CHAPTER THREE

Pioneer Practitioners

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The Afterglow of Discovery

The furor set off by Röntgen's discovery can scarcely be overstated. In 1896 alone nearly one thousand papers dealing with X rays appeared.[1] Books for popular consumption such as *Something About X Rays for Everybody* (Fig. 3.1) and *The ABCs of X Rays* appeared early in that year. Anyone with a cathode ray tube had a go at making "X-ray pictures." Consequently, an eclectic crew formed the ranks of early X-ray aficionados, including photographers, physicists, and physicians. In the first few years after Röntgen's announcement, X-ray studios began to appear both in the United States and Europe, with some run by physicians and others by technical enthusiasts (Fig. 3.2).[2,3] With equipment that was underpowered, unreliable, and difficult to calibrate, results were inconsistent at best.

But public demand for X rays was unquenchable, in part due to America's foremost inventor, Thomas Edison. Edison directed his assistants in testing some eight thousand substances in 1896 to find one which would fluoresce most brightly when exposed to X rays. In May 1896 he designed a roentgen-ray display for the National Electric Exposition in New York. Long lines of incredulous patrons gaped as their bones appeared on the fluoroscope screen (Fig. 3.3). But Edison's entrepreneurial X-ray spirit did not stop there. He shaped a small fluoroscopic screen like the recreational stereoscopes of the day, coated it with brightly fluorescent calcium tungstate, and the Edison Vitascope was available for public purchase in March 1896 (Fig. 3.4).[4]

Edison became a proponent of fluoroscopes rather than radiographic films (perhaps to spur fluoroscope sales), stating in a cable to Lord Kelvin, "...calcium tungstate gives splendid fluorescence...rendering photographs unnecessary."[5] This dogmatic pronouncement, however, did not deter his manufacture and sale of the complete Edison X-ray apparatus (Fig. 3.5), which could be used both for fluoroscopy and radiographic films.

The Race Is On

In the months following Röntgen's discovery, investigators on both sides of the Atlantic worked feverishly to duplicate his findings and produce radiographs. Not surprisingly, conflicting claims of priority regarding production of the first post-Röntgen radiograph have clouded the historical picture. Scottish engineer Alan Campbell Swinton exhibited two plates on 16 January 1896, though he claimed his first roentgenogram had been produced on 7 January. On 13 January German psychiatrist Moritz Jastrowitz displayed a radiographic plate during a lecture in Berlin. Close behind were Russian N. G. Egorov on 16 January, Frenchmen Oudin and Barthélemy on 20 January, and Italian Angelo Batteli on 25 January.[9]

In America the race for the first roentgenogram was a Harvard-Yale contest with a photo finish. On 27 January 1896 Arthur Wright of the Yale physics department placed cardboard-covered photographic paper beneath a cathode ray tube. On the paper he placed a pencil, a pair of scissors, and a quarter. After a fifteen-minute exposure, he obtained "a very clear representation of the objects employed" (Fig. 3.6).[10] A report of his success appeared in the *Engineering and Mining Journal* of 1 February, only four days after the experiment.[11] It was fortunate that publication delays were not such a problem in 1896, since John Trowbridge, director of Harvard's Jefferson Physical Laboratory, documented his radiographic success in the *New York Journal* on 2 February, just one day after Wright.

While Harvard and Yale were vying for priority in the laboratory, another Ivy

Fig. 3.1 Within a year of Röntgen's discovery, the public could learn all about "the new light." (Courtesy of the William Hammer Collection, Smithsonian Institution)

Fig. 3.2 X-ray studios invited customers to come in for a "sitting." (Courtesy of the Center for the American History of Radiology, Reston, Va.)

Fig. 3.3 Edison popularized X rays with public fluoroscopy exhibitions. (Courtesy of the Center for the American History of Radiology, Reston, Va.)

