board Minutes, 12 June 1930.

15. The most vociferous complainant seems to have been bacteriologist Dr. F. Cadham: see MCRRI Board Minutes, 27 November 1934.

16. MCRRI, Treatment Committee Minutes, 21 April 1931.

17. *Report of the Royal Commission on the Use of Radium and X-rays in the Treatment of the Sick,* Legislative Assembly of Ontario, Sess. Paper 41 (Toronto: King's Printer, 1932).

Department of Health engaged its own physicist, John Leitch, who traveled to Buffalo to examine the radon plant at the N.Y. State Institute for Malignant Disease in the summer of 1932.[18] As a result of Leitch's investigations, the department decided to construct its own home-made plant in the physics building at the University of Toronto. The entire glass work for the complicated apparatus (see Fig. 1) was made by a glassblower of the university's physics department.[19] In keeping with public interest and excitement over radium in this era, the arrival of the radium salts to fuel the plant was greeted with much fanfare in the press: "$30,000 Pinch of Salt Brought to University by Four Men in Auto" was the headline in the *Globe* describing the January 1933 delivery of 500 mg of radium in the presence of Leitch, Ontario Health Minister Dr. John Robb, Chief Inspector of Health Dr. John McCullough, and Dr. E. Burton, the university professor of physics.[20]

The Ontario Database

How was the radon from these plants distributed to physicians? In Manitoba, the seeds were sent out in special brass-lead trays delivered by Western Union messenger boys on bicycles.[21] In Ontario, a special requisition form was created for physicians wishing to use radon for their patients, with spaces for information on the doctor's name and practice location, the number of seeds requested, the strength of the seeds required in millicuries (mc),[22] and the location, gender, age, and indigency status of the patient (see Fig. 2). The number and strength of seeds would depend primarily on the size of the lesion and thus the volume requiring irradiation. The physician was also required to give details of the lesion being treated, such as its site, character, and duration, and

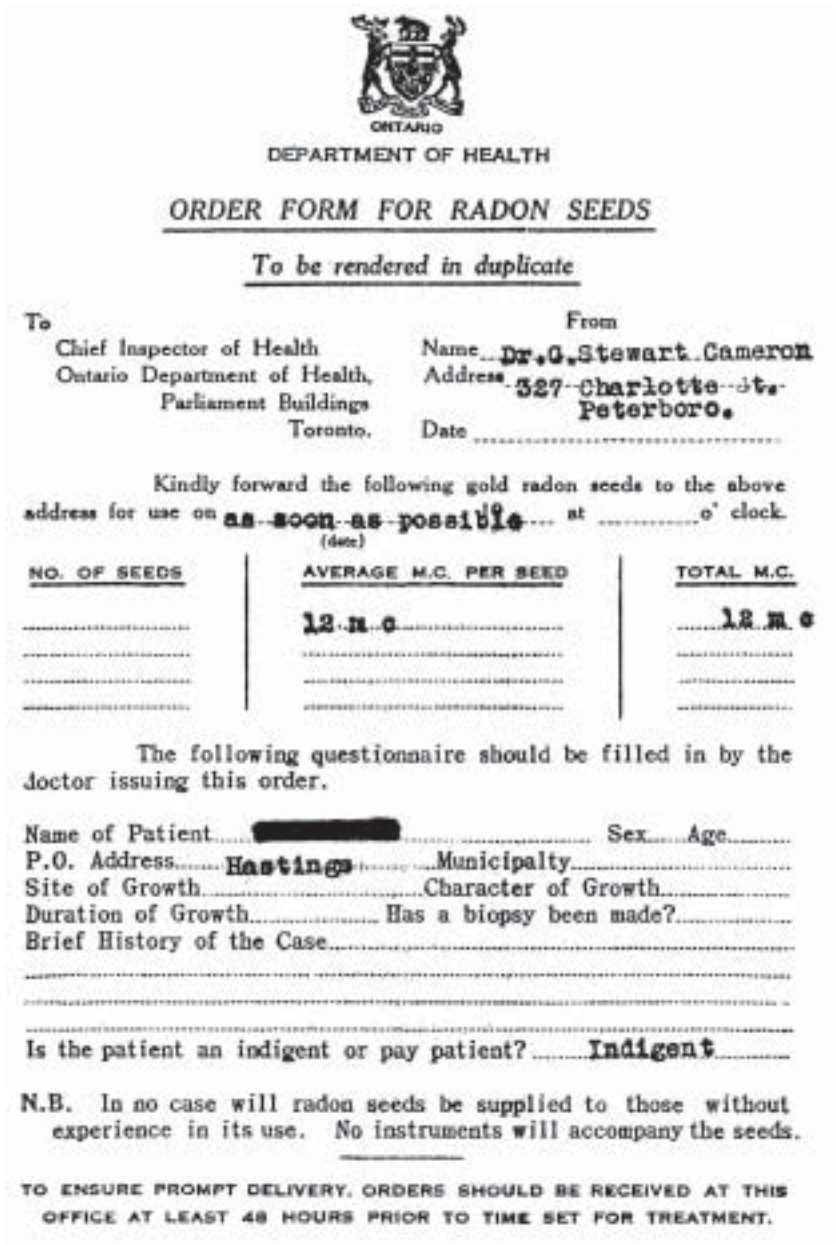
18. John J. Leitch, "Report to the Minister of Health re Emanation Plant," 11 August 1932, Archives of Ontario, Toronto, Ont., Canada, RG 10-106 (Cancer Files), box 44, folder 21 (hereafter cited in the form AO, 44.21; unless otherwise indicated, all citations are from RG 10-106).

19. "Purchase Radium to Reduce Cancer," *Toronto Telegram,* 19 December 1932 (no p. no. identified), clipping Accession Number A1973-0051, Office of the Registrar, University of Toronto Archives, Toronto, Ont., Canada.

20. "$30,000 Pinch of Salt," *Toronto Globe,* 5 January 1933, ibid.

21. Personal communication, Dr. John Linford, 15 April 1998. Linford worked as research assistant and radon pump operator for the MCRRI.

22. The millicurie is the unit of radioactivity (the number of disintegrations per unit time of an isotope). In recent years it has been replaced by the becquerel (Bq). The complex relationship between activity and dose is described in Johns and Cunningham, *Physics* (n. 5).



ONTARIO

DEPARTMENT OF HEALTH

ORDER FORM FOR RADON SEEDS

To be rendered in duplicate

To
Chief Inspector of Health
Ontario Department of Health,
Parliament Buildings
Toronto.

From
Name Dr. G. Stewart Cameron
Address 327 Charlotte St.
Peterboro.
Date .....

Kindly forward the following gold radon seeds to the above address for use on as soon as possible (date) at .....o' clock.

