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ORIGINAL ARTICLE

Mammography device use in Turkey, and quantity and quality analysis of mammography education

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PURPOSE
To evaluate in detail the ways and methods of mammography education, to survey currently used mammography devices, and to determine the quality of mammography examinations in Turkey in order to increase the quality of said examinations and to offer guidance to standardization studies in Turkey.

MATERIALS AND METHODS
This study depended on the analysis of a questionnaire that was completed by volunteering medical centers. The questionnaire was mailed to all institutions in Turkey with a mammography device and which were registered with the Turkish Atomic Energy Commission and individual city health administration databases (n=456).

RESULTS
It was not possible to determine the exact number of mammography devices in Turkey. In all, 270 questionnaires were completed and returned from the registered centers. Among the mammography devices declared (n=291), automatic exposure control (AEC), spot view, and magnification view were not used at 21%, 34%, and 43% of the centers, respectively. Preoperative wire localization was not practiced at 180 centers (62%) despite the ability to do so. At 16% of the centers, mammograms were not labeled and at 57% of the centers labeling was handwritten. At 23% of the centers only small cassettes were used, and at 58% the heat and at 94% the humidity of film storage areas were inappropriate or unknown. At 25% of the centers light and at 15% radiation exposure of the film was present. Mammography quality control tests were performed at 40%, and in 70% control records were not well kept. There were no thermometers in 49% of the centers, no phantom breast at 80%, no sensitometer at 93%, and no densitometer at 81%. At 50% of the centers, regular periodic maintenance was not performed. Second look was performed consistently at 12% of the centers and BI-RADS (Breast Imaging Reporting and Data System) categorization was used at 40%.

CONCLUSION
The exact number of mammography devices is not officially known in Turkey, and it is apparent that registration of some devices was not made by the Turkish Atomic Energy Commission. Questionnaire responses about mammography education and procedures revealed that there was a serious lack of quality across regions. Education, accreditation, inspection, and sanctions are needed immediately to institute standardization and improve quality. This is a critical situation that should be addressed by the Turkish Society of Radiology.

Key words: • *mammography* • *quality control* • *education*

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Mammography has proven itself an effective screening test for breast cancer, the most common malignancy among women, and it has been reported that death rates have decreased due to breast cancer screening (1, 2). Low quality mammograms and evaluations make diagnosis more difficult, which leads to unnecessary extra-imaging, extra-time, and extra expense, ultimately causing a loss of confidence in the effectiveness of mammography (3).

The aim of this study was to evaluate the quality and quantity of mammography devices, mammography usage, and mammography education in Turkey.

Materials and methods

A questionnaire was designed with 64 questions to determine the number of mammography devices in Turkey, their technical features, how and how often these features are used, and the quality and quantity of mammography education between September–December 2004 (4).

The questionnaire was sent in January 2005 with an accompanying cover letter to all medical centers (n= 456) that were known to have a mammography device according to the latest data (2003) provided by the Turkish Atomic Energy Commission (TAEC). In addition, health administrations of 81 provinces were informed and sent the questionnaire, assuming new institutions founded between 2003 and 2005 with mammography devices that had not been registered by TAEC might have existed. They were asked to send the survey to all the health institutions in their region and help collect the data.

Completed questionnaires were collected between January–December 2005. A copy of the results was submitted to the central office of the Turkish Society of Radiology (TSR) for use by future studies. Data were analyzed between January–May 2006.

Results

According to the inventory taken by TAEC in 2003, there were 456 mammography devices in Turkey and 22 Turkish provinces (out of 81) had none. Combining the data provided by provincial health administrations in 2005 and TAEC, it is clear that the actual number of devices was 493 and that 15 provinces had no mammography devices (4). Among the provinces without a device, most were located in eastern and southeastern Turkey (n=12).

The questionnaire was completed and returned by 270 centers, representing 291 out of 493 devices (59.0%). Device distribution was as follows: 187 (69.3%) were at private medical centers, 52 (19.6%) were at state hospitals, and 31 (11.5%) were at university hospitals.

Quality and quantity of mammography devices

Among the 270 centers that responded, 250 centers had only 1 device, 19 centers had 2 devices, and 1 center had 3 devices that were operational, (n=291 devices).

Among the counted devices, 207 (71.1%) were purchased new and 84 (28.9%) were purchased used. Of the machines purchased new, 116 (56.0%) were at private medical centers, 56 (27.1%) were at state hospitals, and 35 (16.9%) were at university hospitals. Among the second-hand devices, 81 (97%) were at private medical centers, 2 (2%) were at state hospitals, and 1 (1%) was at a university hospital.

The number of devices that operated properly all year long was 241 (89.3%), whereas 45 (16.6%) devices did not function because of malfunctions at some point during the year. Time lost to device malfunctions in the last year was less than one week for 137 devices (50.7%), between one week and one month for 19 devices (7.0%), and a few months for 8 devices (2.9%) (4).

