

Radiologic History Exhibit

The Role of Women in Wartime Radiology¹

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■ INTRODUCTION

Soon after the discovery of the x ray, its potential usefulness in evaluating battlefield injuries was appreciated. As early as May 1896, soldiers injured in Italy's Ethiopian campaign were radiographed on their return to Naples by Lieutenant Colonel Giuseppe Alvaro (1). During the Greco-Turkish War of 1897, radiography was performed closer to the front in a German Red Cross hospital in Constantinople. By the end of 1897, x-ray apparatus was transported to the battlefield by the British in the Tirah campaign (2).

The involvement of women in wartime radiology was initially limited. But with creativity and resourcefulness, women managed to serve as radiologists, as well as in other medical specialties, in World War I. Radiology saw tremendous growth in the period between the two world wars. By World War II, the opportunities for women in radiology, as in other fields, increased.

This article recounts highlights in the lives of several women pioneers in radiology in the Spanish-American War through World War II.

■ SPANISH-AMERICAN WAR: ELIZABETH FLEISCHMAN

The United States first used x rays for military purposes during the Spanish-American War in 1898. Three hospital ships were equipped with x-ray apparatus, and major hospitals were outfitted as well (3, pp 1-4). However, many of the injured were not radiographed until after they had returned home.

Elizabeth Fleischman, pioneer x-ray technologist (Fig 1), was well-known for her work in radiographing Spanish-American War casualties after their return to San Francisco, California. Fleischman was born in El Dorado County, California, in 1867 (4). She never finished high school; at the beginning of her senior year, she left school and went to work as a bookkeeper to help with the family finances (5). In 1896, Fleischman became interested in the newly discovered x rays through the influence of her brother-in-law, who was a physician. She took a 6-month course in electrical science at the Van der Naillen School of Engineering and Electricity, San Francisco, and borrowed money from her father to buy x-ray apparatus, including a fluoroscope (6). By 1897, she had established an x-ray laboratory on Sutter Street in San Francisco (7). She radiographed patients under the direction of, or referred by, physicians. She examined ani-

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Figure 1. Elizabeth Fleischman (1867-1905). Pioneer radiographer from San Francisco, California. (Reproduced from *American X-Ray Journal* 1900; 6:723.)

mals as well and experimented with radiographing various substances to learn more about the new technique (8). In those days, artistic skill as well as expertise in photography and anatomy was necessary to produce optimal radiographs.

On December 8, 1898, Fleischman proposed her services as a radiographer to the U.S. Surgeon General. She was referred by the chief army surgeon in California, who felt that the employment of a radiographer would be less expensive for the army than the purchase of x-ray equipment. The request was approved by the surgeon general on December 20, 1898 (9). At the same time, a fee of \$10.00 was approved by the chief surgeon for "services and use of Radiograph for locating bullet lodged in the body of... a patient in the Division Field Hospital, Presidio S.F. Cal. Dec. 3. 98." (10) (Fig 2).

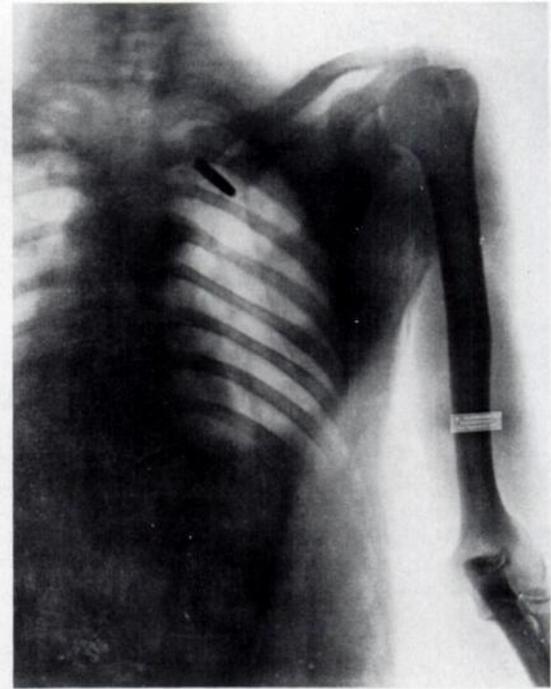


Figure 2. Posteroanterior chest radiograph, taken by Elizabeth Fleischman of a soldier who had been wounded during the Spanish-American War, shows a lodged Mauser bullet. (Reproduced from reference 11, plate X.)

