Mammography

Gerald D. Dodd, Jr., M.D., and Richard H. Gold, M.D.

In the year following Röntgen's discovery of X-rays, approximately one thousand related papers were published. The majority of these were concerned with the physical properties of the rays, and clinical reports were largely confined to orthopedic problems and foreign body detection; attempts to examine the chest, abdomen, and soft tissues were largely unsuccessful. The limitations reflected the embryonic state of equipment. While the low energy irradiation generated by the early, unfocused tubes was theoretically suited to soft tissue radiography, the long exposure times, erratic output, and scattered radiation all contributed to loss of detail. Adequate examinations were limited to those tissues which provided very high or very low absorptive values in contrast to surrounding structures. Bone, as the densest body tissue, was easily visualized, but the structural details of the surrounding soft tissues were indistinct. Even major organs such as the liver, kidneys, and spleen could not be clearly identified, and visualization of the gastrointestinal tract depended on the presence of air. The breasts, as organs composed entirely of various soft tissues with small differences in absorptive density, were not suitable for examination by this new technique. It was not until 1913, with the development of alternating current transformers by Snook and a reliable focused tube by Coolidge, that the production of X-rays in controlled quantities became a reality. Equipment development has continued to the present day, but these two advances provided the basis for all modern X-ray devices and are among the major scientific achievements of the twentieth century.

The history of mammography may be divided into three periods, beginning with the work of a few visionaries who established the feasibility of the examination, an intermediate period in which mammography was used primarily as an adjunct to the physical examination, and the modern era of technical excellence where the major concern has become the detection of nonpalpable cancer in asymptomatic women.

The Early Years

The first use of radiography as a method of imaging breast cancer is credited to Albert Salomon, a surgeon in Berlin in 1913. Salomon (Fig. 18.1) was concerned with demonstrating the extent and avenues of spread of mam-
mary cancers to encourage more adequate surgical resections by his colleagues. His work was confined to radiographs of excised breasts and comprised more than three thousand specimens (Fig. 13.2). Although his observations did not include living subjects, they established the basis for clinical mammography. He clearly differentiated infiltrating tumors from the circumscribed variety and actually identified a nonpalpable cancer adjacent to a large, palpable cyst. Possibly because of the inadequate radiographic techniques of the time, he failed to recognize the diagnostic significance of the punctate calcifications that occurred with some cancers, but he described and illustrated one carcinoma in which calcifications were present.

The potential significance of Salomon’s work was grasped by his colleagues, and in 1927 Kleinschmidt and his associates mentioned the clinical use of mammography in a chapter of a textbook edited by Zwiefel, Payr, and Hirzel. Kleinschmidt credited the technique to Erwin Payr, chief of surgery at the University of Leipzig. The work done in the Leipzig Breast Clinic led to an article by Finsterbusch and Gross, which accurately described the typical calcifications encountered in secretory disease.

During the same period, Dominguez and his associates in Uruguay were also involved with the development of clinical mammography and in 1929 and 1930 published several basic articles related to its clinical potential. Their observations provided the groundwork for Leborgne’s subsequent demonstration of the diagnostic importance of the fine calcifications that may be detected in a high proportion of imaged mammary cancers.

From 1930 onward the number of publications related to mammography increased rapidly. In 1931 Goyanes, Gentil, and Guedes published an excellent paper in the Spanish literature titled “Radiography of the Mammary Gland and Its Diagnostic Value.” Also notable is an article by Vogel in 1932 consisting of a radiographic classification of various benign lesions, with emphasis on the differential features of benign and malignant tumors. These observations remain valid in the interpretation of current-day mammograms. Vogel’s article also included a description of an oblique roentgenogram of the breast which he favored because the axilla was included in the image. The projection described was essentially one in which both the tube and the patient were positioned obliquely to include the maximum amount of breast tissue, chest wall, and axilla. Vogel examined his patients in the supine position, but the basics of this projection have been adapted for use with modern mammographic units. Today mediolateral oblique views are considered indispensable for proper radiographic examination of the breast.
The first major clinical series of mammograms was reported by Stafford Warren, professor of radiology at the University of Rochester and later dean of the School of Medicine at the University of California at Los Angeles (Fig. 13.3). Warren published papers in 1930 and 1932 describing a stereoscopic mammographic technique that included dual fine-grain intensifying screens and a moving radiographic grid (Fig. 13.4). In a series of 119 patients with 58 malignant tumors he achieved an accuracy of 86 percent.12,13 Warren also contributed detailed descriptions of the normal mammary gland at rest and during pregnancy and commented on the large number of cases of “chronic mastitis” encountered in his series. This is probably the entity known as fibrocystic change in current terminology.

Although Warren’s work was outstanding, Gershon-Cohen noted that an equally fundamental article describing the roentgenologic appearance of the normal breast was published by Romagnoli in the Italian literature in 1931.15 In Gershon-Cohen’s opinion, Romagnoli’s work was done simultaneously with, but independent of, Warren’s.15

Other investigators during the early 1930s included Sebold, Reimann and Sebold, Lockwood, Gunsett and Sichel, and Espaillat.16,17,18,19,20,21,22,23 These authors confirmed and expanded on the work that had already been accomplished, but despite their efforts there was little interest shown by the majority of physicians in the clinical uses of mammography.

In 1938 Gershon-Cohen (Fig. 13.5) and Strickler published a detailed description of the roentgenography of the normal breast, emphasizing that knowledge of the normal at all ages and stages of biologic activity was a requisite to the recognition of pathologic conditions.24 They also stressed the need for continued improvement in technique to assure the acceptance of mammography. Compared to other radiologic examinations, soft-tissue radiography of the breast remained a technical step-child twenty-five years after its introduction. The reproductions of mammograms in journals and tests were also unsatisfactory; attempts to relate written descriptions of various normal and
pathologic states to the murky illustrations were most discouraging and played a significant role in the prolonged neglect of the examination.

Throughout the 1930s and 1940s some variations in mammographic technique, as well as occasional new diagnostic criteria, were introduced. In 1933 Baraldi, in Argentina, published radiographic contrast and fine detail, a combination he obtained by the use of very low kilovoltage, a target-film distance of 60 centimeters (cm.), nonscreen film, and optimal X-ray beam collimation. Leborgne also used the collimating cone to compress the breast, a technique that reduced both radiographic tissue scatter and patient motion (Fig. 13.9). The combination of collimation and compression was later adopted by equipment manufacturers and is now a standard component of dedicated mammography machines.

