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Dr. Edith H. Quimby: A pioneering medical physicist and educator with outstanding contributions in radiation dosimetry☆

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1. Introduction

Edith Hinkley Quimby (1891–1982) was a distinguished medical physicist and a pioneer in the research and development of diagnostic and therapeutic applications of radiation in medicine.[1] With her systematic and important research, Quimby was one of the few leading scientists at the first half of the 20th century that established the fields of diagnostic and interventional radiology as we know it today.[2] (Photo credit: Center for the American History of Radiology, courtesy AIP Emilio Segrè Visual Archives)

2. Early life and education

Born on July 10, 1891 in Rockford, Illinois, USA, Edith H. Quimby grew up in a family of 3 children and moved to several different states during her childhood. After graduating from high school in Boise, Idaho, Quimby was awarded a full tuition scholarship to Whitman College in Walla Walla, Washington, where she earned a BS degree in Physics and Mathematics in 1912.[2] It was during her college education that Quimby was first inspired by her teachers, B.H. Brown and W. Bratton, to pursue a career as a scientist. After a short period of teaching science at high school in Nyssa, Oregon, she received a physics fellowship at the University of California where she earned her master's degree in Physics in 1915.[3] During the same period, she married Shirley Leon Quimby, a fellow physics student. Following an appointment as a high school science teacher in Antioch, California, Quimby moved to New York in 1919 together with her husband, who had accepted a Physics teaching position at Columbia University.[4] The same year, Quimby joined as assistant physicist the first research laboratory in the United States devoted to medical applications of radiation, which had been recently established by Dr. Gioacchino Failla, former student of Marie Curie and Chief Physicist at the newly founded New York City Memorial Hospital for Cancer and Allied Diseases.[5,6] As Quimby recalled: “This job turned up. I took it”.[7] This was the beginning of an exciting scientific journey for Quimby that led to many important discoveries and paved the way for establishing the medical physics profession at a period when radiological sciences were still at their infancy. Quimby was later awarded the honorary degree of Doctor of Science (Sc.D.) from Rutgers University in 1956 as well.[1]

☆ This piece is one in a series highlighting the lives and accomplishments of female ACR Gold Medal Winners.

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3. Early career: a pioneer in radiation dosimetry

Between 1919 and 1940, Quimby conducted research to quantify many different aspects of the radio-biological effects of radium and X-rays. Many of her research findings and standards of measurements were published in the form of original research articles in internationally recognized scientific journals and were frequently quoted in the academic and professional literature for decades.[1] As a result, she was among the few first women scientists that began to earn recognition for her substantial contributions to the field of radiological sciences. For example, in 1940 Quimby was the first woman to be awarded the Janeway Medal of the American Radium Society[8] and the following year she was awarded the Gold Medal of the Radiological Society of North America for contributions "which placed every radiologist in her debt".[2]

Quimby realized quickly in her career the need for simple computational models that can be easily employed in clinics to deliver safe and effective radiation treatment doses to patients.[9] Until then, the dose had to be estimated with cumbersome algorithms for each individual patient due to lack of standards.[10] Quimby began by investigating the properties of radium (226-Radium) and X-ray radiation when interacting with living tissue.[11–14] Moreover, she introduced a dose pre-planning system for brachytherapy, also known as the Memorial system, employing a spatially homogenous distribution of radioactive source strength (activity) over a plane or volume of targeted tissue to deliver non-uniform dose distributions with larger dose depositions at the center relative to the periphery of each targeted lesion.[15,16] This was in contrast to the Paterson-Parker pre-planning system for brachytherapy, also known as the Manchester system developed in Manchester's Holt Radium Institute around the same time period, where a spatially heterogeneous radioactive source distribution was applied with higher strength or activity sources being concentrated at the lesions periphery to attain a relatively homogeneous ($\pm$10%) dose distribution across a plane or volume of each targeted lesion.[17] Typically, the overall source strength or activity required delivering the same cumulative dose to similar size planar or volume lesion will be much higher when using the Quimby system.[18] In an effort to facilitate the wide clinical adoption of brachytherapy planning, Quimby published streamlined dose charts to enable the straightforward calculation of the total milligram/hour of radium needed to attain a certain amount of absorbed dose.[13,19]

During the same period, Quimby introduced experimental methods to determine the different beta and gamma radiation doses required to trigger a similar degree of specific biologic effects, such as human skin erythema (skin reddening), thus setting the foundations for the practical calculation in routine medical practice of radiation type-specific quality factors allowing the quick estimation of an equivalent dose (skin erythema dose) which is an amount of radiation dose reflecting not only the physical amount of radiation energy deposited to a certain plane or volume of living tissue (absorbed dose), but also the degree of specific stochastic biologic effects as a result of the applied ionizing radiation to that tissue.[14,20,21] These initial systematic studies were based on roentgen units and equivalent doses relevant to specific biologic effects (skin erythema dose) which is different to the System International (SI) units of equivalent dose employed nowadays.[22,23] Nevertheless, they served as the basis for later establishing the fundamental concept of relative biological effectiveness (RBE) in the field of radiobiology and health physics, thereby allowing us today to apply the appropriate set of experimentally-defined radiation-specific weighting factors to calculate from a given amount of absorbed dose in a living tissue (in SI units of Grays) the respective amount of equivalent dose in the same tissue (in SI units of Sievert) taking into account the stochastic biologic effects of each radiation type applied to that tissue.[24] Moreover, during her early years at Memorial Hospital, Drs. Quimby and Failla were among the first to demonstrate the direct relationship between the darkening of dental films and the degree of skin erythema in radiation workers and the importance for establishing full-scale wearable film badge programs in radiation treatment departments of hospitals to monitor occupational radiation exposure using dental X-ray films with filters distinguishing between gamma and beta radiation.[1,25–31]