One of her best-known radiographs was that of Private John Gretzer, Jr, of the First Nebraska Volunteer Infantry. He had been wounded by a Mauser bullet on March 27, 1899, in the Philippine Islands. Gretzer lost consciousness for a few hours. When he came to, he experienced severe pain in his head, which improved slightly by the 5th week after the injury. He returned to San Francisco and was radiographed on August 20, 1899, 5 months after the injury (Fig 3a). The Mauser bullet was demonstrated in the region of the left occipital lobe. Gretzer was described as being in good general condition; a photograph taken about the same time as the radiograph shows the bullet wound over the left eye (Fig 3b) (11).

Fleischman was commended by the Surgeon General of the United States for her excellent work (12). Some of her radiographs were used to illustrate a book by Captain William C. Borden describing the use of x rays in the Spanish-American War (Fig 4). This book was the



a. **Figure 3.** (a) Radiograph of the head of Private John Gretzer, Jr. taken August 20, 1899, by Elizabeth Fleischman shows a Mauser bullet. (b) Photograph of Private Gretzer taken 5 months after the injury (about the same time as the radiograph) shows the scar from the entrance wound above the left eye. (Fig 3a and 3b reproduced from reference 11, plate XI and p 43, respectively.)

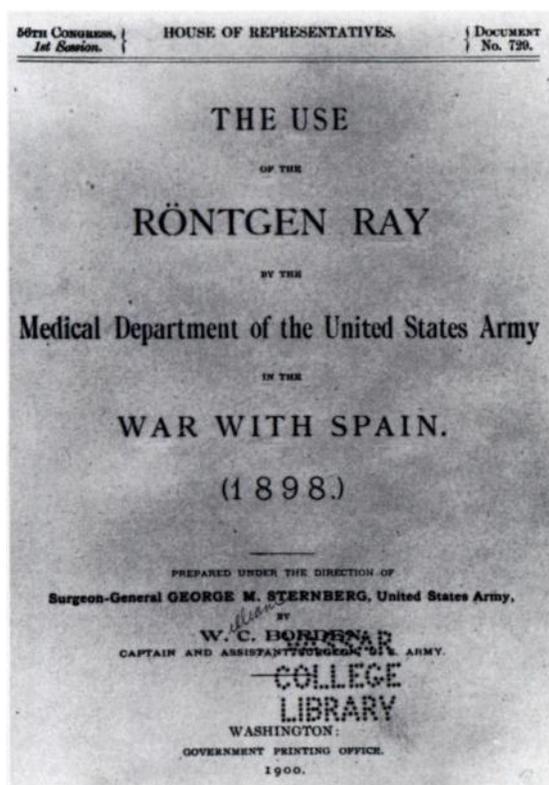


Figure 4. Title page of Captain William C. Borden's landmark text. (Reproduced from reference 11.)

first large-format radiology text published in the United States to display radiographs along with case presentations.

In March 1900, Elizabeth Fleischman became a charter member of the Roentgen Society of the United States (13), which was to become the American Roentgen Ray Society. She was one of the few nonphysicians who were members of that group.

During examinations, Fleischman exposed herself to radiation to show patients that the procedure was painless (7). In 1903, "her hands commenced to show signs of x-ray dermatitis, the nature of which was not understood, and attributed to chemicals used in developing the plates. [She] worked 12 hours a day without protection" (14). The dermatitis progressed to cancer, and her arm was amputated at the shoulder in January 1905. A local recurrence appeared 4 months later; soon after, metastases were noted in her pleura and lungs. Elizabeth Fleischman died on August 3, 1905; she was 38 years old (15).