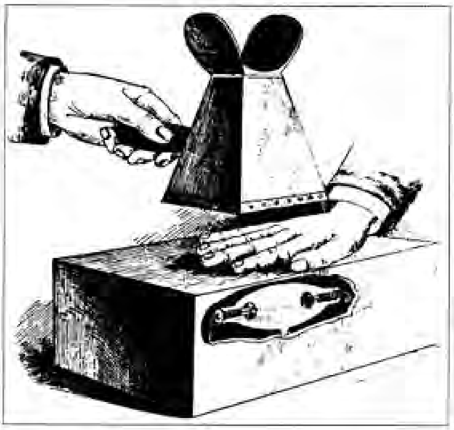


Fig. 3.4 Edison's Vitascope for home fluoroscopy. (Courtesy of the Center for the American History of Radiology, Reston, Va.)

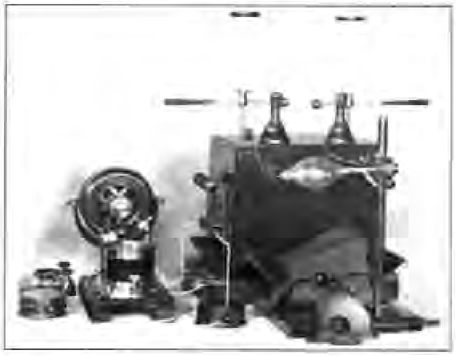


Fig. 3.5 Note the absence of any tube shielding in the Edison X-ray apparatus. (Courtesy of Bruwer, A.J., editor, *Classic Descriptions in Diagnostic Roentgenology*. Springfield, Illinois: Charles C. Thomas, 1964)

League institution, Dartmouth, was making clinical history. Edwin Frost, a professor of astronomy who was familiar with cathode ray tubes, was asked by his physician brother, Gilman Frost, to radiograph the fractured arm of one of his patients. And so, on 3 February 1896 Eddie McCarthy's left forearm was exposed to the tube for twenty minutes.[12] The diagnostic (if somewhat obscure) result represents the first clinical radiograph in America.

Becoming a Specialty

As reports multiplied of successes using roentgen rays to diagnose skeletal abnormalities, find foreign bodies, and treat tumors, the obvious promise that X rays held for medical diagnosis and therapy took center stage. Over the course of the "gas tube years," from 1896 to 1914, the fraction of nonphysicians performing radiography gradually declined. Londoner Sidney Rowland (Fig. 3.9) is regarded as the first medical radiologist, having established a private office with roentgen-ray apparatus as early as February 1896.[13] Although he was active in radiology only until 1897, Rowland also had the distinction of founding the first journal devoted entirely to roentgen rays, the *Archives of Clinical Skiagraphy* (Fig. 3.10).

Of the contenders for the title of first American radiologist, Francis H. Williams of Boston is the consensus front runner (Fig. 3.11). He had the perfect background for a radiology pioneer, with a degree from the Massachusetts Institute of Technology (MIT) and a medical degree. Few early radiologists could speak the language of physicists and engineers, but Williams was ideally suited to act as liaison between their disciplines and clinical medicine. As proof, by May 1896 his MIT colleagues, Charles Norton and Ralph Lawrence, had provided him with equipment which could take exposures as brief as one-fifth of a second.[14]

Williams made good use of these more powerful tools as he detailed radiographic and fluoroscopic techniques which could be utilized by the practicing physician (Fig. 3.12).[15,16] Particularly impressive were the thorough basic descriptions of normal and pathologic findings in fluoroscopy of the chest. Williams described pneumonia, tuber-