Among actively operational devices, 140 (48.1%) used a film-screen, 32 (10.9%) had digitally converted radiography (CR), and 12 (4.1%) had digital technology.

Among all mammography devices, 36 (12.4%) did not have automatic exposure control (AEC) and in 21% of devices that had it, it was not used. The majority of centers without AEC were private medical centers (n=29, 83%).

The parameters for kV and mAs could only be manually selected on 256 (88.0%) devices, whereas kV could be selected only manually and mAs automatically on 16 (5.5%), and both could be selected automatically in only 1 device (0.3%). Eighteen centers (6.2%) reported that they were not sure about the options for kV and mAs selection on their devices.

In practice, kV and mAs were selected only manually on 114 (39.2%) devices, both were automatically selected on 102 devices (35.1%), and kV was selected manually and mAs automatically on 59 (20.3%) devices.

A special plate for spot view was used on 193 devices (66.3%) and on 32 devices (11.0%) it was not used despite its existence. The majority of centers that had devices without spot view or had it and did not use it were private centers.

A mechanism for magnification view was used on 166 devices (57.1%). On 29 devices (9.9%) a magnification view mechanism was present but not used, and in 83 devices (28.5%) it was not present. The majority of centers with a device in which a special mechanism for magnification view was absent or not used when it was present were private centers (76% and 78%, respectively).

Preoperative wire localization was used on 79 devices (27.1%), whereas on 180 devices (61.9%) this modality was not used despite its existence. On 18 devices (6.2%) wire localization was not present. The majority of centers in which a special mechanism for wire localization was absent or not used despite its existence were private centers (89% and 73%, respectively) (4).

Mammography practice

The mean number of mammographies performed was 10.5 per day (range, 1–70).

Mammographies were performed for diagnosis at 52 centers, for screening in 12, and for both screening and diagnosis in 202 centers. Among the centers where mammography was performed for both screening and diagnosis, 68 (33.7%) performed screening and diagnosis equally, while at 43 centers (21.3%) mammography was performed mostly for diagnosis and in 91 centers (45.0%) mostly for screening.

In analogous systems, 226 centers (85.3%) delivered mammography films to the patients, at 29 centers (11.0%) films remained in the radiology department, and in 10 centers (3.7%) films were archived.

Patient records were entered in a notebook at 125 centers (42%), 71 centers (24%) used a computerized archiving system belonging to the mammography unit, 87 (29%) used a hospital-wide computerized archiving system, and 9 centers (3%) stored patient records in other systems being used. No records were taken at 6 centers (2%).

Labels on mammography films, which contained information about the patient and the examination, were used at 227 centers (84.1%), whereas labels were not used at 38 centers (14.1%). The centers that did not label or did not answer the related question were distributed as follows: 30 (69.8%) private centers, 11 (25.6%) state hospitals, and 2 (4.6%) university hospitals. At 130 centers (57.2%) labeling was handwritten, 65 centers (28.6%) used a special printer for a cassette-holder, and 37 centers (16.2%) used paper labels printed by computer.

Mammography development facility, solutions and film conditions

Film development facilities consisted of a darkroom at 237 centers (87.7%), a daylight developing machine at 17 centers (6.3%), and a laser printer at 9 centers (3.3%). In all, 35 different brands of development machinery and 17 different brands of development solutions were used (4).

Among all the development instruments counted, 180 (66.6%) were used for other examinations in addition to mammography and 82 (30.4%) were used solely for mammography.

At 201 centers (74.4%) 18 × 24 cm and 24 × 30 cm cassettes were used versus 62 centers (23.0%) at which only 18 × 24 cm cassettes were used. This question was not answered by 7 centers (2.6%).

The optimal temperature for the storage of mammography films is 15–25°C. Ambient temperature at 113 (41.9%) centers was between 15–25°C, at 5 (1.9%) it was beyond the desired range, and 152 centers (56.2%) did not respond to this question. Humidity was 40%–60% at 17 centers (6.3%), at 17 other centers (6.3%) humidity was beyond this optimal range, and 236 (87.4%) of the centers did not respond to the question. Light exposure of the storage room was zero at 201 (74.5%) centers, very low in 36 (13.3%) centers, low in 9 (3.3%) centers, 11 (4.1%) did not know, and 13 (4.8%) centers did not answer this question. Radiation exposure of the storage room was zero at 229 (84.9%) centers, very low in 12 centers (4.4%), low in 3 centers (1.1%), high in 1 center (0.4%), 13 (4.8%) centers did not know, and 12 (4.4%) centers did not answer the question.

Using the same brand film and screen is considered "compatible" and 140 centers (51.6%) were film-screen compatible, versus 91 centers (33.7%) that were non-compatible.