Of particular importance was Leborgne's observation that approximately 30 percent of mammary cancers contained fine calcifications, particularly those of intraductal origin (Fig. 13.10). Because these calcifications could be visualized in dense breasts, they offered the possibility of detecting a neoplasm without demonstration of the actual mass. The calcifications also afforded the first objective evidence of the potential of mammography to diagnose early, nonpalpable breast cancer. These observations, made in 1949 and 1951, represented a significant step forward in the art and science of mammography.\textsuperscript{29,30}

the first of several reports of pneumomammography as a means of improving visualization of the breast tissues (Fig. 13.6), and in 1930 Ries introduced contrast studies of the mammary ducts, a technique further developed by Hicken in 1937 (Fig. 13.7) and Leborgne in 1944.\textsuperscript{25,26,27,28} Leborgne (Fig. 13.8), a former student of Dominguez, stressed the need for high CO\textsubscript{2} insufflation performed in 1937 by N. Frederick Hicken. There is a large fibroadenoma in the central portion of the breast. (Authors' collection)

Fig. 13.7 Normal ductogram. Thoracentesis injection of the ducts of the left breast. Study performed in December 1935 by N. Frederick Hicken. (Reprinted with permission from Radiography and Clinical Photography)

Fig. 13.8 Raul Leborgne (1907–1970). (Courtesy of Felix Leborgne, M.D., Montevideo, Uruguay)

Fig. 13.9 Leborgne's illustration of the position of the patient for a craniocaudal mammogram. Leborgne's caption: "Observe the characteristics of the cone and the compression pad interposed between it and the breast."
(Reprinted with permission from the American Journal of Roentgenology)
In 1952 Gershon-Cohen and his associates began an extensive series of publications covering many aspects of mammography. They included a similar body of work. During this period Gershon-Cohen and his co-workers were particularly interested in establishing a firm anatomic basis for mammography. Ingleby, a pathologist, correlated the radiographic findings with gross and microscopic sections of the corresponding surgical specimens to explain many previously obscure radiographic features. Nevertheless, synthesis of specimen and radiographic morphology remained difficult, mainly because of problems in spatial resolution and contrast associated with the radiographic techniques then available. The quality of the mammograms, while acceptable for that era, was poor by today's standards, and the teaching points remained difficult to follow. These problems were shared by all mammographers and minimized interest in the examination. Referring physicians seldom, if ever, requested mammograms, and those who did were frequently disappointed by the inability of most radiologists to provide clinically useful information. Additionally, many physicians refused to believe that an X-ray examination might provide more information about a superficial organ than could be obtained by inspection and palpation. Accordingly, the performance of mammography was confined to a few dedicated individuals who, by virtue of their persistence and meticulous work, managed to maintain some level of activity in their individual practices.

In 1956 a chance occurrence resulted in a rebirth of interest in mammography. During the course of a radiotherapy planning conference at the University of Texas M. D. Anderson Hospital and Tumor Institute, a woman with known carcinoma of the breast was presented. Her breasts were pendulous, and there was difficulty in determining the approximate size of the tumor. Attending the conference was a visiting fellow from the Curie Foundation in Paris, Jean Pierre Batani. By chance, Batani had brought with him a mammogram from his parent institution clearly demonstrating a breast cancer. He suggested that routine use of such studies would simplify problems similar to the one presented by the patient being examined. Although not familiar with the precise technical details, Batani recalled that very low kilovoltages and relatively high tube currents were used with fine grain film to produce mammograms of this type. Gilbert
H. Fletcher, a radiotherapist and head of the department of radiology, suggested that the section of diagnostic radiology attempt to develop a mammographic technique equal or superior to that described by Batani. Robert L. Egan (Fig. 13.11), a resident in general radiology rotating through the section of therapeutic radiology, undertook this assignment. Following extensive experiments with various technical combinations, Egan devised a high milliamperage, low kilovoltage, nonfiltered beam methodology suitable to the minor absorptive differences of breast tissues. Multiple kinds of film were also investigated, and eventually type M industrial film was chosen because of its high resolution and wide gray scale. A particularly notable aspect of the Egan technique was the recalibration of standard radiographic equipment to permit the use of precise kilovoltage and milliamperage values. This combination of factors resulted in high-quality mammographic images (Fig. 13.12).

Although the initial results of his efforts were published in Radiology in December 1960, Egan’s work attracted much attention before his paper appeared.43 Philip J. Hodes, professor of radiology at the Thomas Jefferson Medical College in Philadelphia, had learned of Egan’s project and asked that one of his junior staff be instructed in the essentials of mammographic technique and interpretation. Several weeks later, as a member of the guest faculty at the University of Minnesota annual refresher course, Hodes bemoaned the lack of progress in gastrointestinal radiology and exhibited some of Egan’s mammograms as an example of the fresh thinking necessary to assure progress in diagnostic radiology. Medical news writers in the audience sensed a breakthrough in the statistics Hodes quoted from Egan’s work. The ensuing newspaper articles, which were widely distributed, led to Egan being bombarded with requests for further information and, in essence, initiated the era of modern mammography.

The press coverage also attracted the attention of the Cancer Control Program (CCP) of the United States Public Health Service (USPHS). Its director, Lewis C. Robbins, requested permission for a committee of well-known physicians to visit the M. D. Anderson Hospital to evaluate the mammography program. The members of the committee included Thomas Carlile, chief of radiology at the Virginia Mason Clinic in Seattle, Washington; Eugene P. Pendergrass, professor and chairman of the department of radiology of the University of Pennsylvania; Wendell G. Scott, clinical professor of radiology at Washington University of St. Louis; Theodore Hiblish, chief of radiology at the National Institutes of Health; and James Cooney, vice-president for medical affairs of the American Cancer Society (ACS). The committee was impressed by the acceptance of mammography at the M. D. Anderson Hospital and concluded that it had great potential if the technique and its purported accuracy were reproducible.

As a result of the committee findings, a reproducibility study was developed in the spring of 1961 which was intended to answer three basic questions:

1. Could radiologists as a group obtain mammograms of uniformly high quality?

2. What proportion of breast malignancies could be diagnosed by mammography before biopsy?

3. Could existing radiographic equipment be adapted to this technique?

The study was conducted jointly by the National Cancer Institute (NCI), the M. D. Anderson Hospital, and the USPHS CCP. The responsibilities for training, report collection, statistical
evaluation, and protocol compliance were divided among these agencies.

A total of twenty-four institutions were involved. The training of radiologists from the participating institutions was accomplished during a five-day visit to the M. D. Anderson Hospital and Tumor Institute, during which Egan instructed them in his technique and the basics of mammographic interpretation. Particularly emphasized was the importance of the pattern of cooperation and communication that had been developed between surgeons, pathologists, and radiologists at the M. D. Anderson Hospital.44

Two years after the implementation of the reproducibility study, on the basis of fifteen hundred patients examined, it was concluded by the sponsoring agencies that the mammography technique was reproducible and that the minor equipment modifications required could be accomplished in most departments. The latter included removable tube filtration, recalibration of kilovoltage and milliamperage settings, the use of variable extension cones and, for most installations, the availability of ceiling-mounted radiographic tube cranes. It was also determined that a true-positive diagnostic rate of 85 percent could be anticipated.