NO. OF SEEDS	AVERAGE M.C. PER SEED	TOTAL M.C.
.....	12 m c	12 m c
.....	.....	.....
.....	.....	.....
.....	.....	.....

The following questionnaire should be filled in by the doctor issuing this order.

Name of Patient [redacted] Sex..... Age.....
P.O. Address Hastings Municipalty.....
Site of Growth..... Character of Growth.....
Duration of Growth..... Has a biopsy been made?.....
Brief History of the Case.....
.....
.....
.....
Is the patient an indigent or pay patient? Indigent

N.B. In no case will radon seeds be supplied to those without experience in its use. No instruments will accompany the seeds.

TO ENSURE PROMPT DELIVERY, ORDERS SHOULD BE RECEIVED AT THIS OFFICE AT LEAST 48 HOURS PRIOR TO TIME SET FOR TREATMENT.

Fig. 2. Sample of order form for radon seeds used by Ontario Department of Health. Reprinted with permission from Archives of Ontario, Toronto, Ont., Canada, RG 10-106, file 44.2.

whether or not a biopsy had been performed. The practitioner submitting the form was also asked to give a brief written history of the case. After the requisition was approved by McCullough, seeds of the required quantity and strength were prepared by Leitch and sent to the physician in cotton bags wrapped in lead foil and cotton wadding.[23] The seeds were less than 1 mm in diameter and 4 mm long, and varied in strength from .5 to 3 mc. The Department of Health charged $1.00 per millicurie plus the cost of postage; the seeds were supplied free for indigent patients. (This is lower than the $2.50/mc charged in Manitoba, or the $3.50/mc charged by the commercial Radium Chemical Company.)[24]

Representing an extremely useful database, 2,404 of the radon requisitions (covering the period from the beginning of radon production in 1933 to the end of 1940) have been kept in the Archives of Ontario. In order to analyze the use and distribution of radon in this period, information from them was abstracted into a computer spreadsheet program. Diagnoses were assigned retrospectively by converting the diagnostic information on the slips to the International Classification of Diseases (ICD) version 9 codes. In all steps of the analysis, the anonymity of the patients was preserved.

The interpretation of these data is limited by a couple of factors. First, the database was created from requisitions for treatment rather than the actual treatment given, so it may give an inaccurate picture of actual practice; however, most of the order forms are accompanied by an additional form documenting the processing of the order, and it appears that very few orders were unfilled. In addition, the diagnoses recorded on the order slips may not have been completely accurate, since only 40 percent of the treatments were for lesions whose diagnosis was confirmed by a biopsy. More unfortunately, no data are available about the outcome of treatment, so it is not possible to assess the impact of radon treatment in reducing the morbidity and mortality from cancer in Ontario. Similarly, no data about the toxicity or long-term complications are available. Nevertheless, the data provide an illuminating picture of radon treatment in the pre–World War II era.

Who Were the Patients?

Initially, the success of the Ontario radon plant was questionable, for the number of requests received annually actually declined during its first

23. The procedure for ordering and preparation of the seeds is found in a letter from J. McCullough to A. Walkey, 24 February 1933, AO, 36.13.

24. MCRRI, Treatment Committee Minutes, 28 January 1931.

three full years of operation. After 1937 the demand for radon increased, and by 1939 more than four hundred requests were being processed each year. What can the order forms tell us about the patients? First, 1,435 (60%) of them were men, 897 (37%) were women, and on 72 (3%) forms the gender was not stated. The average age of the patients was fifty-five, with a range from infancy to one hundred years; 196 (8%) were less than a year in age. Because the government paid for radon for poor patients, physicians had to indicate whether each patient could pay for the treatment or was "indigent": 1,345 (56%) of the requests were for paying patients, 926 (39%) for indigent patients (information missing for the remaining 5%). There was no gender correlation in the proportions of indigent and paying patients. However, the proportion of indigent patients declined through the 1930s (from 40% in '34 to 30% in '40), probably due to the resolution of the Depression.

Geographical Distribution

The patients lived in fifty-one of the then fifty-four counties of Ontario, with a few from outside the province (30 from Quebec). One of the government's goals in setting up the cancer program was to provide equitable access to radiation therapy for all residents, and the database can provide information about how completely this goal was attained. The utilization rates for radon therapy for Ontario as a whole, and for each county, were obtained by dividing the number of requests by the Ontario and county populations. The overall utilization of radon for this period was 7.4 requests/100,000 people, but this varied by county from below 1/100,000 to more than 25/100,000. Figure 3 is a diagrammatic representation of these findings. While the low use of this new therapy in the remote northern areas of the province might be expected, the "cold" patches in the southern regions suggest that not all citizens had equal access to the cancer program.[25] Such inequalities may have arisen because of local physicians' unfamiliarity with radon, their reluctance to use it, or the availability of private radiotherapy in certain areas. In any case, these data give credence to 1940 observations by the government's own statistician, Dr. Hardisty Sellers, that there were already geographic inequalities in access to the cancer system.[26]

25. This analysis assumes that the distribution of types of cancer was equal among all the counties.

26. A. Hardisty Sellers, "The Contribution of the Ontario Cancer Clinics to the Control of Cancer," *Can. Pub. Health J.,* 1940, *31* (2): 72–76.