In centers that used film development solutions, the brand of solution and film, and film type were chosen by the doctor responsible for the mammography unit at 135 centers (50%), by the clinical chief at 33 centers (12.2%), by the adjudication commission at 69

centers (25.5%), and by unknown people at 38 centers (14.1%) (4).

Ultrasonography (US) was used in addition to mammography at 253 centers (94%), whereas at 12 centers (4%) US was not used. US was used only for breast examinations at 31 centers (11.5%), whereas at 222 centers (82.2%) it was also used for other procedures (4).

US-guided lesion localization was performed at 81 centers (30.0%), fine needle aspiration was performed at 120 centers (44.4%), and core biopsy was performed at 51 centers (18.8%).

Image quality inspection

Quality control was performed at 161 centers (59.6%) compared to 95 centers (35.2%) where it was not, and 14 centers (5.2%) did not respond to this question. Quality control was performed by a mammography technician at 97 centers (35.9%), by technical service at 130 centers (48.1%), and by a physics engineer at 3 centers (1.1%).

Quality control test records were properly kept at 81 centers (30%), while at 138 centers (51.1%) they were not, and 51 centers (18.9%) did not answer the question.

Densitometers were used at 52 centers (19.3%), 12 centers (4.4%) had a densitometer but did not use it, and 160 centers (59.3%) did not have a densitometer. A sensitometer was present at 20 centers (7.4%), but was not used at 10 centers (3.7%) despite its existence. There was no sensitometer at 182 centers (67.4%). A phantom breast was used at 54 centers (20%), 18 centers (6.7%) had one but did not use it, and 152 centers (56.3%) did not have one. A thermometer for the development bath was used at 140 centers (51.8%), 4 centers (1.5%) had one but did not use it, and 92 centers (34.1%) did not have one (4).

When a problem appeared in quality control 184 centers (68.2%) consulted technical service, 10 centers (3.7%) consulted a physics engineer, and 24 (8.9%) consulted other persons.

Regular periodic maintenance service (other than breakdown) was performed at 136 centers (50.4%) and was not performed at 124 centers (45.9%). Regular periodic maintenance service was not performed at 24 centers (8.9%) because it was not requested by the radiology department, at 35 centers (13.0%) because it was not requested by the directors of the institution, and at 54 centers (20%) because of increasing costs.

Technical maintenance was satisfactory at 179 centers (66.3%), whereas 46 centers (17.0%) were not pleased with the service.

The degree of satisfaction of those who answered the questionnaire about mammograms performed in their own facility was very good at 77 centers (28.5%), good at 116 centers (43.0%), medium at 58 centers (21.5%), poor at 6 centers (2.0%), and very poor at 1 center (0.4%).

Environmental conditions and view boxes with which mammograms are evaluated were very good at 63 centers (23.3%), good at 144 centers (53.3%), medium at 45 (16.7%), poor at 7 centers (2.6%), and very poor at 1 center (0.4%).

The cause of negative factors while evaluating films was excessive patient numbers at 71 centers, environmental conditions at 57 centers (like light and noise), and view boxes at 51 centers. View boxes were used only for mammograms at 61 (22.6%) centers and for other examinations in addition to mammograms at 190 centers (70.4%). Three centers (1.10%) did not know if view boxes were used solely for mammograms.

Mammography personnel

The mean number of technicians in centers who were educated specifically for mammography was 2.0 (range, 0–8). The mean number of specialist doctors (radiologists) working in centers was 2.1 (range, 0–8). Second look of mammograms was always performed at 31 centers (11.5%), sometimes at 99 centers (36.7%), and was never performed at 128 centers (47.4%).

The Breast Imaging Reporting and Data System (BI-RADS) was used while reporting mammograms at 108 centers (40%), whereas it was not used at 134 centers (49.6%). In all, 9 centers (3.3%) had no information about BI-RADS.

Mammography education at institutions providing specialty education

Specialty education was provided by 43 centers (15.9%) among the 270 that answered the questionnaire, of which 31 (72%) were university hospitals and 12 (28%) were state hospitals.

The mean number of faculty or clinical chiefs who were educated specifically in mammography was 1.2 (range, 0–3). Apart from them, the mean number of specialists who were responsible for mammography was 1.6 (range, 0–10).

At 32 centers (74.4%) radiology residents had a mammography rotation, whereas at 7 centers (16.3%) there was no mammography rotation.

The mean duration of mammography rotation was 4.6 months (range, 1–9 months). At 39 centers (90.7%) residents had this rotation at their own institution.

During mammography rotation, residents reported mammograms without consulting the responsible specialist at 12 centers (28.0%), while reporting was done after consultation at 26 centers (60.4%). Other centers did not answer this question.