Figure 5. Marie Curie in her laboratory in 1912. (Reproduced from reference 16.)



Figure 6. Irene Curie in a military hospital, Amiens, France, in 1916. (Courtesy of the Archives Curie et Joliot-Curie, Musée de Laboratoire.)

■ WORLD WAR I

By the beginning of World War I, the specialty of radiology was still in its infancy. Although physicians in other specialties were beginning to use radiologic techniques as a diagnostic adjunct, there were relatively few whose practice was dedicated solely to radiology (3, pp xv-xx).

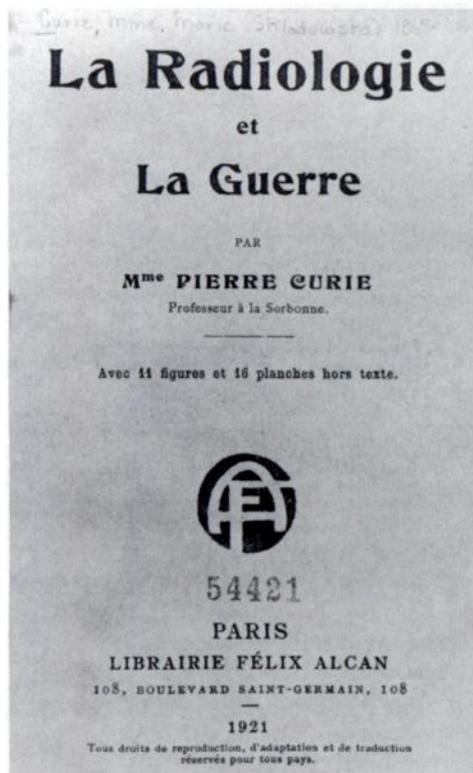
● Marie Curie

Marie Curie (Fig 5) is one of the most revered names in the history of the discovery of radiation. However, not everyone is aware of her wartime contributions to diagnostic radiology.

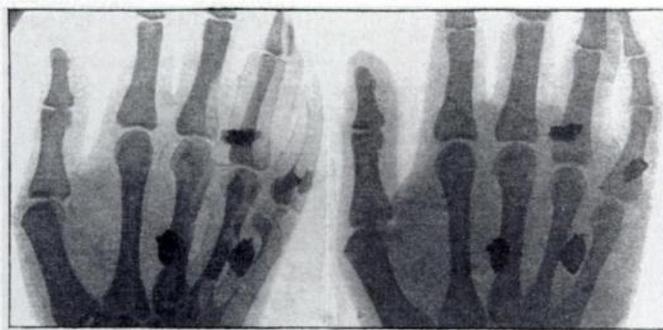
In the first months of the war, military hospitals were established throughout France. Most of these hospitals did not have radiology equipment, and there were only a handful of radiologic specialists in the large cities. Madame Curie assumed the task of setting up radiologic and radiotherapeutic services for the military hospitals. During August and September 1914, she collected all the equipment she could find in laboratories and stores and established sev-

eral "stations of radiology." Volunteers were both recruited and trained by Curie to operate the equipment. She wrote: "At the beginning of the war there was little knowledge of radiology, and apparatus in the hands of those who did not understand how to handle it deteriorated quickly and was soon useless. The practice of radiology...in war-time does not require much medical knowledge; it can be sufficiently grasped by intelligent persons who know how to study and who have some knowledge of electrical machinery. Professors, engineers, or university students often made good manipulators. I had to look for those who were temporarily free from military service, or who happened to be stationed in the locality where I needed them. But even after I had secured them, these operators were often transferred by military orders, and I had to search again for others to fill their places. For this reason, I determined to train women to do this work" (17, pp 216-217).

The Health Service, on her proposal, added a department of radiology to the Nurses' School of the Edith Cavell Hospital. From 1916 to



a.



Radiographie d'une main contenant 4 éclats d'obus. Fracture d'un métacarpien.
Radiographie de la même main avec déplacement d'ampoule perpendiculairement à la direction des os. La face dorsale de la main repose sur la plaque. D'après le déplacement de l'image des os et de celle des éclats, on peut juger que l'éclat qui se projette entre le 4^e et 5^e métacarpien est palmaire; les autres sont dorsaux. Ces indications ont suffi pour leur extraction.

b.