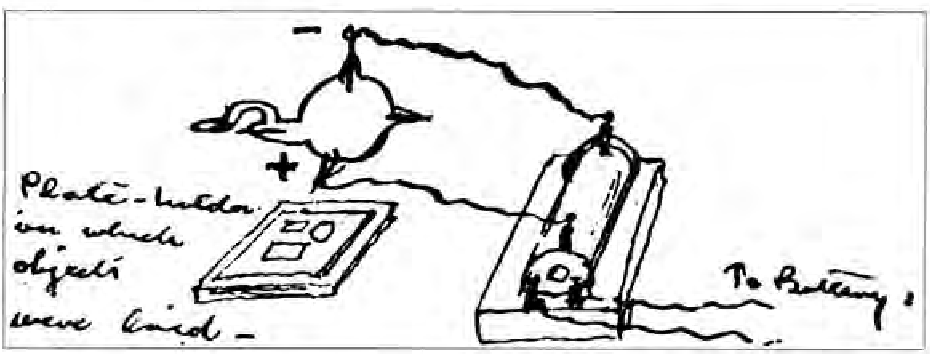


Fig. 3.6 Wright's drawing of his 1896 radiography set-up. (Courtesy of the Center for the American History of Radiology, Reston, Va.)

Edison and the New Light

Thomas Edison began experimenting with X rays as early as January 1896, but public awareness of his work rose after he received a 5 February 1896 telegram from publishing mogul William Randolph Hearst of the *New York Journal*. It read: "Will you as an especial favor...undertake to make a cathodograph of a human brain...?"[6] Hordes of reporters flocked to Edison's West Orange, New Jersey, laboratory, but a 12 February one-hour exposure of his assistant's head yielded only a "curvilinear murkiness." The chagrined inventor explained in the 14 February *New York Daily Tribune* that "...the bony structure of the cranium would offer insuperable obstacles."[7] Even Mr. Edison did not foresee computed tomography scanning.

Home fluoroscopes were not Thomas Edison's sole scheme for getting X rays to the buying public. He anticipated far wider appeal for his X-ray tube light bulb (a standard X-ray tube coated with fluorescent calcium tungstate) (Fig. 3.7). Unfortunately, Edison's assistant, Clarence Dally (Fig. 3.8), who fashioned and tested the tubes, developed severe radiation burns and skin ulceration. Mr. Edison commented with characteristic pragmatism: "...I started to make a number of these lamps, but I soon found that the rays had affected poisonously my assistant, Mr. Dally, so that...his flesh commenced to ulcerate. I then concluded that it would not be a very popular kind of light, so I dropped it...."[8] Dally died of metastatic skin cancer after 144 failed skin grafts and bilateral arm amputations.

Fig. 3.7 Thomas Edison photographed by the light of his X-ray tube light bulb (arrow).

Fig. 3.8 Clarence Dally (background) undergoing fluoroscopy by Thomas Edison. (Figs. 3.7 and 3.8 courtesy of the Center for the American History of Radiology, Reston, Va.)

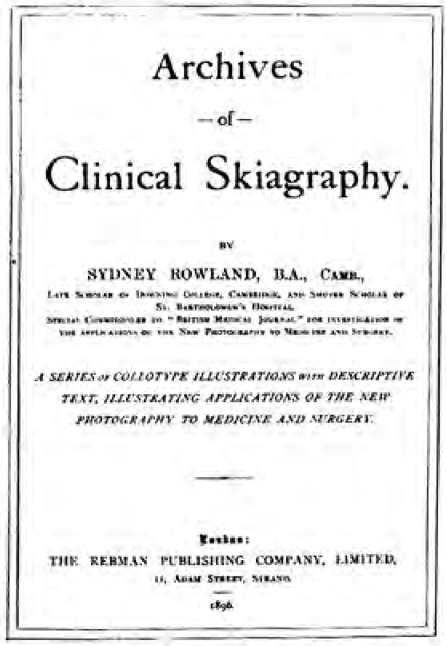
Fig. 3.9 Sidney Rowland. (Courtesy of the Center for the American History of Radiology, Reston, Va.)

culosis, aneurysms, pleural effusions, pulmonary edema, emphysema, and tumors (Figs. 3.13a, 3.13b). He recounted his experiences in 1897 with a pithy summary:

> The normal brightness of the chest having been observed in the fluoroscope, the departure from the normal in two directions may be noted by comparison. First, a given part of the chest may be darker than normal...which is due to the increase of density that occurs in tuberculosis, pneumonia,...new growths, or to fluid in the pleural and pericardial sacs....Second, a given part of the chest may be brighter than normal, because...of the diminution in density, due in the case of emphysema to increase in the amount of air in the lungs, or in the case of pneumothorax, to increase in the amount of air entering the thorax and displacing the lung.[17]

Fig. 3.11 Francis Williams. (Courtesy of the Center for the American History of Radiology, Reston, Va.)