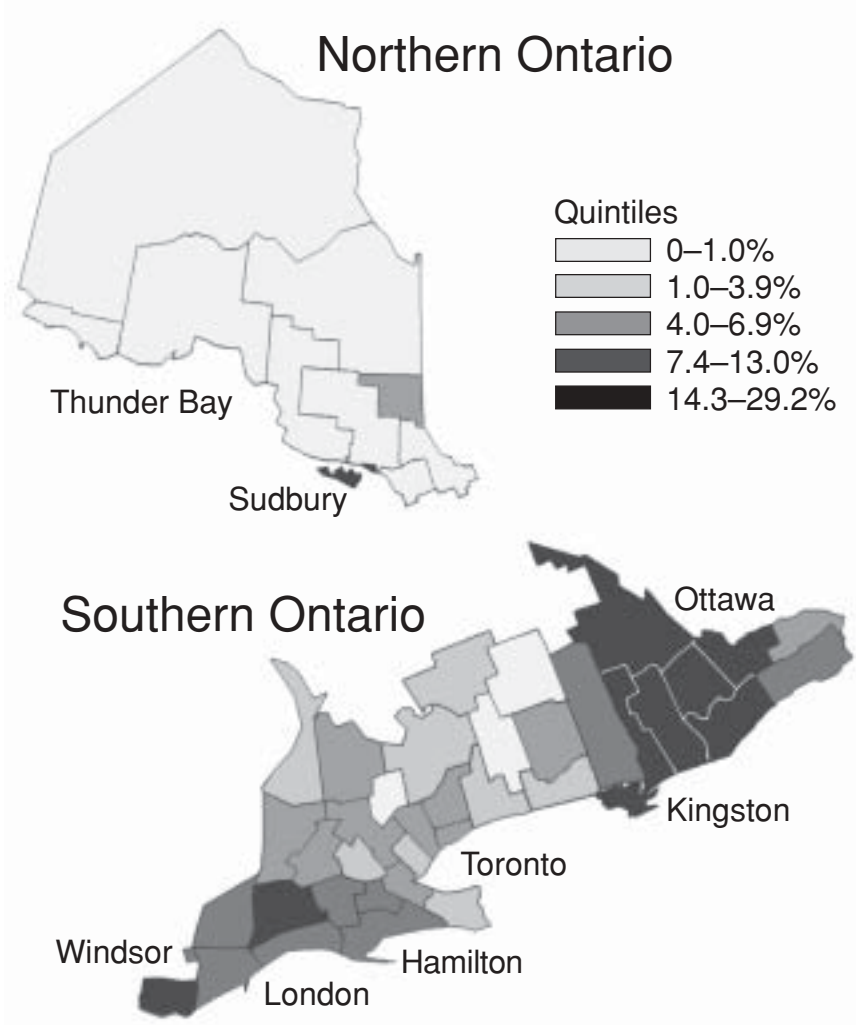


Fig. 3. Utilization of radon in Ontario by county in the period 1933–40. Darker areas correspond to areas of high utilization, lighter areas to low utilization.

Although the patients came from all parts of the province, the locations of the treating practitioners were more restricted. Figure 4 shows the distribution of requests by the geographic location of the requesting practitioner. At first glance, it appears as though the use of radon was consistent with the government's plans to centralize cancer treatment, since the majority of treatment appears to have been concentrated in the six cities where there were cancer clinics. However, closer examination of

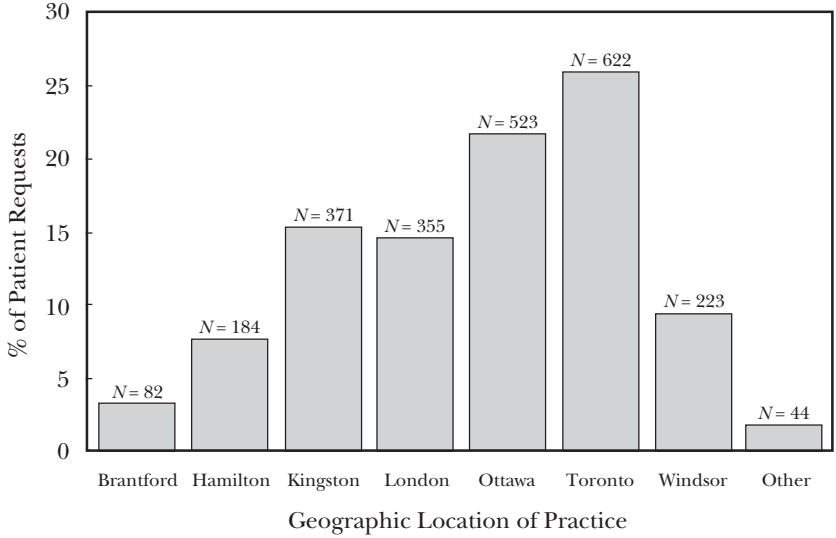


Fig. 4. The geographic distribution of the treating practitioners.

the data reveals some important anomalies. First, 3.4% of the requisitions were from the small city of Brantford: they were submitted by Dr. E. Hicks, a private practitioner who had trained with one of the American pioneers of radium therapy, Howard Kelly of Johns Hopkins, and who had published on his experience with radium.[27] Second, many of the requisitions from larger centers such as Ottawa or Toronto were from private practitioners who were not affiliated with cancer clinics. Analysis of the slips submitted from Toronto shows requests from six hospitals and ten private practitioners or clinics in various parts of the city; in fact, the requests from private practices or hospitals outnumber the requests from the government's Institute of Radiotherapy at the Toronto General Hospital. Finally, 44 slips were received from physicians in small, sometimes remote centers such as Peterborough, Owen Sound, and Kirkland Lake. In short, the data show that radon was far more widely dispersed than official government policy suggested.

What Were the Diseases?

Figure 5 shows the distribution of diagnoses found on the order slips. The two most common conditions treated were skin and lip cancers,

27. By 1932 Hicks had treated more than a thousand radium cases: Everett Hicks, "Fifteen Years' Experience with Radium," *Can. Med. Assoc. J.,* 1932, *26:* 569–71.

tumors in sites easily accessible to radon seed implantation. Other frequently treated malignancies were oral cavity and bladder cancers. Perhaps the most interesting observation is that although the radon plant was erected as part of the government's program of cancer control, the third most common group of conditions were benign: hemangiomas, benign proliferations of blood vessels that can occur anywhere in the body, but particularly on the skin, where they cause disfiguring lumps or marks. Nearly all of the infants in this study were treated for hemangiomas that had been present since birth. A typical example was the case of a five-month-old girl for whom radon was requested in December 1936 at the Hospital for Sick Children to treat a "hemangioma on scalp, increasing in size." The use of radiotherapy to treat such lesions was commonplace at the time,[28] and receded only after the propensity of hemangiomas to undergo spontaneous resolution was recognized.[29]

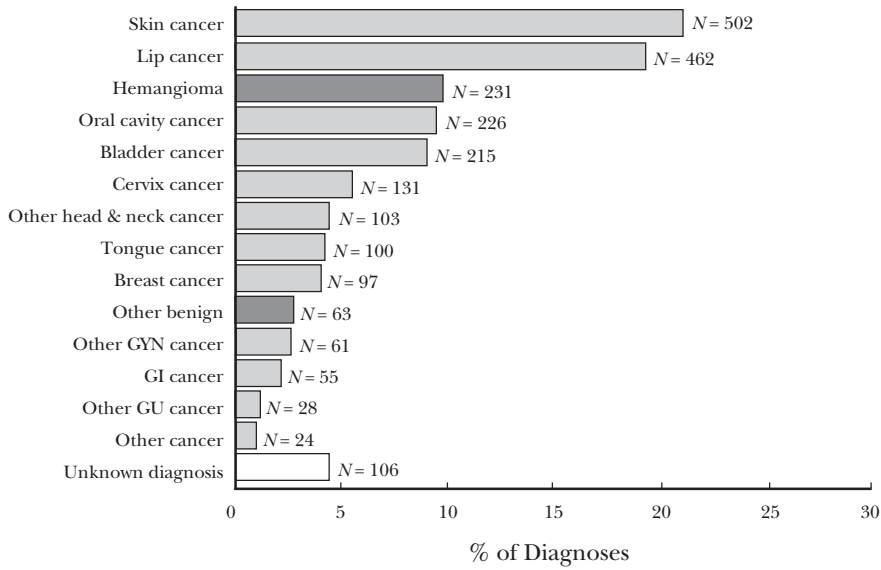


Fig. 5. The distribution of diagnoses among the requisitions.