During the period of the reproducibility study, Robert Egan had joined the staff of the department of radiology at Emory University in Atlanta. With the acceptance of the study data, a training center was also established at that institution for the indoctrination of additional radiologists and technologists. A similar program was maintained at M. D. Anderson under the direction of John McGraw. The programs proved so successful that a subcommittee on mammography of the Advisory Committee to the USPHS’s CCP recommended the establishment of additional centers. At the request of the CCP, a committee appointed by the American College of Radiology (ACR) selected thirteen centers to be developed for the instruction of radiologists, radiologic residents, and technologists. The recommendation was implemented by the CCP, and by 1968, when the program was discontinued, twelve hundred radiologists and seven hundred radiographers had been trained.45

**The Middle Years—Evolving Techniques**

Despite the demonstrated validity and reproducibility of mammography, acceptance of the technique continued to lag during the 1960s. In this respect, its lack of acceptance paralleled the early years of the Papinocolau smear. General practitioners and gynecologists had been skeptical that cytology could detect an early cancer in a patient with a normal appearing cervix. Similarly, some surgeons and oncologists remained doubtful that an imaging technique could detect a cancerous mass in a clinically normal breast. In addition, the majority of radiologists remained untrained in mammography and more often than not failed in attempts to produce an adequate examination. Nevertheless, the gradual evolution of equipment and technique was destined to have a significant influence on the use of mammography.

In 1940 Chester F. Carlson, a physicist and attorney, was issued a patent which covered the basic principles of electrophotography or xerography. In 1944 he entered into an agreement with the Battelle Development Corporation of Columbus, Ohio, a subsidiary of the Battelle Memorial Institute, formed for the express purpose of sponsoring new inventions. The product of this joint effort was licensed in 1947 to the Haloid Corporation of Rochester, New York. Haloid, later to become the Xerox Corporation, initiated the development of xerography as a commercial office copier. In 1952, as the result of interest on the part of the New York State Civil Defense Commission, John Roach and Herman Hilleboe began a series of investigations into the potential of xerography for medical imaging.46 Mammography was among the examinations investigated, but it met with limited success due to the configuration of
the Xerox plates. Similarly, in 1960 Harold Gould, Francis Ruzicka, and others published a series of papers on the use of xerography for imaging the breasts.\textsuperscript{47,48} They concluded that the technique had great promise, but that difficulties with the equipment precluded its widespread use.

In 1964 John Wolfe (Fig. 13.13) became interested in the xeroradiographic process and obtained a unit which had been used for xeroradiography nearly twenty years before. Through perseverance he was able to overcome many of the problems that had discouraged previous investigators, including a significant reduction in the quantity of radiation required to produce a serviceable image. His close cooperation with the Xerox Corporation permitted him to gain a thorough understanding of the process and made possible the identification of factors that favored or adversely affected good image quality.

In 1966 Wolfe's work attracted the interest of the ACR.\textsuperscript{49} Wendell Scott, chairman of the Committee on Mammography and Diseases of the Breast, was impressed by Wolfe's presentation at the fifth annual Mammography Conference and urged the Xerox Corporation to develop and refine its system for mammographic use. The first commercial unit for this purpose became available in 1971 (Fig. 13.14) and, by the late 1970s, xerography had become a widely accepted alternative to film mammography. Xeromammograms could be interpreted in reflected light and, with the characteristic effects of edge enhancement and broad-area contrast, seemingly resolved many of the problems associated with film mammography (Fig. 13.15). This superiority was later contested as technical advances improved film quality, but most mammographers who have worked with both feel that the experience of the interpreter is of greater importance than differences in the characteristics of the recording media. In any event, the contributions of Wolfe to the mammographic literature were significant and...
mammography on a sound anatomic basis, but it was not until the investigations of Steven Gallager (Fig. 13.19) and John Martin (Fig. 13.20) that a comprehensive correlation of the roentgen findings with gross sections and microscopic pathology was achieved. Gallager, a pathologist, and Martin, a radiologist, had correctly observed that there were many mammographic observations for which anatomic and histologic bases were lacking and, conversely, many histopathologic findings with no apparent mammographic counterparts. Their work, employing the gross and microscopic comparison of whole organ sections with corresponding preoperative mammograms, yielded much new information concerning the early development, intramammary spread, and classification of mammary cancers. In 1971 it led to the concept of “minimal” breast cancer, defined as lobular carcinoma in situ, noninvasive intraductal carcinoma, or minimally invasive lesions with a mass no more than 0.5 cm. in diameter. Martin and Gallager believed that if properly treated, the cure rate for minimal cancers should approach 100 percent. This prediction has been substantiated by subsequent clinical studies.

The diagnosis of subclinical lesions created an unanticipated problem. Surgeons found it difficult to be certain
that the proper tissue had been obtained for histologic examination, and repeated biopsies were often necessary. On occasion, cancers were overlooked. The dilemma led to the introduction of preoperative needle localization of subclinical lesions. In 1963 Gerald Dodd and William Delaney introduced the technique at Thomas Jefferson Medical College in Philadelphia.\(^5\) A 20, 4-inch spinal needle or disposable needle of the appropriate length was introduced into the breast immediately prior to surgery, using the preoperative mammogram as a guide. When it was determined by postinsertion radiographic films that the tip of the needle was within or immediately adjacent to the suspect area, the proximal end was bent or clipped at the skin and the patient sent to the operating suite (Fig. 13.21a). The surgeon then excised the tissue about the tip for microscopic examination. Use of this procedure avoided excisions of large amounts of tissue in patients with benign disease, minimized the possibility of a false-negative pathology report and shortened the time required for the biopsy procedure.

The pathologist also experienced problems in identifying small tumors or areas of calcification in the biopsy specimens. The introduction of specimen radiography essentially solved this problem. The specimen may be examined in the department of radiology or with portable industrial instruments which can be kept in the pathology department. Various techniques have been devised to permit precise localization of the suspect areas and questionable histologic sections can be supplemented by additional specimen radiographs (Fig. 13.21b). Specimen radiography was initially confined to biopsy specimens but has now been applied to mastectomy specimens for more thorough analysis of the primary tumor.

Needle localizations, having proven reliable and relatively atraumatic, have been progressively refined by other mammographers.\(^54,55,56\) Their widespread use as an adjunct to mammography has added significantly to our knowledge of the natural history of breast cancer. A sequence of progression from ductal hyperplasia to anaplasia, preinvasion, and invasion has been identified with attendant implications for treatment and mortality.