In addition to his landmark work in chest fluoroscopy, Williams contributed in the areas of radiographic foreign body localization, detection of kidney and bladder stones, and radiation safety. His 1901 volume, *The Roentgen Rays in Medicine and Surgery*, was the first major textbook in American radiology. In the post-Röntgen years the medical literature indicates that Francis Williams led his peers in radiologic experience, precision in observation, and clarity of interpretation.



Archives
— of —
Clinical Skiagraphy.

BY

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Fig. 3.10 The first of many journals dedicated to the study of Röntgen's rays. (Courtesy of the Center for the American History of Radiology, Reston, Va.)

William Rollins and the Beginning of Radiation Safety

Demonstrating that radiology pioneering could be a family affair was Francis Williams's brother-in-law, Boston physician and dentist William Rollins (Fig. 3.14). He had a penchant for the mechanical and fathered useful innovations such as a dental fluoroscope, as well as schemes to sharpen the radiographic image, including the use of image intensifying screens and X-ray beam collimating diaphragms. The fanciful "see–hear," a combination fluoroscopy screen and stethoscope, certainly attested to his ingenuity.[18] But unquestionably his most far-reaching contribution was to radiation safety.

Although reports of burn-like ulcerating dermatitis associated with X rays had begun to appear by March 1896, scientific thinking could not have been more divided regarding the cause.

One particularly noteworthy theory was detailed in 1896 by Boston X-ray equipment manufacturer G. A. Frei. Skin damage, he declared, was "not caused by the action of the X rays in any way." He attributed the injury instead to the type of electrical apparatus powering the tube. In his definitively titled work, "X Rays Harmless with the Static Machine," Frei averred that "...whatever ill effects we get on our skins are caused only when we use induction coils...while no such effects are perceived when we employ the static machine"—a notably pragmatic view, since Frei's company made static machines.[19] Famed investigator Nikola Tesla, however, presumably was free from such sources of bias when he likewise asserted in late 1896 that local electrical effects rather than X rays were the culprit: "As to the hurtful actions on the skin...they are not due to the roentgen rays but merely to the ozone generated in contact with the skin."[20]

With mainstream science holding X rays blameless, the pioneers who continued to preach caution deserve particular credit. One such prophet was Elihu Thomson, who in November 1896 deliberately exposed his little finger for one-half hour to an X-ray tube powered by a static machine.[21] The ensuing severe burn put Mr. Frei's contention permanently to rest.

Five years later Rollins shook up the status quo with a brief letter to the editor of the *Boston Medical and Surgical Journal* (now the *New England Journal of Medicine*), ominously titled "X-Light Kills."[22] In it he demonstrated that a guinea pig in a closed, electrically insulated box could be killed by X rays. This not only disproved Tesla's dictum, but also introduced a hitherto unrecognized caveat: since the guinea pig was killed with no visible burns, lack of skin damage did not mean that a given level of X-ray exposure was safe.

The response of the radiology establishment was swift. A letter of reply appeared in the same column two weeks later and a word battle of truly life-and-death proportions took shape. Venerable radiology pioneer Ernest Codman, who had disputed Elihu Thomson's self-immolating experi-

Fig. 3.12 Francis Williams performing one of his masterful chest fluoroscopies. (Reprinted with permission from the MacMillan Co.)