28. See M. Lundell, C. J. Furst, B. Hedlund, and L. E. Holm, "Radium Treatment for Hemangioma in Early Childhood: Reconstruction and Dosimetry of Treatments, 1920–1959," *Acta Oncol.,* 1990, *29:* 551–55.

29. Robert Jackson, "The Natural History of Strawberry Naevi," *J. Cutan. Med. & Surg.,* 1998, *2:* 187–89.

Radon was requested for other benign conditions such as moles (nevi), epulis (inflammatory swelling of gum tissue), and gynecological problems such as uterine fibroids and abnormal uterine bleeding. There was one requisition for treatment of tuberculosis, and one for a thirty-six-year-old woman with mitral stenosis who had had two attacks of heart failure, and who was to be "sterilized by intrauterine radon." Together, hemangiomas and other benign conditions represented 12% of the radon requests.

The brief clinical notes that accompanied each order indicate that many patients had been heavily treated already, or had advanced, inoperable cancers. For example, a patient treated by Dr. Hicks of Brantford was a seventy-year-old man whose cancer of the lip had first been treated with a "plaster" (probably caustic) in 1929, and who had gone on to have recurrent tumor despite both radium therapy and surgery. Another case was a sixty-two-year-old woman who had had a "radical amputation" of her breast for cancer in March 1937; despite postoperative X-ray therapy, by February 1938 she had developed nodules of recurrent tumor on the skin and radon was tried. For patients such as these, radon offered the last hope of cure, or at least relief.

Table 1 shows that the diagnoses for which radon was requested varied markedly by treatment center. In London, for example, 50% of the radon requisitions were for skin cancer treatment, compared with less than 10% in Toronto and Hamilton. In Ottawa almost 20% of the radon was used to treat hemangiomas, while no patient with this condition was treated with radon in Hamilton or Brantford. These variations indicate a lack of agreement among practitioners across the province about the indications and usefulness of radon therapy.

Compromising on Cancer

In summary, these data provide both a picture of the use of radon in this period, and a revelation of a number of problems in the government's new cancer program. First, there was marked variation in utilization rates across the province. Second, there was considerable variation in the applications of radon: it was applied for different conditions in different locations. Third, the distribution of radon was much wider than the government's policy of centralization suggested. Finally, a substantial proportion of the treatments were for benign rather than malignant conditions.

The variations in the applications of radon across the province can be explained by a lack of agreement among physicians about the indications for radiotherapy—indeed, the Ontario Royal Commission of 1931–32

Table 1. Variations in diagnosis percentages according to the location of the practice.
Calculated from radon requisition forms in Archives of Ontario, Toronto, Ont., Canada, RG 10-106.

Diagnosis	Brantford	Hamilton	Kingston	London	Ottawa	Toronto	Windsor	Other	Average across Ontario
Skin cancer	28.1[a]	9.2	21.8	50.1	18.9	7.7	20.6	22.7	20.9
Lip cancer	25.6	3.3	47.7	21.1	26.2	1.5	9.4	36.4	19.2
Hemangioma	0	0	1.4	7.6	19.7	15.3	0.5	0	9.6
Oral cavity cancer	6.1	16.9	14.0	11.3	10.3	5.5	3.6	4.6	9.4
Bladder cancer	3.7	13.0	1.6	0	3.4	23.3	7.6	4.6	8.9
Cervix cancer	9.8	2.7	1.1	0.3	0.2	15.3	7.2	2.3	5.4
Other ENT cancer	1.2	8.7	1.6	2.0	4.2	4.8	9.4	0	4.3
Tongue cancer	1.2	5.4	5.1	3.4	4.8	3.7	4.0	2.3	4.2
Breast cancer	6.1	17.9	1.4	0.9	1.0	1.0	17.9	0	4.0
Other benign	2.4	2.2	0	0.9	5.4	4.0	0.5	0	2.6
Other GYN cancer	4.9	4.9	1.1	1.1	3.3	2.4	2.7	4.6	2.5
GI cancer	1.2	9.2	1.4	0.3	0.4	1.8	7.6	2.3	2.3
Other GU cancer	4.9	4.4	0.5	0	1.7	0.8	0	0	1.2
Other cancer	4.9	2.2	0.5	0	0	1.0	3.1	2.3	1.0
Unknown Dx	0	0	0.8	1.1	0.6	12.1	5.8	18.2	4.4

[a] All figures are percentages

had found a wide range of opinion about the role and techniques of radium administration around the world.[30] The use of radiotherapy evolved on an empiric basis, and practices were based on institutional and individual experience rather than on evidence from clinical trials.[31]

The wide distribution of radon and its use for conditions other than cancer arose from the conflicts and compromises resulting from the government's attempt to impose its cancer program on the already existing framework of private medical practice. During the deliberations of the Commission, specialists such as Dr. Gordon Richards, head of radiology at Toronto General Hospital, had urged the government to adopt a highly centralized system in which radium and radon would be strictly controlled and used only by specialists. Although Richards's ideas naturally had the endorsement of cancer specialists working in academic centers, they did not meet with the universal approval of the medical profession as a whole. Prior to the 1930s cancer treatment, including radium therapy, had been carried out by private practitioners throughout the province, many of whom (such as Hicks) had acquired expertise in radiotherapy through experience or training. These practitioners saw the government's cancer program as a threat to their authority and autonomy. For surgeons, there was the threat of the loss of the glamour and prestige of owning and using radium which would result from the absorption of radiotherapy into clinics.

The anxiety of organized medicine about the potential intrusion of the state into health care resulted in governmental compromises on cancer. A meeting between Ontario Minister of Health John Robb and representatives of the Ontario Medical Association in April 1932 was a watershed event in the history of cancer control in Ontario, for Robb's responses to his confreres contained the seeds of compromises that fundamentally influenced public policy on cancer and laid the foundation for problems in years to come.[32] In response to apprehension about plans to centralize cancer services in the three cities with medical schools (Toronto, London, and Kingston), and the apparent neglect of other cities, Robb indicated that he was willing to consider a cancer center for Ottawa, and smaller "diagnostic clinics" in other centers. In a decision that fundamentally weakened the cancer clinics' position in treatment,

30. *Report of the Royal Commission* (n. 17).

31. For the early evolution of radiotherapy, see Charles R. R. Hayter, "The Clinic as Laboratory: The Case of Radiation Therapy, 1896–1920," *Bull. Hist. Med.,* 1998, *72:* 663–88.