---

**Fig. 13.19** Stephen Gallagher. (Authors' collection)

---

**Fig. 13.20** John Martin. (Courtesy of John E. Martin, Houston)

---

**Fig. 13.21** Preoperative needle localization of nonpalpable lesions: a. Cephalocaudal projection. A small, central mass has been transfixed by a straight needle designed for this purpose. b. Biopsy specimen radiograph (magnified). The tip of the needle is within the suspect mass indicating the site from which tissue specimens should be obtained. (Authors' collection)
Thus, by the early 1970s the stage had been set for the routine use of mammography as a clinical tool and as a potential screening procedure for the detection and treatment of breast cancer in asymptomatic women.

MODERN MAMMOGRAPHY

Although technology significantly improved during the decade following Egan’s landmark paper, concern persisted about the level of X-ray exposure necessary for both film mammography and xeromammography. In 1970, in an effort to reduce radiation dose and exposure times, J. L. Price and P. D. Butler in Britain investigated the potential of a high-definition intensifying screen held in close contact with industrial film by an air-evacuated polyethylene envelope. The results were promising, and Bernard Ostrum and Harold Isard of the Albert Einstein Medical Center in Philadelphia requested Robert Wayrnen, of the DuPont de Nemours Company, to explore the possibility of developing a similar system. The result was the first screen-film combination for mammography, the DuPont LoDose(R) system, reported by Ostrum and his colleagues in 1972.

In 1976 a paper by John Bailar of the NCI raised the possibility that mammography, because of the carcinogenic potential of radiation, would cause more breast cancers than it would save lives through early detection. The ensuing debate was sensationalized by the media, but stimulated the investigation of more advanced screen-film systems. These not only reduced dose and motion blurring, but significantly lessened tube heating, with salutary effects on kilovoltage, focal spot-to-skin distance, scattered radiation, and magnification potential.

The shorter exposures also made possible the routine use of molybdenum targets and filters. The wave length spectrum of molybdenum was known to be more suited than tungsten to soft tissue radiography. However, with slower film systems, excessive quantities of the low energy radiation emitted by molyb-
denum were necessary to produce a usable image. With the faster screen-film packs this drawback was minimized and the quality of mammograms improved by the superior differential absorption characteristics of the molybdenum spectrum.

In the mid-1970s mammographers were divided in their preference for film studies or xerograms; each had useful characteristics and convincing advocates. However, with the development of screen-film systems that required substantially less exposure to produce excellent images, the proponents of xerography began to waver. By 1990, despite continued improvements in equipment reliability and dose, the Xerox Company made a marketing decision to discontinue its medical products. In the opinion of many this was unfortunate. The Xerox 175 system, the final product tested by the Xerox Corporation, had a resolving power which exceeded that of available screen-film systems, operated at a dose level equivalent to that of screen-film mammograms performed with radiographic grids, and maintained the desirable characteristic of edge enhancement while increasing broad area contrast. Although not as well-suited as screen-film mammography to screening procedures, it did offer an added dimension to the examination of the dense breast.

The development of mammography equipment continued in parallel with that of the image-recording products. The introduction of dedicated mammographic X-ray units was particularly important. Screen-film combinations are more susceptible to variations in dose than nonscreen film, and a fixed tube-film distance is preferable, as are automatic exposure controls. When these components are used in conjunction with beryllium window tubes, appropriate filters, small focal spots, radiographic grids, and breast compression devices, dedicated mammographic units produce films of outstanding clarity (Fig. 13.22). Additionally, the technological advances have resulted in a dose rate for screen-film systems that varies between 100 and 300 millirads per image.
depending on whether a radiographic grid is employed. It is generally agreed that doses of this magnitude have a negligible carcinogenic potential.82

The introduction of magnification mammography has also greatly improved the detection and analysis of intramammary abnormalities. In 1977 Edward A. Sickles, Kunio Doi, and Harry K. Genant reported that enlarged images were useful in distinguishing malignant from benign disease, particularly with respect to the detection and analysis of calcifications.83 Magnified images have become a frequent complement to standard mammograms; the majority of dedicated mammography units now permit magnification of one and one-half to two times to improve the detail of suspicious areas.

The conventional needles employed for localization purposes may be displaced by patient movement. In 1976 Frank and his colleagues described a needle-hook wire assembly.84 Following insertion, the needle could be withdrawn over the wire, allowing the hooked wire to remain fixed within the breast tissue at the site of the lesion. However, because the hook protruded beyond the bevel of the needle, a small incision was necessary to facilitate introduction. Once inserted, repositioning of the wire was difficult.

In 1980 Daniel Kopans and Salvatore Deluca reported a modification of the Frank system, using a wire with an overbent hook that remained retracted within the needle during insertion; the hook was bare only when the needle was withdrawn over the wire. The needle could be repositioned before the hook was engaged, but once the hook was unsheathed it could not be withdrawn.85 This drawback was corrected by Marc Homer who introduced a wire manufactured from a semi-elastic metal; the curved hook at the end of the wire had a "memory" so that even after being straightened, the configuration of the hook would return. Thus the hook could be retracted at will for subsequent repositioning.86

As a result of these improvements in equipment, recording media, and ancillary devices, modern mammograms are far superior to those produced in the middle years. Guidewire localization has resulted in less deforming biopsies, and the decreased dose to the breast has essentially negated the theoretical threat of radiation carcinogenesis. Unfortunately, because existing benefit analyses are based on clinical series that antedated these technological improvements, it has proven difficult to convince epidemiologists and statisticians of the very real differences between modern mammography (after 1980) and its predecessors.

**SCREENING MAMMOGRAPHY FOR THE EARLY DETECTION OF BREAST CANCER**

The possibility of using mammography as a screening tool was mentioned by many pioneers in the field, but the concept was first implemented by Gershon-Cohen and his associates in 1958.87 In 1961 and 1967 he published five- and ten-year follow-ups of the screened population and concluded that periodic breast roentgenography of women over age forty should be seriously considered.88,89 Unfortunately, little attention was paid to his work, in part because it included no control population. That flaw was corrected in the screening project of the Health Insurance Plan (HIP) of Greater New York beginning in 1963. Conceived by Shapiro, Strax, and others, the HIP project, well-designed from the statistical standpoint, represents the only large-scale, randomized, and controlled study of mammography ever performed in the United States.79 At the end of five years, a 50 percent decrease in mortality was found in those women who entered the program at age fifty and over. No similar benefit was demonstrable in the forty to forty-nine age group; only a 5 percent
Nevertheless, the long-term results have proven useful and may be more pertinent to modern mammography than the HIP study. Of the 2,567 cancers diagnosed in 282,000 women, 41.6 percent were apparent only by mammography. The comparable figure in the HIP study was 33.3 percent. In women forty to forty-nine years of age, mammography alone detected 35.4 percent of 762 tumors compared with 19.4 percent in the HIP study. In those younger women, 16.5 percent of infiltrating cancers were less than 1 cm. in diameter, and 52 percent of these were apparent only by mammography. The comparable figure in the earlier HIP study was 3.5 percent.