4. Later career

In 1941–42, Quimby was appointed Assistant Professor at Cornell University Medical College and began teaching radiology courses. The following year she followed her mentor Dr. Gioacchino Failla to Columbia University College of Physician and Surgeons, where she was appointed Associate Professor of Radiology and later full Professor (1954). At Columbia University, Quimby contributed to the growth of one of the first and most recognized education programs in Radiological Physics in the United States. During the same period, Quimby expanded her research to artificial radioactive isotopes produced by accelerators and reactors, such as the synthetically produced radioactive sodium[32,33] and iodine.[34,35] In collaboration with other Columbia investigators, Quimby studied the use of these isotopes for the treatment of thyroid disease,[36,37] various circulation studies[38–40] and the diagnosis of brain tumors,[41] thus setting the foundations for nuclear medicine. Moreover, Quimby and Dr. Leonidas D. Marinelli published a series of mathematical models allowing the estimation of radiation dose distributions and their biological effects in internal organs, which served as the theoretical basis for today's internal radiation dosimetry models.[42,43] Furthermore, she co-authored with physicists Otto Glasser, Lauriston Taylor, and James Weatherwax, a reference book entitled "*Physical Foundations of Radiology*" that quickly became a classic textbook for radiation dosimetry at the time.[44]

In addition to her teaching and research activities, Quimby contributed to the Manhattan Project, participated in the Atomic Energy Commission, served as a consultant on radiation therapy to the United States Veterans Administration and chaired a scientific committee of the National Council on Radiation Protection and Measurements.[4] She was also a renowned oral examiner for the American Board of Radiology (ABR) for nearly half a century.[45] Of note, Quimby advocated for the need of clinical medical physics departments in large hospitals across the United States, the inclusion of a physics section in the ABR examination and for the professional rights of medical physicists.[45–49] Quimby has also been credited for her pioneering research in the safe handling of radioactive materials and as being one of the first physicists raising awareness regarding the harmful biological effects of radiation.[50–53]

In the 1950s, Quimby's work began to receive international recognition and resulted in numerous awards by several scientific societies. In 1954, she was elected as president of the American Radium Society of which she remained a devoted member for many more years.[4,54] In 1963, the American College of Radiology (ACR) bestowed upon Quimby the ACR Gold Medal, making her only the second woman in the history of the organization at that time to win the college's highest award; the first woman was Marie Sklodowska Curie, 32 years earlier in 1931.[55,56] Quimby was also one of the founding members of the American Association of Physicists in Medicine (AAPM) from which she received in 1978 the William D. Coolidge Award for her pioneering work on nuclear medicine, radiation therapy, diagnostic radiology and radiation protection.[57] The AAPM later established a lifetime achievement award in her honor.[49]

5. Devoted educator and examiner

Edith H. Quimby had also been co-organizing since 1954, together with Dr. Sergei Feitelberg and Dr. Solomon Silver, a highly renowned annual training course in the "Clinical Use of Radioactive Isotopes" taking place in various New York based institutions with a medical physics training program.[46,58,59] The course aimed at teaching in theory and clinical practice the proper clinical use of radioactive isotopes and included primary and guest lectures, experimental lab exercises and clinical measurements on patients and specimens.[59] Originally conceived as an annual 4-week full-time comprehensive course to allow participation across the United States, the response was so enthusiastic that it became necessary to offer later an alternate 8-month course for interested physicians and physicists in the New York City metro area.[45] The course curriculum was also published as a textbook in 3 editions.[60–62]

In fact, Quimby had earned the reputation of a devoted educator and meticulous board examiner among radiology residents and medical physicists across the United States.[45,46] Dr. Stanley J. Goldsmith, Professor Emeritus of Radiology at Weill Cornell Medical College, was a student in Quimby's 8-month course in June 1968 at Mount Sinai Hospital. When we interviewed him regarding his memories of Dr. Quimby during our literature research, Dr. Goldsmith had stated: "*She [Quimby] was very serious and very strict, the class started at 4pm and at 4pm she would walk over and close the door and lock it... You knew you were in the presence of a force, someone with a major impact on dosimetry…when people would say 'Edith Quimby' [it was] with reverence.*"

After her retirement in 1960 as Professor Emeritus of Radiology at Columbia University, Quimby continued her research,[63,64] education and professional activities at various scientific societies until 1978 when she left Columbia University. She lived with her husband in Greenwich Village in Manhattan, was a member of the League of Women Voters and enjoyed sports, bridge, theater and detective novels. She died in October 11, 1982 at the age of 91.[1,65]

6. Legacy

Quimby is considered as one of the 20th century's most prominent researchers in medical physics and nuclear medicine.[1] Her pivotal research contributions exemplified the value of devoting one's life-long career to the fearless search of answers, which later shaped forever the field of radiation dosimetry. Her streamlined, yet effective, radiation dose calculation methodologies quickly set the standards for future generations of physician and physicists enabling so many breakthroughs in the diagnosis and treatment of a vast range of diseases. Quimby was also a true pioneer in being one of the few first female scientists whose work had such a profound impact in her discipline deservingly earning a wide recognition and the true admiration of her colleagues and students at a period with a very low representation of women scientists. As noted by Harold Rossi of Columbia University in *Physics Today*, Quimby will surely be remember in the history of science: "*… all too often, the creative achievements of scientific pioneers are overshadowed by further developments made by others or simply become anonymous components of accepted practice. Fortunately, Quimby's exceptional service to radiological physics was widely recognized*".[65]

CRediT author statement

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Declaration of competing interest

None.

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