Figure 7. (a) Title page of Madame Curie's book about radiology in World War I. (b) Left, "radiograph of a hand with four pieces of shrapnel. Metacarpal fracture" (18). Right, "radiograph of the same hand with the x-ray beam repositioned perpendicularly to the bones. The dorsal aspect of the hand is resting on the film. According to the displacement of the image of the bones and that of the shrapnel, one can determine that the shrapnel projected between the fourth and fifth metacarpal is palmar, the others are dorsal. This information is sufficient for extraction of the shrapnel" (18). (Fig 7a and 7b reproduced from reference 18, p 80.)

1918, Madame Curie, with the help of her daughter Irene and a woman named Mademoiselle Klein, trained 150 x-ray technicians at the Radium Institute in the theoretical and practical knowledge of electricity, x rays, and anatomy (16, pp 302-303). Curie was very persistent in her desire to provide radiologic services to the field hospitals. Often, she personally loaded x-ray apparatus onto the train, with the help of the employees, to make sure that it would arrive speedily at its destination (17, pp 215-216). Through the efforts of Marie Curie, approximately 200 radiologic installations were established in the French and Belgian war zones (17, p 211).

On several of the trips, Madame Curie was accompanied by her daughter Irene, then 17 years old (Fig 6). Irene had studied nursing and learned the basic techniques of radiology, so that she was able to direct an x-ray facility on her own. In *La Radiologie et La Guerre*, Madame Curie described several radiographic

methods of localizing bullets, which she and Irene taught the military surgeons (Fig 7). She wrote the following about an episode involving Irene and a military surgeon: "A radiographer, recently placed at the hospital, localized a piece of shrapnel that had gone through and crushed the femur; the surgeon, who had reason to be dissatisfied with his previous radiologist, refused to search for the shrapnel on the side he was told it was accessible; instead, he first looked for it at the site of the wound. Not finding anything, he decided to explore according to the findings on the x-ray examination, and found the bullet right away. It is obvious that he didn't follow the advice of the radiographer because he had no confidence in the method of localization. On the contrary, since that episode, he has shown confidence that he lacked before" (18, pp 107-108).

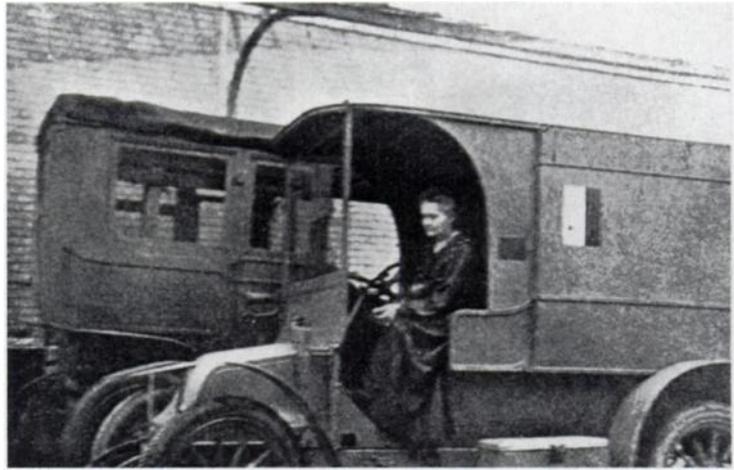


Figure 8. “Marie Curie at the wheel of the famous Renault car converted into a radiological unit, in which, from August 1914 on, she circulated from hospital to hospital” (16). (Reproduced from reference 16.)

On realizing that all of the hospitals of the Paris region were not serviced by the radiologic stations, Curie “fitted up, with the help of the Red Cross, a radiologic car. It was simply a touring motor-car, arranged for the transport of a complete radiologic apparatus...” (17, pp 210-211) (Fig 8). During the war years, she equipped and gave to the army 20 radiologic cars (car frames and some equipment were donated). Curie personally traveled to the front with her “radiologic car,” driving herself when necessary, to train personnel and personally assist in radiographing the wounded (Fig 8).