The results of the BCDDP program were also significant for tumor size and prognosis. Some 38 percent of all cancers detected were under 1 cm. in size, and 68 percent of those were noninfiltrating. Thirty-two percent of these minimal cancers (noninvasive or under 1 cm. in size) were found in women younger than fifty years of age. These figures are significant when it is recalled that the overall five-year survival rate for patients with tumors 3 cm. in size at the time of diagnosis is 50 percent; this rate rises to 65 percent for tumors 2 cm. in diameter and to 80 percent for cancers 1 cm. in size. The twenty-year survival rate for minimal cancers under 0.5 cm. has been calculated to be 95 percent.

These results indicate that a substantial improvement occurred in the quality of mammography between the HIP and BCDDP studies, a factor of particular significance in the younger age group. In addition, a concomitant ten- to twenty-fold decrease in radiation dose was achieved.

Thermography was deleted from the BCDDP program after two years when it became apparent that it was not sufficiently sensitive or specific to be used as a screening procedure.

In 1976 the ACR, impressed by the results of the HIP study and the preliminary evaluation of the BCDDP, adopted a set of guidelines which recommended that forty- to forty-nine-year-old women have mammography and physical exami-
nations performed at one- to two-year
intervals, unless more frequent ex-
aminations were medically warranted. For
women fifty years of age and older, annu-
al mammograms and physical examina-
tions were recommended.

In 1977, because of the possible
risks of radiation exposure and a con-
tinuing lack of significant benefit for
women under fifty years of age, restric-
tions on the use of mammography were
adopted for the BCDDP. A consensus
development meeting on breast cancer
screening held by the NCI produced
guidelines which stipulated that asym-
ptomatic women from forty to forty-nine
years of age might have mammography
only if they, or their mothers or sisters,
had breast cancer. Women from thirty-
five to thirty-nine years of age were eli-
gable for mammography only if they
had a personal history of breast cancer,
while all women older than fifty years
of age were to continue having mam-
mograms annually. Although the
guidelines were intended to apply only
to women enrolled in the BCDDP,
widespread press coverage of the possi-
ble ill effects of radiation led to the
avoidance of clinically indicated mam-
mography by women who were not
enrolled in the project.

As a cosponsor of the BCDDP, the
ACS concurred in the 1977 restrictions,
but in 1980 independently issued
guidelines recommending a baseline
mammogram between the ages of thirty-
five and forty and urged women
younger than fifty to consult their physi-
cian about the need for mammography.
The recommendation for annual mam-
mography for women over fifty was
unchanged.

In 1985 the HIP data began to show
a trend toward benefit in younger
women as well as a continued decrease
in mortality for those over fifty years of
age. The results of the BCDDP also
suggested equal benefits for all women
over the age of forty. For these reasons,
the ACS altered its guidelines to specif-
ically recommend mammography at
one- to two-year intervals for women
between the ages of forty and forty-
ine. This decision placed the guide-
lines of the ACS and the ACR in agree-
ment on essential points.

During the 1980s the use of mam-
mography as a screening procedure
increased rapidly. To provide guidance
for members, many organizations de-
veloped statements on mammography,
some of which specified both the age
groups in which the procedure was indi-
cated and the frequency of examination.
There was not universal agreement, and
both physicians and their patients were
confused by conflicting statements.

In February 1987 the ACR convened a
series of meetings of thirteen concerned
organizations in an attempt to develop
uniform recommendations for screening
mammography. Because the ACR and
ACS guidelines were similar, they were
used as a focus for the discussions. All par-
ticipants agreed that annual screening
was necessary in women fifty and older,
and that the screening process should
include both physical examination and
mammography. Twelve organizations,
including the NCI, agreed that the
screening of asymptomatic women
should begin at age forty and continue at
one- to two-year intervals until age fifty.
The American College of Physicians
(ACP) did not join in the consensus, con-
tending that existing data did not justify
the screening of women in the younger
age group. Independently, the Preventive
Services Task Force of the Federal Drug
Administration (FDA) expressed the
same opinion as the ACP.

In 1991 the news media became
privey to portions of the results of the
Canadian National Breast Screening
Study (CNBSS). In essence, the avail-
able information suggested that women
aged forty to forty-nine who had under-
gone annual mammography and physi-
cal examination had a higher death
rate than those in the control group.
The latter had received only one breast
physical examination at the inception
of the study. The imputation that those
who have had mammography are more
likely to die of breast cancer was seized
by the lay press and widely publicized
(Fig. 13.24). While the release of this
undocumented information was unfor-
tunate, the observation was potentially
important and required careful evaluation, particularly since one arm of the CNBSS represented the only randomized study specifically designed to evaluate the effect of mammography and physical examination in women aged forty to forty-nine.

In February 1993 the NCI convened an International Workshop on Screening Breast Cancer. The conclusions of the workshop are contained in the so-called "Fletcher Report." Few proponents of screening were invited to the workshop and, despite their complaints that numerous scientific mistakes were made in evaluating much of the data, it was concluded that there was no compelling evidence to support screening women in the younger age groups.

Despite opposition by the National Cancer Advisory Board, the NCI used the now published results of the CNBSS and the Fletcher Report as the basis for unilaterally withdrawing from the 1987-1988 consensus agreement. Women aged forty to forty-nine were urged to consult their physicians concerning the relative merits of screening mammography, and the recommendation for women over age fifty was changed from screening on an annual basis to every one to two years.

In response to the NCI action, the ACR and ACS reaffirmed their belief in the value of screening younger women. It is probable that only the passage of time will conclusively settle this question, but a recently completed meta-analysis of the seven randomized trials with unscreened control groups shows a 14 percent decrease in mortality of younger women if the Canadian study is included. This is not statistically significant, but if the CNBSS is excluded, there is a 24 percent decrease, a statistically significant figure (CI 0.62 - 0.95). The reasons for the delayed appearance of benefit in the younger age group are complex but are probably related to menopause, faulty structure of the trials, and the technical limitations of earlier mammography.