32. Report of Cancer Committee to the Ontario Medical Association Board of Directors, 18 April 1932, in OMA Archives, Department of Corporate Affairs, Ontario Medical Association.

he said he would allow cancer surgery to be continued in small communities. Finally, he said that he was willing to permit radon to be distributed from the radon plant to outside practitioners, as long as they were competent to use it. Subsequently, the decision to compromise on radon distribution was announced in the press.[33] The Ontario database shows the degree to which this compromise became reality: radon was indeed widely distributed outside the cancer clinics, and often for conditions that did not fall under the mandate of the cancer program.

John McCullough: Dispenser of Radon

Indeed, political compromise was embodied in the process for ordering radon. Despite numerous suggestions to create an agency to oversee the use of radon, this body was never established. The decision as to who might use radon was left in the hands of one person: the province's chief inspector of health, Dr. John McCullough, whose actions were not open to any form of outside scrutiny.[34] McCullough was a University of Toronto medical graduate who had served as Ontario's chief inspector of health since 1910. By the early 1930s, he had much experience with the distribution of medical treatments through the provincial government's distribution of such products as diphtheria and other antitoxins and insulin for the poor. Having acted as secretary to the 1931 Royal Commission, he was also knowledgeable about cancer. He acknowledged that there were no regulations to cover the control of radon, but he reassured others that he issued it only to "those competent to use it."[35] Although the determination of competence was supposed to be a key factor in the decision, in fact there were no formal criteria nor any mechanism for establishing competence. The problem was compounded by the lack of central bodies for training and certification in radiotherapy in the 1930s: most physicians who acquired competence in radiotherapy during this period did so through informal visits to treatment centers, or through courses sponsored by radium suppliers. It was not until after World War II that specialist boards to oversee training, examination, and qualifications in radiotherapy were established in Canada and the United States.[36]

33. "First Ontario Centre for Cancer Treatment Announced for Toronto," *Toronto Globe,* 24 August 1932.

34. On McCullough's life and career, see F. Adams, "John W. S. McCullough: An Appreciation," *Can. Pub. Health J.,* 1941, *32* (2): 89–91. Adams credits McCullough with the creation and strength of the Ontario Department of Health.

35. J. McCullough to Dr. Gatewood, 8 May 1935, AO, 32.13.

36. In Canada, the first specialist certification examinations in therapeutic radiology were held by the Royal College of Physicians and Surgeons of Canada in 1946.

The correspondence between McCullough and physicians requesting radon suggests that some decisions about who was granted access to the new therapy were based on political factors and personal allegiances more than on a rigorous evaluation of credentials, and reveals that the distribution of radon to physicians outside the cancer clinics was a practice that began virtually simultaneously with the opening of the radon plant. In February 1933, McCullough authorized the release of radon to Dr. Stewart Cameron of Peterborough without any review of Cameron's credentials and, on the assumption that he would become a regular customer, subsequently sent him a supply of order forms.[37] Cameron had been using radium in his gynecology practice since the early 1920s.[38] Other established practitioners, such as Drs. Hicks of Brantford and Carlos Fuller of Windsor, also received radon without any review of their credentials. Dr. J. E. Carson (also of Brantford) was granted radon for use on an elderly lady with a skin cancer on the nose who did not wish to travel for treatment. Carson appears to have had no background in radiotherapy, but he was an experienced surgeon. McCullough sent him some detailed instructions for the application of radon, including the use of sheet lead to protect the eyes.[39]

McCullough was aware that this distribution of radon outside cancer clinics potentially undermined the policy of centralized cancer care. At the first meeting of the Cancer Committee in November 1934, Gordon Richards suggested that radon was being disseminated too freely and pointed out that "it would be very easy for the Government to defeat the purpose for which they have established these clinics, by a wide or considerable extension of the distribution of radon seeds"; in response, McCullough pointed out that he and Leitch had endeavored to "keep down" the distribution of radon, and this effort had been helped by the limited quantity available.[40] The effort to restrict the circulation of radon had, however, engendered ill will between McCullough and private physicians. Nonetheless, McCullough indicated that in the future the distribution of radon would be "strictly kept down."[41]

Indeed, McCullough had been already encouraged by his boss, Health Minister John Robb (to whom requests for radon were sometimes ini-

37. Memorandum from McCullough to Leitch, 3 February 1933; letter from McCullough to Dr. G. Stewart Cameron, 11 April 1933, AO, 44.2.

38. G. Stewart Cameron, "Some Uses of Radium in Diseases of Women," *Can. Med. Assoc. J.,* 1923, *13:* 872–76.

39. Correspondence between McCullough and Dr. J. E. Carson, September–October 1933, AO, 24.9.

40. Cancer Committee Minutes, 23 November 1934, AO, 11.7.

41. Ibid.

tially directed) to take a "cautious" attitude in dealing with private physicians' requests, particularly in locales where private radiotherapy might compete with the government's clinics.[42] As a result, McCullough did make some attempts to restrict radon distribution. In contrast to well-established practitioners in urban centers, less-prominent physicians in remote locations did not always receive radon. When Dr. G. W. Smith of North Bay wrote asking for radon for a patient who could not travel to Toronto, McCullough asked him for a statement of his radiotherapy experience; when Smith admitted that he had no experience with radon but was willing to undertake instruction, McCullough refused the request and suggested that the patient be sent to Toronto by the municipality.[43] Occasionally McCullough's refusal to supply radon provoked a hostile or sarcastic response: when he refused radon to Dr. Alan Jackson of Simcoe (who had previously obtained radon from an American company) for a paying patient, Jackson expressed a "peculiar reaction" at the inconsistency of the Department of Health's refusing to supply radon to paying patients while it distributed radon and liver extract free to poor patients.[44]

McCullough's role as provincial dispenser of radon was difficult and fraught with multiple conflicting demands. As a former member of the very Commission that had brought the expensive radon plant into being, he had a vested personal interest in ensuring its success. As the data show, the demand for radon actually declined during the first three years of the plant's operation, and it is possible that, faced with dwindling use, McCullough became more compliant with physicians' requests simply to ensure that the plant remained viable. The gas was produced continuously, and it was a political and economic embarrassment to have the expensive product siphoned off and discarded because nobody was using it. An additional factor was the competition faced from private producers of radon in the United States: companies such as the Radium Emanation Corporation of New York advertised in medical journals and distributed radon to Canadian physicians. Dr. Norman Guiou of Ottawa was one practitioner who used American radon, and he had convinced the Canadian postal authorities to waive the duty and ensure rapid delivery.[45] If private physicians were to continue to administer radiotherapy, it was surely better for them to get their radon from a Canadian source.