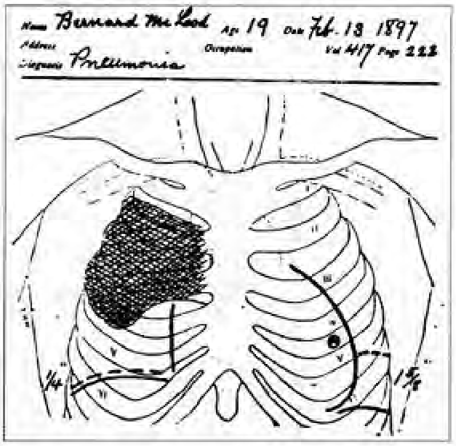


Fig. 3.13a A succinct Francis Williams fluoroscopy report describing pneumonia.

3.13b A thoracic aortic aneurysm diagnosed and outlined by Francis Williams. (Reprinted with permission from the MacMillan Co.)

Fig. 3.14 William Rollins.(Courtesy of the Center for the American History of Radiology, Reston, Va.)

ment, gave a no less definitive title to his submission: "No Practical Danger from the X Ray." "Such sensational headings as 'X light kills' are apt to give a wrong impression," he declared. "The fact that the X ray is in daily use in the large hospitals without harmful results should be put in blacker type than the death of two guinea pigs."[23] He reiterated his objections in a 1902 paper, "The Cases of Accidental X-Ray Burns Hitherto Recorded":

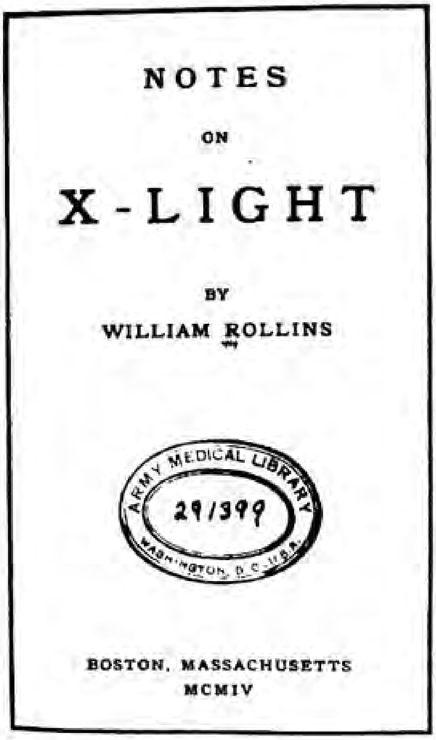
> The frequency of X-ray injuries has been much exaggerated by the medical press....The cause of X-ray injuries is not definitely known. It is some form of energy closely allied to the...X ray and radiates with it from the...terminal....There is no good evidence of injury to the deeper tissues without primary interference with the skin.[24]

Rollins steadfastly maintained his position, however, and codified his "X light axioms" in a 1904 volume titled *Notes on X-Light* (Fig. 3.15).[25] The misfortune that was soon to befall many early radiologists would validate his admonitions that the smallest possible beam should strike the patient, and no rays should reach the observer.

The Debt Begins to Come Due

This advice came too late for some, however. The sad fate of Clarence Dally, Thomas Edison's assistant, has already been recounted. But it was the death of its physicians which affected the fledgling science most deeply. A particularly illustrative case is that of Walter Dodd (Fig. 3.17). At eighteen he was working as an assistant janitor at Harvard's Boylston Chemical Laboratory. Dodd studied as he worked and in 1892, at age twenty-three, was appointed assistant apothecary at the Massachusetts General Hospital. By 1896 he was not only chief apothecary but also the hospital's official photographer.