The CNBSS findings have been severely criticized, primarily by radiologists with substantial clinical experience in screening mammography. Although differences of opinion still exist on the details and merits of the screening process, the efforts of the ACS and similar organizations have resulted in the widespread use of both screening and breast scanning in women aged 50 and 60. It is believed that breast cancer in women under 50 and in women over 60 is best managed in a similar fashion, with screening mammography being the primary method.

Women who have breast scanning are more likely to die of cancer

By John Cassady, Toronto, and Tim Raymond, Geneva

in which the tumour is re-

moved, radiation given to the

breast and then only after a

period of six to eight weeks of

chemotherapy given. This

is the technique used in the

United States and other na-

cions.
diagnostic mammography. As of 1993 approximately 74 percent of all women aged forty and older had had at least one mammogram during their lifetimes. However, approximately two-thirds of these were not screened on a regular basis. The need for routine screening is not perceived by many women, and many will not seek the examination unless referred by a physician. Older women are less likely to be informed and, despite declining costs, financial and cultural barriers persist, particularly for minorities and the economically disadvantaged. Nevertheless, despite these problems, the effect of screening has become manifest in the stages of disease seen in clinical practice. Between 1972 and 1988 the number of in situ cancers diagnosed by mammography rose from 1.9 to 12.9 percent. During the same period the number of regional cancers dropped from 42 to 27.8 percent with a corresponding decrease in the number of radical mastectomies performed.

Similar improvement has also occurred in mortality rates. Essentially unchanged since 1950, there is now an overall decline of approximately 6 percent, varying from 9.3 percent in women fifty to fifty-nine years of age to 3.4 percent in those seventy to seventy-nine. Pertinent to the question of younger women is an 8.1 percent decrease in those forty to forty-nine years of age. Undoubtedly the use of adjuvant therapy plays a part in this decrease, but it is probable that a major factor is the detection of earlier stage disease due to the increasing use of mammography.

The Role of the American College of Radiology in the Acceptance of Mammography

Many individuals and institutions have been involved in the development of mammography, but the contribution of the ACR has been unique. Often regarded as a socio-economic organization, the ACR has assumed educational, legislative, and public service roles in furthering acceptance of the examination. The ACR was not directly involved in the mammography reproducibility study or the initial training programs at the M. D. Anderson Hospital and Emory University. However, all members of the original committee appointed by the USPHS to review the Anderson program were radiologists, three of whom, Eugene P. Pendergrass, Thomas Carlile, and Wendell Scott, were active in the affairs of the ACR and past or future presidents of the ACR. Eugene Pendergrass was also a past-president of the ACS.

In November 1962 the University Cancer Foundation of M. D. Anderson Hospital devoted an issue of its publication, The Cancer Bulletin, to the subject of mammography. Justin Stein, then chairman of the ACR's Committee on Cancer and a future president of the ACS, suggested that the ACR obtain copies of this publication for distribution to its membership. The USPHS's CCP provided funds for the purchase of fifty-five thousand copies and paid all mailing costs. These pass-through funds represented the first moneys ever received by the ACR from a government entity as well as its initial effort to stimulate the use of mammography by radiologists.

As a result of the publicity given Egan's work and the subsequent publication of his first paper in 1960, a number of radiologists expressed interest in mammography. Many of these visited M. D. Anderson Hospital to acquire the necessary technical and interpretive skills. Because of their numbers and continued interest, M.D. Anderson Hospital and the CCP began a series of annual seminars with primary emphasis on mammographic technique (Fig. 13.25). Following Egan's appointment to the staff of Emory University in Atlanta, that institution was included as a host. With each annual seminar the program content was broadened to touch upon other specialties, such as surgery, pathology, and medical oncology. Representatives of these specialties were first included as members of the faculty in 1967, reflecting the multidisciplinary nature of the breast cancer problem.
In 1965, at the urging of Lewis Robbins of the CCP and Robert Egan, the Board of Chancellors of the ACR formed a Committee on Mammography to be chaired by Wendell Scott of St. Louis, Missouri. Because of the reluctance of some chancellors to have the ACR linked to a government agency, the committee was given a broad base by the inclusion of representatives from other specialties. Initially requested by the CCP to recommend sites for additional mammography training centers, few of the committee members had had any personal experience with the technique. In order to gain some insight, Scott and his committee attended the 1965 annual seminar held in Atlanta. As a result they became enthusiastic proponents of mammography and actively encouraged greater participation by the ACR. In this effort, the committee was well served by the addition of William Melton to the ACR staff. A former hospital administrator, Melton had been recruited by the CCP to oversee the mammography project. With changes in the CCP leadership and a consequent downsizing of the mammography effort, Melton was an ideal choice to assume a similar role for the ACR. Prior to his retirement in 1978, he worked closely with Egan in the development of manuals and teaching files, provided liaison with government agencies, and oversaw the organizational aspects of the ACR mammography effort.

Robert Egan had served as program chairman of all seminars through 1967, but in view of the active participation of Scott and his committee, suggested that the eighth meeting, in 1968, be held at Washington University in St. Louis, with joint sponsorship by the ACR committee and the CCP. Following adoption of this suggestion, Scott changed the name of the ACR committee to the Committee on Mammography and Diseases of the Breast to reflect its broadened responsibilities and multidisciplinary nature.

As a result of the widened content of the seventh and eighth seminars, the 1969 meeting was designated the National Conference on Cancer of the Breast. This title has been continued to the present, with the twenty-sixth con-

Fig. 13.25 Participants and observers in the seminar on technique and reproducibility held at the M. D. Anderson Hospital in May 1963. (Authors' collection)

ference held in 1994. In 1982 the conference was placed on a biennial basis, and all funding was assumed by the ACR, although the ACS continued cosponsorship.

After the death of Scott in 1972, Richard Lester of Duke University was appointed chairman of the ACR’s Committee on Mammography and Diseases of the Breast. During his tenure the committee directed its efforts toward the education of practicing radiologists. Despite the fact that between 1964 and 1969 thirteen hundred radiologists and twenty-three hundred technologists had been trained in the fourteen USPHS sponsored centers, the
great majority of radiologists remained unfamiliar with the technique of mammography. In an attempt to remedy this deficiency, the scope of the annual mammography conference was expanded, and other ACR training projects were developed. These included a professional self-evaluation and continuing education test and a detailed technical evaluation of all available mammography equipment. An effort was also made by the ACR to gain the cooperation of the NCI in the reactivation of all or part of the fourteen training centers that had been discontinued in 1969, a request that was eventually denied. However, in 1976 the committee negotiated a contract with NCI for the production and distribution of teaching materials to seven centers at which practicing radiologists, residents in radiology, and technologists could, at their own expense, receive indoctrination in the technical and interpretive aspects of mammography.