Of her wartime experience, Curie wrote: “nothing was so moving as to be with the wounded and to take care of them. We were drawn to them because of their suffering and because of the patience with which they bore it. Almost everyone did his best to facilitate the X-ray examination, notwithstanding the pain caused by any displacement. One learned very soon to know them individually and to exchange with them a few friendly words. Those who were not familiar with the examination, wanted very much to be reassured about the effect of the strange apparatus they were going to experience. I can never forget the terrible impression of all that destruction of human life and health. To hate the very idea of war, it ought to be sufficient to see once what I have seen so many times, all through those years...” (17, pp 215-216).

● **British Medical Women**

By the time the First World War began, Madame Curie had both the fame and influence to be able to serve her country, France, without resistance. In Britain and the United States, the services of expert women radiologists were refused by those in power, and they were forced to seek other means to serve.

Florence Ada Stoney.—Florence Ada Stoney, MD (Fig 9), pioneer British radiologist, was born into a progressive family in Ireland in 1870. Her father, G. Johnstone Stoney, ScD, FRS, was secretary to the Queen’s University of Belfast (20). He advocated the higher education of women, and it was “through his influence the first Irish medical license was opened to women.... This forced the hand of London University to open its degrees to women within a year” (21). Stoney obtained her medical degree with honors from the London School of Medicine for Women, where she received awards in every subject taken (22). She was demonstrator in anatomy at the London School of Medicine for Women for 6 years and “gave up anatomy only when she found that there was no prospect of a woman being appointed at that time to the lectureship” (19, p 855).

In 1902, Stoney organized the x-ray department at the Royal Free Hospital. This hospital, founded in 1828, was the first English general hospital to allow the clinical instruction of female medical students, beginning in 1877 (23).

Before World War I, Stoney visited the United States “specially to see X-ray work.” Her



Figure 9. Florence A. Stoney, MD (1870-1932). (Reproduced from reference 19.)

account of this visit was published in the *Archives of the Roentgen Ray*. She visited several cities, including Schenectady, New York; Boston, Massachusetts; New York, New York; Washington, DC; Baltimore, Maryland; and Philadelphia, Pennsylvania. She wrote, "I found the doctors in America, both in the hospitals and in private, very ready to allow me to see the work in their departments—medical women not being kept out of everything so much as in England" (24). She was particularly impressed with radiation protection: "I found that nowhere is the X-ray operator left exposed to the rays, except during fluoroscopic examination.... In many places they have given up fluoroscopic work as too dangerous to the operator. In one private office the fluorescent screen was reflected in a mirror. In this way the operator remains behind his lead partition even for setting the plate in position..." (24).

Florence and her sister Edith Stoney, a mathematical physicist, assembled a portable x-ray

machine. On the first day of World War I, they offered their services and equipment to the British War Office but were refused (20). Florence Stoney thereupon joined the volunteer Women's Imperial Service League hospital unit organized by Mrs St Clair Stobart and became head of its medical staff and x-ray department. The unit went to Antwerp, Belgium, on September 20, 1914, at the invitation of the Belgian Red Cross. They were assigned an old music hall next to a British ammunition dump; it took 5 days for the women to convert it into a fully equipped hospital with 135 beds. Because of its location, the hall was one of the first buildings to be shelled 3 weeks later. Stoney was much admired for her courageous and decisive leadership during the bombardment (25). The women succeeded in getting the wounded patients out and left the burning city only 20 minutes before the access bridge was blown up by the retreating Belgians. Dr Stoney and her unit received the 1914 Star for their bravery.

In November 1914, Stoney's group was relocated to the medieval Chateau Tourlaville, near Cherbourg, France. Her unit had to produce its own electricity by using water power from a local stream. This power not only supplied the x-ray plant but also provided light for the hospital (26). In her account of this experience, she wrote: "We had a busy time changing a disused ancient chateau into a modern hospital..."