42. John Robb to McCullough, 9 March 1933, AO, 35.12.

43. See correspondence between McCullough and Dr. G. W. Smith of North Bay, March 1933, AO, 24.9.

44. A. B. Jackson to McCullough, 16 March 1934, AO, 35.12.

45. Dr. Norman Guiou to McCullough, 25 November 1933, AO, 44a.4.

One way of supporting the government's radiotherapy program was to encourage patients to attend the cancer clinics. McCullough often received letters from patients or their families asking for advice about medical treatment. For example, in February 1933 he received a request for advice from a thirty-year-old woman concerned about two pea-sized lumps on her head: she wanted them treated, because "it is very important that I live for approximately another hundred years."[46] Although he thought the lesions were unlikely to be malignant, McCullough recommended assessment in London or Toronto.[47] Most correspondence between patients and McCullough from this era dealt with the inability to pay for treatment. McCullough often received requests for advice from patients distressed over straitened financial circumstances. For example, in April 1932 he received a letter from a resident of Kapuskasing asking for advice about how to obtain radium therapy for his wife: she had received an operation for cancer of the uterus which had depleted his funds, and now had back pain for which irradiation was recommended. He had been unemployed for two years, and was unable to pay for radium. He wrote: "It is very pitiful to see my wife suffer so much because I am unable to pay for treatments."[48] McCullough suggested sending the patient to Toronto General Hospital, where she would be treated for free; how the impoverished couple would travel from Kapuskasing to Toronto was not addressed.[49] In November 1934 a resident of Wiarton wrote requesting information on where he could get treatment for lip cancer. He too could not afford to pay any medical bills, and again McCullough advised speedy attendance at the cancer clinic at TGH.[50] The policy of free treatment for the poor thus encouraged utilization of the cancer clinics.

46. Mrs. W. H. to McCullough, 23 February 1933, AO, 24.9.

47. McCullough to Mrs. W. H., 4 March 1933, ibid.

48. Mr. T. G. to McCullough, 30 August 1932, AO, 24.8. A similar request was received in March 1933 from a young man who had already received radium treatment from Gordon Richards for a growth on his lip but who was now so "broke" he could not afford more. His letter was filled with urgency based on fear: "Anything you may be able to do, sir, will be greatly appreciated, as this terrible 'thing' spreads rapidly" (Mr. C. H. to McCullough, 14 March 1933, AO, 24.9).

49. McCullough to Mr. T. G., 15 September 1932, AO, 24.8.

50. Mr. G. G. to McCullough, 20 November 1934; McCullough to Mr. G. G., 23 November 1934, AO, 24.10.

Radon in Manitoba: The MCRRI and the "Approved List"

Were the problems of control and distribution of radon unique to Ontario? Comparison with events in Manitoba suggests that these issues were universal, occurring wherever radon plants were established and decisions about use and distribution had to be made. As in Ontario, the Manitoba authorities had to balance the need for centralization of service against the demands of the medical profession. The expert advice received by the Board of the MCRRI was that radium should not be distributed outside treatment centers. Reporting on a visit to England, Winnipeg dermatologist Dr. Hugh Mackay told the members of the Board that the Radium Institute in London wanted to abandon its "very unsatisfactory" practice of distributing radium to outside practitioners.[51] Dr. Douglas Quick, a native of Canada who was a leading American radium expert, told the members of the MCRRI's Treatment Committee that "radium should not be sent out to local practitioners for use upon their private cases but that the patients should be brought to the Radium Institute for diagnosis and treatment"; if the MCRRI really wanted to lower the mortality from cancer, its patients should have the benefit of expert examination and advice in a central facility.[52]

As in other jurisdictions, the MCRRI had to make compromises with the ideals expressed by specialists such as Quick. In Winnipeg, the situation was complicated by the fact that the MCRRI had no clinic of its own where patients could be seen and treated independently of other facilties. Instead, radon and radium were to be used at "Tumour Clinics" set up at Winnipeg General and St. Boniface Hospitals, and by other practitioners in the city. In February 1931 the Treatment Committee developed its policy on the distribution of radon: Physicians wishing to use radium or radon would have to apply to the Board stating their qualifications; the names of successful applicants would be placed on an "Approved List" that would allow them to receive radium. The criteria for approval were suitably fluid: the physician had to have spent two months at a recognized clinic devoted to cancer, or to have "an equivalent amount of practical experience in the use of radium and its emanations."[53] The last clause allowed the approval of physicians who lacked formal training but who had gained experience in radiotherapy in their practices. The MCRRI was aware that its assumption of the control of radon might prove contentious, and sent a delicately worded letter to the

51. MCRRI, Board Minutes, 25 July 1930.
52. MCRRI, Treatment Committee Minutes, 28 August 1930.
53. Ibid., 4 February 1931.

Manitoba Medical Association (MMA) stating that "they do not wish to put anything in the way of any doctor using radon, but they feel that it is incumbent upon them to ask that such medical men familiarize himself [*sic*] thoroughly with its use."[54] By the end of the summer of 1931, more than ten physicians had their names on the Approved List—indicating that the use of radium in private practice prior to the MCRRI was perhaps more widespread than other evidence suggests.

Although the concept of the Approved List gave doctors and patients access to the new treatment, it undermined the position of the MCRRI with respect to cancer treatment. As in Ontario, the distribution of radon led to uses that did not fit the context of a cancer program. Statistics prepared by the registrar of the MCRRI, Dr. Daniel Nicholson, show that almost one-third of the radiation treatments dispensed from the MCRRI were for benign conditions—in fact, benign menorrhagia was second only to cancer of the cervix as the commonest condition treated by the radium owned by the MCRRI.[55] After menorrhagia, "non-malignant skin conditions" such as keratoses and nevi were the commonest benign conditions. In his report, Nicholson gave dermatologist Hugh Mackay's fifteen years' experience of excellent results with such treatment as justification for its use.

A review of the minutes of the MRCCI's Treatment Committee from this period does not reveal any publicly expressed misgivings about the use of the Institute's radon for benign conditions—possibly due to the same factors related to the blurring of the distinction between "pre-cancer" and "cancer" that permitted the treatment of benign conditions at other centers such as the Institut du Radium in Montreal.[56] In fact, the use of radon for benign conditions was probably tolerated as a means of shoring up the utilization of the radon plant. At a meeting of the MCRRI's Finance Committee in October 1932, Dr. Gordon Fahrni noted that many "leading medical men" on the Approved List were not using radon.[57] The following month Macdonald, the Institute's radium physi-

54. Letter to Dr. F. W. Jackson, Secretary, Manitoba Medical Association, from Dr. G. S. Fahrni, January 1931, reprinted in *Manitoba Med. Assoc. Bull.,* 1931, *113* (1): 27–28.

55. Daniel Nicholson, "Types of Malignant Disease Treated by Radium at the Cancer Relief and Research Institute in Manitoba," *Can. Med. Assoc. J.,* 1935, *32:* 492–500. Menorrhagia is defined in *Stedman's Medical Dictionary* as "excessively profuse or prolonged menstruation."