In early 1896 the first X-ray tube arrived at Harvard (Fig. 3.18). Intern Harvey Cushing, later a famous neurosurgeon, and Ernest Codman, above-described minimizer of radiation danger, produced the first radiograph.[28] With Cushing's departure the X-ray machine became the province of the photography department and of Walter Dodd. In just eight months he developed severe radiodermatitis, progressing within the year to ulcerations. Over the next four years, as multiple areas of skin cancer developed, the usual sad script of the "Röntgen martyrs" ensued: skin graft after skin graft, followed by serial amputations whittling


NOTES

ON

X-LIGHT

BY

WILLIAM ROLLINS

BOSTON, MASSACHUSETTS

MCMIV

Fig. 3.15 Rollins compiled his truly insightful observations concerning radiography and radiation safety into this privately published text in 1904. (Courtesy of the Center for the American History of Radiology, Reston, Va.)

THE DARK SIDE OF THE FORCE

William Rollins is rightfully regarded as the "patron saint" of early radiation safety, with insightful warnings designed to protect patient and X-ray worker alike. Unfortunately, his advice did not stop there (Fig. 3.16).[26] After discovering the sterilization effects of the new ray, he offered it as an ideal and painless means of reshaping the gene pool more to his liking. The flurry of radio-eugenics papers was a brief tarnish on the luster of early radiology.[27] These notions of technological "race-shaping" with the X ray were revived in the United States and Germany during the years preceding World War II.

Notes on X Light: On the Importance of Treating the Generative Organs of Degenerates by X Light to prevent their Increase.—Dr. WILLIAMS ROLLINS (*Boston Med. and Sur. Journ.*, February 16, 1905) claims that, as the exposure to X light of animals can make them sterile and can kill the fœtus in all stages of development, laws should be passed which will enable the power of X rays to be used to protect the race against the constant menace from the children of degenerates. The present attempts to diminish as far as possible this risk by confining the degenerates in prisons and asylums are inefficient, because in the intervals when they are free, they exercise their generative functions to the serious detriment of society. As the X-light treatment is painless, and if used by those skilled in the art without risk, one of the reasons which has ever deterred society from protecting itself by surgical operations is absent.

Fig. 3.16 Rollins could not resist the notion of social engineering using the power of the new ray. (Reprinted with permission from *Archives of the Roentgen Ray* 9 (1905):296)

away at the fingers and hands. Incredibly, Dodd enrolled in medical school in 1900 at the age of thirty-two, finally achieving his medical degree in 1908. He promptly returned to the Massachusetts General Hospital as radiologist, becoming "instructor in the use of the Roentgen ray" at Harvard Medical School. In 1915, after more disfiguring and poorly healed surgeries, Dodd volunteered for service as a radiologist in France during World War I. His selflessness was unrewarded in this life; he died of metastatic cancer in December 1916.[29]

Boston was not the sole locale for either pioneering work in radiology or for the tragedy wrought by such work. John Cox in Montreal, Russell Carman in St. Louis (and later Rochester, Minnesota), Lewis Cole in New York, Wolfram Fuchs in Chicago, and George Pfahler, Mihran Kassabian, and Charles Leonard in Philadelphia were working to cement the place of the X ray within medicine and the place of the radiologist within the family of medical specialties.

Charles Leonard (Fig. 3.19) had the unusual experience of being present as his own case of radiation injury was reported at the 1908 meeting of the American Roentgen Ray Society (ARRS).[30] He had been a skeptic regarding the seriousness of potential harm from X rays but was forced to reverse his stance by 1907, when extremely painful burns and skin ulcerations began to affect him.[31] A touch of prophetic fatalism permeated Leonard's

Fig. 3.17 Walter Dodd. (Courtesy of the Center for the American History of Radiology, Reston, Va.)

discussion of his own case, as he questioned the heroic surgical measures endured by many of the Röntgen martyrs: "I have yet to find in the whole category of those who have died as a result of X-ray dermatitis one who was not subjected to repeat operations. That they are not living now shows that the operation did not cut short the disease."[32] What was cut short were the careers and lives of many of early radiology's best.