Most of our cases were septic fractures, for nearly all were septic by the time they reached us, 4-8 days generally after being wounded....

The x-rays were much in request to show the exact condition of the part, and the position of the fragments... examples... are seen in the following photographs" (27) (Fig 10). While in Cherbourg, she discovered that one could distinguish a sequestrum from live bone with radiography (19).

Stoney returned to England, whereupon Sir Alfred Keogh appointed her head of the x-ray and electrical department at the Military Hospital at Fulham in March 1915. Fulham Military Hospital was large, with over 1,000 beds. More than 15,000 cases passed through the x-ray department, where Stoney trained her own assistants as well as radiographers for other hospitals (25). She was the first woman physician to be accepted for full-time work under the British War Office (28, p 54). For a long time, she was the only woman on the staff (19). During her time at the Fulham Military Hospital, Stoney continued her academic activities. She published a study on hyperthyroidism in soldiers in *The Lancet* (29). In June 1919, Stoney received the Order of the British Empire.

“Dr. Stoney’s charming whimsical manner made it difficult to perceive at first the strength of her personality. She did not seek adventure, but only the opportunity of quiet service. Her organizing skill and tact undoubtedly opened the door through which many medical women subsequently passed without fuss or hindrance to give war service which was recognized as being of the utmost value” (20).

Edith Stoney.—On being refused for service by the British War Office, Edith Stoney did not go to Antwerp with her sister. Instead, she joined the Scottish Women’s Hospitals. She set up and ran the x-ray equipment of the tent hospital at Troyes, France, where she was noted for her use of x rays to localize foreign bodies. In the fall of 1915, the French authorities transferred her hospital unit to Serbia. Before leaving, Stoney had the foresight to purchase a portable engine in Paris to ensure the efficiency of her x-ray department. When the hospital was installed in Serbia, no electrical supply was available. Because of her engine, theirs was the only British hospital able to produce x rays. Furthermore, Stoney’s engine provided electricity for lighting the entire hospital.

When the French retreated from Serbia, the hospital moved to a location just outside Salonika, Greece. Stoney continued to run the x-ray department and also radiographed patients referred by British and French doctors from other hospitals. Her background in physics was most useful. She wrote, “It is easy to work x-rays when someone else has installed

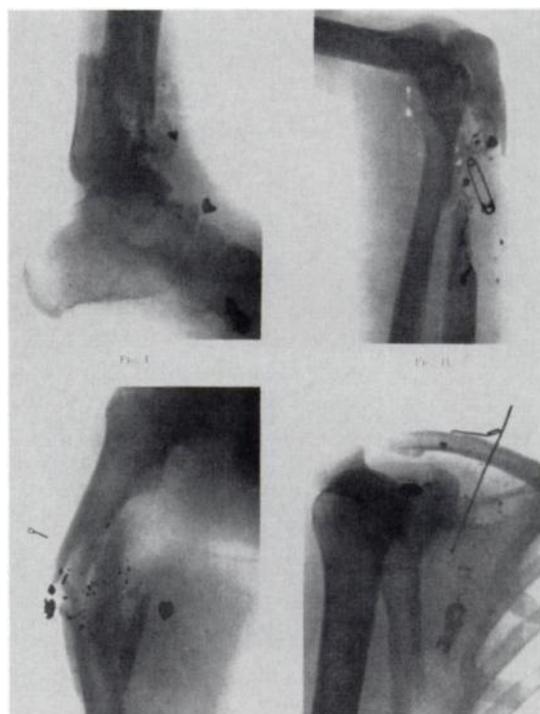


Figure 10. Radiographs of wounded soldiers examined by Dr Stoney in Cherbourg, France, show fractures and associated shrapnel fragments. (Reproduced from reference 27.)

them; but in a moving hospital, in difficult circumstances, physics is a help in getting the apparatus up and working well...” (28, pp 55–58).