56. Charles R. R. Hayter, "Tarnished Adornment: The Troubled History of Québec's Institut du Radium, 1923–1967," *Can. Bull. Med. Hist.* (in press).

57. MCRRI, Finance Committee Minutes, 12 October 1932.

cist, presented data to the Board showing that orders for radon were actually declining.[58]

The underutilization of the MCRRI's radium was of concern for two reasons. First, the lack of fees for the use of radium threatened the Institute's financial viability: a large proportion of its income came from the sale of radon.[59] Fees for poor patients were supposed to be subsidized by municipalities, but this income was already reduced by the onset of the Depression.[60] Second, it suggested that the Institute had had only a limited impact in promoting the use of radiotherapy in Manitoba: physicians were not using radon as enthusiastically as predicted.

As a result of these concerns, Dr. Fahrni (chair of the MCRRI's Treatment Committee) convened a special meeting of all the physicians on the Approved List in November 1932 to seek their "cooperation" in dealing with the cancer problem—a polite way of asking them to increase their use of the Institute's radium. Those present at the meeting supported the idea of restricting the use of radium to "highly trained men" (i.e., themselves) and decided to form a clinical group for the exchange of ideas about cancer.[61] The formation of the "clinical group" might have fostered interest in radiotherapy, but radium use continued to decline: two years after the physicians' meeting, Nicholson presented graphs to the Board showing a persistent downward trend.[62]

The message behind these statistics was clear: the use of radon by Winnipeg physicians was not as popular as had been anticipated. One reason may have been that some physicians wanted their name on the Approved List merely for reasons of prestige, rather than actually wanting to use radon. Another was the reluctance of local surgeons to submit their patients to irradiation, which pointed to the emerging conflict between radiologists and surgeons over the value of radiation in treating cancer. The Treatment Committee noted that "a large number of patients in the Winnipeg General Hospital who should be receiving radium treatment [were] being treated surgically."[63] An additional factor was

58. MCRRI, Board Minutes, 4 November 1932.

59. In 1935, the sale of radium constituted almost 40 percent of the Institute's revenue; the remainder came from donated funds such as a grant from the Winnipeg Foundation: MCRRI, Executive Committee Minutes, 29 November 1935.

60. See MCRRI, Finance Committee Minutes of 13 July 1931, at which meeting several delinquent patient accounts were charged to a "Charity Account."

61. MCRRI, Treatment Committee Minutes, 21 November 1932.

62. MCRRI, Board Minutes, 27 November 1934.

63. MCRRI, Treatment Committee Minutes, 15 October 1934.

that many physicians resented the fact that control of the distribution of radon was in the hands of a non-M.D., Macdonald.[64]

The declining use of radon threatened the future of the MCRRI and uncovered a fundamental weakness in its organization: its main source of revenue was supposed to be the sale of radon to Winnipeg physicians; the existence of the Institute therefore depended on their cooperation and purchase of radon, but it had no means of enforcing or even encouraging cooperation. As one doctor pointed out, it had become a mere "pedlar [*sic*] of radium," whose success depended on orders from outside physicians.[65] By November 1934 there was clear recognition that the Institute's role needed to be strengthened. Fahrni told the Board that the Institute did not have sufficient control over the treatment of cancer and presented a resolution from the Treatment Committee suggesting the establishment of a central institute for the treatment of cancer, which would exert greater authority over the management of the disease.[66] These sentiments were reinforced by a resolution of the Union of Manitoba Municipalities calling for governmental support for cancer clinics akin to the support for TB sanatoria.[67]

As a result of these resolutions, a full-scale reexamination of the role and structure of the MCRRI took place in 1935. These deliberations resulted in the start of annual governmental grants to the Institute, which helped to stabilize its financial situation, but they also exposed more fully the opposition of the medical profession to its control of radon. As a result of its review of the Institute's operations, the MMA expressed its concern about the conflict between the powers of the Board to determine the competence of M.D.s to use radon and the licensing power of the College and Physicians and Surgeons of Manitoba. The MMA pointed out that the College was the legal body that established standards and regulations for medical practice, and the Board of the MCRRI had no right to intrude on the College's jurisdiction. The MMA was concerned that the MCRRI Board was violating the traditional principle of having only one body (the College) to regulate medical practice, and was therefore setting a dangerous precedent.[68] In the context of cancer treatment, these statements can be read as asserting

64. Personal communication from Dr. John Linford, 15 April 1998.

65. MCRRI, Treatment Committee Minutes, 25 April 1933.

66. MCRRI, Board Minutes, 27 November 1934.

67. Manitoba Medical Association, Minutes of Executive, 7 March 1935, *MMA Review,* 1935, *15* (4): 13.

68. Report of Advisory Council of the MMA re MCRRI, *MMA Review,* 1935, *15* (8): 9–10.

the determination of the medical profession at large to retain its access to radon. Against this background, the MCRRI was clearly not in any position to increase its authority over the use of radon. Although the Board wanted the Institute to be transformed from a "radium supply depot" to an agency that would have "the supervision of all things related to cancer,"[69] this vision was simply not attainable in the Manitoba medical culture of the 1930s. It was not until the post–World War II era that cancer treatment became more coordinated in Manitoba.[70]

Later Developments in Ontario

In Ontario, the conflict over control of radon played out differently. Influential and outspoken specialists such as Richards did manage to alter practice patterns before 1940. There is evidence that after McCullough's retirement in 1935, government officials began to take a harder line regarding requests for radon. The change in attitude is shown by a 1936 letter written by Leitch to Stratford radiologist Dr. W. M. Gilmore, who had asked him to make arrangements for a supply of radon as required, emphasizing that radiotherapy fell within his field of expertise; Leitch replied firmly: "It is quite impossible for us to consider the general distribution of radon which would, of course, be contrary to the principle of centralized treatment of cancer," and he reminded Gilmore of the government cancer clinic in London.[71] That the government was now willing to refuse radon even to a radiological specialist demonstrates a renewed desire to restrict distribution and shore up the position of the cancer clinics. Indeed, statistics prepared for the Department of Health showed that the proportion of radon sent to private physicians declined from 57% in 1933 to 16% in 1938.[72] In Ontario, centralization was beginning to take hold.

69. MCRRI Board Minutes, 14 August 1936.

70. In 1941 the MCRRI took over the radiotherapy department in the Winnipeg General Hospital; and in 1957 the Manitoba Cancer Treatment and Research Foundation was formed. See anonymous documents such as "History Leading to the Formation of the Foundation," CEO office files, Manitoba Cancer Treatment and Research Foundation, Winnipeg, Manitoba, Canada.