In the same year, the ACR's Committee on Mammography and Diseases of the Breast promulgated guidelines for the performance of screening mammography. The essentials of these remain in effect, but have, as noted, at times been in conflict with the recommendations of other organizations. Particularly noteworthy was the disagreement with the NCI following the 1976 publication of the paper by John Bailar questioning whether the possible carcinogenic effects of the radiation associated with mammography outweighed the benefits of early detection. The conflicting viewpoints and a general misunderstanding of the controversy by the public caused a precipitous drop in the use of mammography, including its use for symptomatic women. The ACR committee, perforce, devoted much of its time and energy to debating the benefits of screening with various agencies and consumer groups, many of whom were not well informed of the pros and cons of the conflicting recommendations.

In 1982 Robert McLelland became chairman of the Committee on Mammography and Diseases of the Breast. Under his direction, its educational efforts became more diverse; a slide set was produced for presentation by radiologists to nonradiologists, and the proceedings of the national breast conferences were expanded into detailed publications on the diagnosis and treatment of breast cancer. The committee developed position papers on ultrasound and thermography in the diagnosis of breast disease and tested the concept of geographically dispersed mammography workshops to assure an even distribution of mammography services.

In 1983 the ACS altered its guidelines to recommend the screening of asymptomatic women between the ages of forty and forty-nine on a one- to two-year basis. This change brought the ACS and ACR guidelines into agreement and resulted in a gradual increase in the use of mammography as ACS divisions and units actively promoted the screening of asymptomatic women. However, complaints about the quality and costs of mammography were frequent at the community level. To solve these problems and improve communication between the ACS and the ACR, a liaison committee was formed under the chairmanship of Gerald Dodd, who was active in the leadership of both organizations. In 1986 the liaison committee requested that the ACR establish a mammography accreditation program. The program, if successfully completed by an applicant, would certify that the facility was capable of producing technically superior mammograms that would be interpreted by physicians with adequate training in the examination. The suggested program was based on an existing ACR service that offered accreditation for departments of radiology. Seed money was provided by the ACS, and the program was introduced in March 1987 as a joint effort between the Practice Accreditation Committee of the Commission on Radiologic Practice and the Commission on Physics. The essentials of the program were developed by ACR members Tearle L. Meyer, R. Edward Hendrick, and Harold Lasky. By 1994, 90 percent
of the estimated twelve thousand mammo-
graphic units in the United States had been entered in the accreditation
process. Of these, approximately 65 per-
cent had been accredited, with the
remainder still in the process. Failures
ranged from 30 to 35 percent, with the
majority of first-time failures achieving
accreditation following corrective mea-
sures. From its inception, the process
was designed to be educational, not
punitive, and led to a noticeable
improvement nationwide in the quality
of mammography. The accredited facil-
ities are listed with the divisions and units
of the ACS and the lists are available to
the general public upon request.

In August 1986 Thomas Meaney,
chairman of the ACR Board of
Chancellors, established a breast task
force. All activities of the ACR related to
breast disease are coordinated through
the task force to avoid duplication and
assure intercommittee cooperation.
Working closely with the ACS and several
national medical groups, the task force
began to push for the general acceptance
of accredited screening programs.

In response to the increasing
demand for accountability on the part
of professionals and their organizations,
the ACR in 1990 issued standards for the
performance of screening mammogra-
phy. The standards do not constitute
rules but are recommended principles
of practice that, if followed, generally
produce quality radiologic care. All
aspects of the mammographic examina-
tion are covered, including physician
education, practical experience, quality
control programs, report content, and
communication responsibilities.

The various committees comprising
the task force also expanded their edu-
cational efforts, including a mammog-
raphy home study course, weekend
mammography teaching seminars, a
lexicon on standardized mammogra-
phy terminology, mammography quali-
ty control manuals, and a cooperative
effort with the ACS to develop stan-
dards for the treatment of early breast
cancer. The American Registry of
Radiologic Technologists also was sup-
pported in the development of a spe-
cially competency examination in
mammography.

Financial support for many aspects of
the college program was received from
the ACS and the Centers for Disease
Control (CDC). The ACS, as part of its
program of physician education, provid-
ed financial assistance to the ACR for
the development and distribution of the
Mammography Home Study Course and
the Mammography Quality Control
Manuals. The latter are the most detailed
quality control documents ever produced
for a single radiographic examination
and serve as an integral part of the mam-
ography accreditation program.

The CDC funded a cooperative agree-
ment with the ACR to advance educational
and scientific progress in mammography
quality assurance. Under the codirection
of Lawrence Bassett and R. Edward Hendrick,
the agreement has proved an outstanding
model of cooperation between govern-
ment and private sources.

In October 1992 the Mammography
Quality Standards Act (MQSA) was signed
by President George Bush. This act essen-
tially codified the ACR's voluntary accre-
ditation program, making its provisions
mandatory for all physicians who wish to
practice screening mammography.

The ACR is a volunteer organiza-
tion, and the continuing effort to estab-
lish mammography as an effective
screening procedure is the product of
many dedicated and concerned profes-
sionals. A comprehensive acknowledg-
ment of all who have contributed is not
possible, but the success of the program
is a testimonial to their efforts.

Without the support of the ACS it is
doubtful that mammography would
have reached its present level of usage.
The fifty-nine divisions and almost
three hundred units of the ACS repre-
sent a membership of three million
men and women devoted to conquer-
ing cancer. Their advocacy of mammo-
graphy and their willingness to offer
financial and political support to the
educational and quality assurance pro-
grams of the ACR have greatly aided the
acceptance of these programs and offer
additional hope to women in the battle
against this disease.
POLITICAL AND SOCIOECONOMIC ASPECTS of Mammography

The awakening of public interest in breast cancer has resulted in the perception of an epidemic, a perception which has been abetted by the involvement of the media and the frequently less-than-accurate messages transmitted to the public. Medical practice remains an art, and physicians are not infallible—facts often forgotten by the public. The inability of researchers, clinicians, and governmental authorities to agree on all aspects of the diagnosis and treatment of a given disease is not understood by the public at large and remains a source of confusion and irritation. When these uncertainties are mixed with the continuing drum of publicity, the public's frustration is apt to culminate in legal and legislative activities intended to solve perceived problems.

Traditionally, public messages about breast cancer from the ACS, the NCI, and similar agencies have taken the positive form of providing knowledge about the benefits of early detection of breast cancer. Increasingly, as public awareness grows, the messages have begun to address policy issues such as mammography quality assurance, barriers to breast cancer detection, and treatment for poor and underserved women. Most recently, information about the need for funding additional research in prevention, detection, and treatment has become paramount. This message has coincided with the emergence of a strong cancer advocacy movement which strives to make breast cancer the top health priority of the nation. This increasing involvement of the public has inevitably been reflected in legislative and legal activity.