Agnes Savill.—The Scottish Women’s Hospitals had organized, financed, and maintained over 1,000 beds in France and Serbia by the fall of 1915. Agnes Savill, MD, was another nonradiologist who served with the Scottish Women’s Hospital. Her unit was stationed in Roy-aumont, France. She provided the following description of “some of the difficulties experienced by the x-ray worker”: “The Abbey was a most beautiful building, but for purposes of a hospital it was much too large and rambling.... An x-ray room was fitted up on the first floor, close to the operating theatre. No ‘developing’ room could be found on the same floor; and only a large cupboard was ultimately available on the ground floor. The cupboard had no water supply; but with a fish-kettle filled with water it was not difficult to obtain excellent results.... For the final washing the photographs had to be carried upstairs to a washing sink.... The experience...has rendered me most unsym-



Figure 11. Gertrude Webster Welton. (From *Legenda*, 1903. Courtesy of the Wellesley College Archives, Margaret Clapp Library, Wellesley, Mass.)

pathetic with young workers who say it is impossible to work well without all the luxuries and conveniences to which a training in a medical school has made them accustomed" (30).

In 1915, Florence Stoney visited the Scottish Women's Hospital at Royaumont, France, and taught Dr Savill "all that she had learned of war radiology." Savill's account made special mention of Florence Stoney's background as an anatomist, which made her consultations especially valuable to the surgeons. During her wartime service, Savill also became skilled in localizing foreign bodies by means of the roentgen ray.

● **American Medical Women**

In the United States, the situation regarding the acceptance of women physicians was similar to that in Britain. The Medical Women's National Association (MWNA) established the American Women's Hospitals in 1917 to provide a means for women to serve.

The United States did not enter World War I until April 1917. U.S. Surgeon General Gorgas initially expressed a willingness to hire women physicians, including radiologists, as contract surgeons (31). In response, the War Service Committee of the MWNA formed a Sub-Committee on Roentgenology chaired by Gertrude Webster Welton, MD, of New York, New York (Fig 11). Welton, instructor in roentgenology at the New York Polyclinic Medical School and Hospital (32), was well qualified to lead the committee. She lectured on military radiology at the Twelfth Annual Meeting of the Women's Medical Society of New York State (33).

Welton's committee obtained a list of 31 women who had registered either with the Council of National Defense or the American Women's Hospitals, or who were "known to be doing x-ray work," so that they would be ready when called on by their country to serve. Although some of the women were specialists in radiology, others were clinicians who included radiologic techniques in their practice. Thus, the committee researched the availability of appropriate training. Schools of military radiology were established in nine cities to meet the need for trained personnel. However, women were not admitted to these schools.

The final report of the Sub-Committee on Roentgenology ends as follows: "It would seem that the best way of gaining admission... is to revise the law which requires all commissioned officers to be men. To demand admission is neither dignified nor expedient. Nor is it just for us as an organization to encourage women to leave their present occupations... As there are so few women roentgenologists, and as their services are not needed at present in the army or navy or for civilian relief, this committee feels that the National Association's duty is done to the country and to them if an accurate registry is maintained that they may be called upon when needed..." (34).

The American Women's Hospitals provided the only organized opportunity for women radiologists to serve abroad. Two radiologists, Ruth Ingraham, MD, of Brooklyn, New York, and



Figure 12. Ruth Ingraham, MD (1886-1971). (Courtesy of Archives and Special Collections on Women in Medicine, Medical College of Pennsylvania, Philadelphia.)

Gladys Lydia Carr, MD, of Boston, Massachusetts, eventually served through the American Women's Hospitals.

Ruth Ingraham, who received her medical degree from Johns Hopkins School of Medicine in 1914, became roentgenologist at the Brooklyn Hospital, New York, in 1917. She remained there until 1940 and was probably the first woman to head a radiology department in this country. In her Vassar class notes of 1917, she wrote, "The Brooklyn Hospital has offered itself as a Base Hospital, so it is not likely I would be sent away immediately, but I feel very ready to go now. I suppose it is a somewhat selfish feeling to be glad that my special work can be put to immediate service—wherein I myself can be real active—though my activity will probably be in staying just where I am now" (35). In 1918, she wrote, "Am on call any time now to be sent to France by the American Women's



Figure 13. Hospital number 1, among the American Women's Hospitals, at Luzancy, France. (Courtesy of Archives and Special Collections on Women in Medicine, Medical College of Pennsylvania, Philadelphia.)