71. Dr. W. M. Gilmore to Leitch, 13 October 1936; Leitch to Gilmore, 19 October 1936, AO, 44.23.

72. Table entitled "Distribution of Radon," dated 4 January 1938, AO, RG 10-201, box 22.

Dangers Overlooked

Nonetheless, the data presented in this article show that despite superficial efforts to control its use, radon was often distributed outside treatment centers and used for noncancer conditions. It is always tempting to criticize past medical procedures on the basis that they do not meet contemporary standards of safety or efficacy, and it would be easy to criticize the past use of radon for benign conditions on this basis. While many physicians in the 1930s believed that radon was an effective treatment for distressing benign conditions for which there was no other available treatment, and while many patients undoubtedly experienced relief, it is clear that this use of radon ran counter to two already established ideas: first, the radon plants had been constructed specifically to serve cancer programs; and second, there was an awareness of potential harm. Around 1930, Gordon Richards had urged the control of radon in order to protect the public from "the unskilful use of an agent far more potent for harm than any which has ever before been placed in the hands of the profession."[73]

The question naturally arises, to what extent were the concerns of specialists such as Richards valid? What harmful effects actually resulted from the distribution of radon? Were patients or physicians aware of these harmful effects? In fact, the harmful effects of radiation had been recognized from the early years of experimentation with X rays, and in the early twentieth century a number of American pioneers in radiology died as a result of these effects.[74] Martyrs of a different sort were the radium-dial painters of New Jersey, whose well-publicized deaths in the 1920s from radium poisoning turned public attention to the issue.[75] The illnesses suffered by the dial-painters—including cancer, anemia, leukopenia, and bone necrosis—drew attention to the myriad ways in which uncontrolled exposure to radiation could harm the body. Such experiences led to efforts to protect radiation workers from overexposure. Yet the establishment of regulations came slowly, hampered by two problems: the lack of an internationally accepted unit for the radiation dose,

73. Document entitled "How Best Can the Radium Problem Be Solved in Canada?" AO, 44(b). Although this document is unattributed, the style and content are undoubtedly Richards's.

74. Percy Brown, *American Martyrs to Science through the Roentgen Rays* (Springfield, Ill.: Thomas, 1936).

75. On the radium-dial painters, see Claudia Clark, *Radium Girls: Women and Industrial Health Reform, 1910–1935* (Chapel Hill: University of North Carolina Press, 1997); Catherine Caufield, *Multiple Exposures: Chronicles of the Radiation Age* (Toronto: Stoddart, 1989), esp. part 1, chap. 4: "The Dial Painters" (pp. 29–38).

and difficulty in deciding what dose was safe. The British X-Ray and Radium Committee issued its first recommendations, based on the 1915 guidelines of the Roentgen Society of Great Britain, in 1921.[76] Early guidelines dealt with such issues as working hours, the use of protective shields, and the necessity for radiation workers to undergo periodic health exams. The British standards were the basis for international protective measures adopted at the International Congress of Radiology in Stockholm in 1928.

Despite these efforts to limit radiation exposure to workers in the field, the public continued to be exposed through the widespread proliferation of procedures and practices involving the application of radiation. A well-known example of a nonmedical use of radiation was the shoe-fitting fluoroscope, a machine that used X rays to purportedly increase the accuracy of shoe-fitting; the widespread use of this device between the 1920s and 1950s shows the discordance between the awareness of hazards and the enthusiasm for radiation in these decades.[77] The popularity of such radiation devices was fueled by cultural optimism about science and persistent marvel at the wondrous powers of radiation. As Spencer Weart has shown, the publicity surrounding the deaths of the radium-dial painters did nothing to quell the appetite of the public for news and information with a positive spin on radiation. In his analysis of American periodical literature titles, Weart found that radium hazards were no longer news by the mid-1930s, and that most radiation-related titles were optimistic.[78]

Against this background of cultural acceptance, it is not surprising to find a lack of resistance among patients or physicians to the widespread use of radon in the 1930s. Were these treatments harmful? Of particular concern are the treatments given to children, whose developing tissues are especially susceptible to even low doses of radiation. Leukemia, breast cancer, brain cancer, and thyroid cancer have been associated with irradiation in childhood.[79] A study of more than fourteen thousand

76. A useful summary of the state of radiation protection in the early 1930s is in *Report of the Royal Commission* (n. 17), pp. 157–61; see also F. G. Spear, "The British X-Ray and Radium Protection Committee" (editorial), *Brit. J. Radiol.,* 1953, *26:* 553–54.

77. Jacalyn Duffin and Charles Hayter, "Baring the Sole: The Rise and Fall of the Shoe-Fitting Fluoroscope," *Isis,* 2000, *91* (2): 260–82.

78. Spencer R. Weart, *Nuclear Fear: A History of Images* (Cambridge: Harvard University Press, 1988), pp. 52–54.

79. American Academy of Pediatrics, "Risk of Ionizing Radiation to Children: A Subject Review," *Pediatrics,* 1998, *4:* 717–19; Alan D. Steinfeld, "Consequences of Childhood Irradiation," *Amer. Fam. Physician,* 1978, *17* (3): 175–81.

infants, children, and adolescents irradiated for skin hemangioma with radium or X rays at the Radiumhemmet, Stockholm, between 1920 and 1959 confirmed an increased relative risk of cancer of 1.2.[80] Specifically, there was an increased risk for breast and soft-tissue tumors, and a relationship between radiation dose and the development of thyroid cancer. It is not difficult to assume that the use of radon for benign purposes in the 1930s did result in similar adverse health outcomes for some patients in North America. The true magnitude of the health problems arising will likely never be documented, for the wide variety of potential problems is difficult to quantify in the absence of reliable estimates of radiation dose. In addition, there are huge logistical and ethical difficulties inherent in identifying, contacting, and assessing the population at risk. Nonetheless, I have been made aware of two women who developed cancer in the same breast where they had received radium treatment for birthmarks as children. These anecdotes are reminders that the distribution of radon in the 1930s had far-reaching, insidious, and potentially devastating consequences.

Conclusion

The stories of radon distribution in Ontario and Manitoba in the 1930s illustrate the key dilemma faced by the planners of early cancer control systems, and indeed of any state involvement in health care: balancing the conflicting needs of the state and the medical profession. Radon plants were key technological features of state cancer programs. From the government's perspective, radon was a tool by means of which it could try to assert its power over cancer; from the specialists' perspective, control over the technology was a way of defining a specialty and exerting control over cancer treatment. However, these assertions of governmental and specialist authority met with resistance from the medical profession. As a result, public health administrators in both provinces ignored the advice of experts and permitted radon to be distributed widely. In both Ontario and Manitoba, radon gas seeped uncontrolled from its central origins, permeated the foundations of the newly constructed cancer programs, and ultimately weakened their authority.

80. C. J. Furst, M. Lundell, and M.-E. Holm, "Tumors after Radiotherapy for Skin Hemangioma in Childhood: A Case-Control Study," *Acta Oncol.,* 1990, *29:* 557–62.