Because the carcinogenic potential of screening mammography is no longer a major problem, the question of universal screening now revolves about cost versus benefit and access. In the age of limited budgets and governmental cutbacks, cost concerns are valid but are amenable to solution through certain procedural and technical modifications of the examination and the introduction of appropriate government support programs. In 1986 Congresswoman Mary Rose O'Park introduced a bill to include screening mammography as a Medicare benefit. That same year, the Maryland legislature passed a bill requiring the state's Medicaid program to pay up to $100 for a screening mammogram.

Early in 1987, Representative Claude Pepper, then chairman of the House Committee on Aging, held a special hearing on screening mammography. This allowed proponents of screening, including medical and women's groups, to urge the federal government to take a more active role in supporting screening mammography. About the same time, several state legislatures responded to pressures by mandating that health insurance carriers offer compensation for screening mammography. In Michigan the legislative act specified that compensation would be provided only to those facilities that had gained accreditation from the ACR.

The 1988 Catastrophic Health Legislation Act added several new benefits to the Medicare program, including a provision to cover screening mammography for female Medicare beneficiaries on a biennial basis. The legislation set a payment cap of $500 and directed the Health Care Financing Administration (HCFA) to develop detailed guidelines for personnel and equipment to be used in the new program. However, the entire bill, including the coverage of screening mammography, was repealed a year later. Although physician-referred (symptomatic) mammography has been covered since the beginning of Medicare, coverage for asymptomatic women would have been a first for Medicare. It drew particular attention from HCFA administrators because it would have cost an estimated $500 million annually, and would have created a precedent for covering the cost of other screening procedures. Although screening mammography was not a primary cause for repealing the act, the total burden on Medicare recipients was considered excessive.

In 1990 Medicare reintroduced screening mammography for its eligible female beneficiaries, some fifteen to
eighteen million women. This was followed by enactment of the Breast and Cervical Mortality Prevention Act of 1990. A federally-run program of grants to states, it was designed to reduce mortality among poor and underserved women through the establishment of breast and cervical cancer screening, education, and referral centers. Twelve states were awarded grants with existing funds, and advocacy groups continue to lobby for increased federal dollars to expand the program.

During the 92nd Congress, there were a large number of bills introduced to improve access by expanding Medicare coverage for women over sixty-five to annual mammography. At the time the law was passed, budget constraints played a role in limiting the Medicare mammography benefit to every other year for older women. While the majority of guidelines which have been offered by various organizations call for annual examination of older women, if fiscal constraints must play a role, biennial mammography is probably best confined to the older rather than younger women.

In addition to federal policy efforts, forty-nine states have enacted laws requiring health insurance providers in those states to offer coverage for early cancer detection tests, including screening mammography. While this effort is diluted to some extent by laws governing private insurance, it still represents a major advance in providing access to cancer detection procedures.

One of the most important legislative initiatives during the 102nd Congress was the establishment of a nation-wide program of mammography quality assurance. The MQSA of 1992, introduced by Senator Brock Adams of the state of Washington and Representative Pat Schroeder of Colorado, built on the program of accreditation of facilities for equipment, personnel, and quality control offered by the ACR. While approximately three-quarters of all facilities have either been accredited or applied for accreditation in this program, it is voluntary, and the need for total compliance has been repeatedly demonstrated. Although thirty-three states have established some required form of quality assurance, only a handful have enacted tough programs which approximate that of the ACR. Implementation of the MQSA under the jurisdiction of the FDA should ensure the safety and technical accuracy of the examination through the added feature of annual inspections. The ACR has been designated as an implementing agent. Failure to comply with the provisions of the act can result in suspension or revocation of certification and civil penalties.

Delay in diagnosis and errors in diagnosis of breast cancer have become the most frequent causes for negligence lawsuits and the leading causes of monetary awards. The willingness of some radiologists to accept self-referred individuals has placed them in the position of the primary physician with the attendant responsibilities of that role. Evidence of adequate communication among the radiologist, the referring physician, and the patient has become extremely important, as has the documented follow-up of suspicious studies. Many precedents now exist wherein the radiologist has been held negligent even though he or she has promptly and correctly reported the examination and dispatched a report to the referring physician in the usual manner. Documented verbal and/or certified notification of the referring physician of a positive or suspicious study is now deemed mandatory in addition to the standard report. Also emerging is the threat of suit against the primary physician because of failure to order screening studies.

The efforts of the USPHS, the ACR, the ACS, and various academic and private mammography centers significantly increased the numbers of physicians competent in mammography, but formal action by the American Board of Radiology (ABR) was necessary to ensure inclusion of the examination in the curriculum of residency training programs. Beginning in 1983 the ABR included questions on diseases of the breast and mammography in the written portion of its certifying examination. Actual mammograms could be shown to candidates as part of the oral examina-
tion, but this was discretionary and often omitted. It was not until 1990 that a separate section on mammography was introduced as a requirement of the oral examination. This, in turn, prompted increased attention to diseases of the breast in residency training programs. Candidate performance in mammography now equals that in other examination sections, assuring a steady supply of radiologists properly trained in the basics of mammographic technique and interpretation.

Unfortunately, the debate concerning the efficacy and frequency of screening examinations has become politicized. Although the risk from current radiation doses is well within acceptable limits, activists have seized on the potentially carcinogenic effects of radiation as a reason for abandoning mammography. It is usually proposed that money is spent for screening be diverted to basic research.

Many clinicians feel that younger women should be screened at one-year intervals rather than two, and the NCI remains adamant that recommendations for screening women ages forty to forty-nine are inappropriate. At issue are the various trials and players who purportedly have developed information relative to the efficacy of screening in younger women. Unfortunately, all of the trials reported thus far suffer from deficiencies, and, individually, none has the statistical power to prove either benefit or nonbenefit in women under fifty years of age. The result has been confusion on the part of both the public and their physicians, and the debate has become increasingly bitter. Charges of “political correctness” have been leveled, and the Congress has entered the dispute by characterizing the NCI’s position as “misused science.” 95,96

While it is evident that screening mammography, physical examination, and breast self-examination do not provide a final answer to the problem of breast cancer, they unquestionably have had an impact clinically and have generated sufficient evidence to support their interim use until more efficient methodologies are developed.97,98,99

REFERENCES


81 Fletcher, S.W.; Black, W.; Harris, R.; et al., "Report of the International Workshop on Screening for Breast Cancer, Feb. 24-25, 1993," sponsored by the National Cancer Institute, Bethesda, Md.
87. Broder, S., Presentation to the National Cancer Advisory Board, 10 January, 1995.
88. Egan, R., "Experience with Mammography.
89. Ballar, J., "Mammography.