Along the Fringes

As Emerson noted, there is no history, only biography. The story of radiology's fledgling years is no exception. William Morton was a radiology pioneer who regularly traveled from the mainstream of the profession to the fringes. Scion of a noted medical family and a neurologist by training, Morton was a leading voice in the electrotherapeutics movement. In particular, he extolled the curative virtues of static electricity in papers such as "Electrostatic Currents and the Cure of Locomotor Ataxia, Rheumatoid Arthritis, Neuritis, Migraine, Incontinence of Urine, Sexual Impotence, and Uterine Fibroids."[33] His familiarity with electrical apparatus made the move into radiology an easy one. Morton was an insightful investigator. He foresaw the utility of the new rays in identifying calcifications in arteries and other tissues, as well as recognizing the importance of bowel gas as a sort of natural contrast medium. In 1896 Morton produced the first dental radiograph in America and authored the first book about X rays written by a physician. In the first years of this century he turned his attention to the X ray and radium therapy of cancer.[34]

Then, in 1904 the newspapers trumpeted the headlines that Morton had a cure for cancer (Fig. 3.20a). He was credited with the discovery of "liquid sunshine" therapy. The patient would drink a liquid that fluoresced in response to radiation, then X rays or radium rays would be directed at the organ of interest, bathing it with internal "sunshine" (Fig. 3.20b). Unfortunately for Dr. Morton,

Fig. 3.18 Radiography comes to the Massachusetts General Hospital. (Courtesy of Eisenberg, R.L., from *Radiology: An Illustrated History*, Mosby-Yearbook, 1993)

Fig. 3.19 Charles Leonard. (Courtesy of the Center for the American History of Radiology, Reston, Va.)

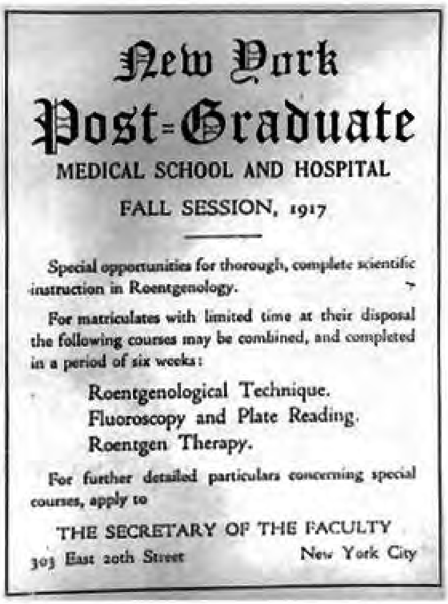


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Fig. 3.21 Radiographer, radiologist, and radiotherapist in just six weeks! (Reproduced with permission from the *American Journal of Roentgenology*)

A

B

Fig. 3.20a Morton basks in the glow of publicity from "liquid sunshine." (Courtesy of the William Hammer Collection, Smithsonian Institution)

Fig. 3.20b The "liquid sunshine" cure in action. (Courtesy of the William Hammer Collection, Smithsonian Institution) this was not his only bad idea. In 1913 he was sentenced to prison for his part in a fraudulent mining scheme.

POSTSCRIPT

A 1910 survey of ARRS members revealed that most of the pioneer radiologists were young men, having received medical degrees from 1896 to 1903.[35] Even fourteen years after the discovery of X rays, however, only 27 percent of society members acknowledged limiting their practice to radiology, with 40 percent still engaged in general medical practice. Formal training could be cursory, at best (Fig. 3.21). With few textbooks and journals for support, the early radiologist had to rely on the "retrospectoscope" method to acquire and sharpen his diagnostic skills. When a fluoroscopic or radiographic plate examination yielded equivocal results, the radiologist would attend the subsequent surgery or autopsy. Radiographic studies could then be reviewed in light of the anatomy and pathology. Given this painstaking trial-and-error approach, as well as tools which today seem the technologic equivalents of flint knives, it is little short of amazing that the early radiological pioneers were able to forge an enduring and vital medical specialty.

▶ ▶ ▶ ▶ ▶ ▶

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