Hospitals, and hope my call will come very soon.... The news lately has made me feel like doing something directly" (36).

Ingraham was called shortly thereafter, and in October 1918, she arrived in France. She served as radiologist at the first American Women's Hospitals facility in Luzancy, one of 15 women physicians who served in the war zone in France in cooperation with the American Committee for Devastated France (Figs 12, 13).

After the war was over, the American Women's Hospitals continued its mission in the form of relief work in France and in other areas. They selected and equipped eight women physicians for service with the American Committee for Armenian and Syrian Relief, later known as the Near East Relief Committee. Among these women was Dr Gladys Lydia Carr. In November 1917, Carr was allowed to attend classes at the National Military School of Roentgenology in New York for 2 weeks. At the suggestion of Dr Gertrude Welton, Carr asked whether her attendance at the school might be considered a precedent for other women who desired admission; the answer was no (37).

Carr, who was electrotherapist and roentgenologist at the New England Hospital for Women and Children, Boston, requested a 1-year leave of absence in February 1919 to serve with the Near East Relief Committee (38). That



Figure 14. Melson Barfield-Carter, MD (1895-1973). (Courtesy of the Reynolds Historical Library, University of Alabama at Birmingham.)

month, she sailed for Constantinople; her assignment was to supervise the installation of x-ray equipment in hospitals throughout Turkey (39). She remained in Turkey for 9 months, returning to the United States in November 1919 (40).

Carr subsequently relocated to California and then to Iowa. She eventually lost both index fingers and then her left hand to radiation-induced malignancy (41); she died in 1950 at the age of 71 years.

World War I provided opportunities for women at home who were needed to replace men who had gone. For example, Dr Elsie Fox became the radiologist at the City Hospital, New York, for 1½ years but relinquished her position when her predecessor returned from the war (42).

■ WORLD WAR II: AMERICAN MEDICAL WOMEN

It was during the period between the two world wars that radiology came into its own as a recognized medical specialty. Advances in equipment and formalized training for radiolo-

gists and technologists helped to develop the field. World War II also provided opportunities for women in the United States when so many men were called to serve. Dr Lucy Squire states that she was offered a residency position at Massachusetts General Hospital, Boston, in 1942 "because all the men had gone to North Africa" (43).

In 1943, women physicians in the United States were finally given the opportunity to serve their country; part of the impetus for this was the fact that the number of male physicians could not keep up with the increasing size of the Armed Forces (44). Extensive lobbying by Dr Emily Dunning Barringer, president of the American Medical Women's Association, and Dorothy Kenyon, a well-known judge and professional lobbyist hired by Barringer in December 1941, helped change public opinion. In December 1942, Congressman Emmanuel Celler of New York introduced legislation to allow women to be commissioned in the military. Congressman John Sparkman of Alabama went further by introducing a bill to specifically permit women physicians to be commissioned. In 1943, the American Medical Association, which had long opposed the commissioning of women, withdrew its opposition to allowing women physicians in the medical reserves. At the hearings in March 1943, Congressman Celler stated, "I think women doctors have reached a situation where they should not be judged by sex; they should be judged by accomplishments and skill" (43). The Sparkman Bill was approved and was signed into law by President Franklin D. Roosevelt on April 16, 1943.

In August 1943, Melson Barfield-Carter, MD, a radiologist from Birmingham, Alabama, became the third woman physician to be inducted into the army as a major. On her return to civilian life, she became the first chairperson of the Department of Radiology at the University of Alabama Medical Center (Fig 14).

The opportunities for women physicians gained during World War II have continued to increase, parallel with the increased acceptance of women in other spheres. The determination and ingenuity of the early women in radiology who insisted on being involved has finally led to the respect and acceptance so well deserved.

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