Radiology residents evaluated a mean 1,703 (range, 95–5,200) mammograms during their mammography rotation.

Problems and the rate of their appearance are shown in Table.

Discussion

Particular guidelines and rules were described and made mandatory through the use of sanctions in order to maintain the standardization and quality of mammography examinations in countries where mammography screening is performed (5–7). In Turkey, such sanctions concerning mammography procedures for maintaining and increasing quality do not exist.

Neither TAEC nor the State Statistics Institute and provincial health administrations have reliable information on the number of mammography devices and their distribution in Turkey. Combining data provided by TAEC and provincial health administrations, we found that there were at least 493 mammography devices in Turkey.

According to our data, in large residential regions like Ankara and İstanbul, there is one mammography device for less than every 10,000 women ≥40 years of age, and 456,000 women in the same age group living in other provinces without mammography devices are deprived of mammography service (4).

The number and rate of second-hand devices (28.9%) that were purchased were lower than we expected. Considering the economic situation of Turkey, first-hand device preference of the cent-

ers may give the impression that there is a concern for the quality of mammography examination, whereas it is obvious that mammography performances do not reflect this concern (4).

University and state hospitals are lacking in adequate device repair and regular periodic maintenance as a result of accepting unclear technical service contracts prior to device purchase, lack of regular maintenance after installation, remote service areas, lack of communication with the service authorities, lack of knowledge and experience concerning service and device repair, lack of reliable service, the high cost of service, and adjudication methods aimed at procuring the cheapest service rather than the most qualified.

It is crucial to select a suitable film and development solution, and to inspect the development time, temperature, and the quality of film processing in order to see formations in different breast densities and detect cancer. However, in our study, it was revealed that 50% of the development solutions and 47.1% of film brands and types were selected by people exclusive of doctors responsible for mammography (adjudication commission or other personnel). Comparative tests were performed at 29.6% and 41.5% of the centers prior to film and development solution purchases, respectively.

It is mandatory to have an AEC mechanism in order to perform a proper exposure in film-screen mammographies; however, 12.4% of the centers did not use AEC and 8.9% did not know if they had AEC.

Manual selection of kV and mAs during mammography exposures can cause over- or underexposure, and kV and mAs were determined manually at 39.2% of centers in our study.

Spot view and magnification view were used at 34% and 43% of the centers, respectively. Centers that had spot and magnification graphics, but did not use them (11% for spot view and 10% for magnification view) highlight that the main problem is lack of education. Not using spot and magnification graphics despite having had them was 2.4 and 3.5 times higher, respectively, in private centers when compared to state hospitals.

Preoperative wire localization was not performed at 73% of the centers. More dramatically, it was not performed despite the ability to do so at 62% of the centers. This data points to the incompetence of radiologists performing interventional breast procedures.

Patient records were handwritten or kept in the hospital's general recording system at the rate of 71% and no recording system was present in mammography units. While that causes the loss of films and the inability to make a comparison to future examinations, it also hinders retrospective self-evaluation for individuals and institutions. The mandatory labeling of patient names and surnames was not performed at 13.7% of the centers which makes it impossible to resolve identification problems that might arise during reporting. Indication of patient age (60.4% of the centers did not indicate) is important for diagnosing pathologies that may be related to patient age, as well as structure and type of the breast. We found that only 18 × 24 cm cassettes were used at 23% of the centers. It is impossible to display the entire breast using a small sized image receiver, especially when breasts are large, which means that a possible cancer could be missed in the breast tissue that is not included on the image (4).

According to our study, the ambient temperature where films were stored was beyond the optimal range (15–25 °C) at 58% of the centers which results in the deterioration of the films. Improper humidity causes stable electric artifacts, which appear as lightning or bugs on the film. Frequent appearance of these artifacts in daily clinical practice can be explained easily as 93.7% of the centers included in our study had inappropriate humidity. Places where mammography films are stored

Problems in mammography performance and their rates according to this study

Problems	Rate (%)
Not using AEC or not having knowledge of AEC	21
Not using spot view or not answering the related question	34
Not using magnification view or not answering the related question	43
Not using the localization device despite having it	62
Not labeling films or not answering the related question	16
Handwritten labels	57
Use of only small cassettes	23
Not maintaining the appropriate temperature in film storage room or not answering the related question	58
Not having appropriate humidity in film storage room or not answering the related question	94
Having light exposure in film storage room or not answering the related question	25
Having radiation exposure in film storage room or not answering the related question	15
Not having regular quality control	40
Not keeping regular quality control records	70
Not using a thermometer	49
Not using a phantom breast	80
Not using a sensitometer	93
Not using a densitometer	81
Not performing regular mammography device maintenance	50
Lack of a constant second-look	88
Not using BI-RADS	60

AEC: automatic exposure control, BI-RADS: Breast Imaging Reporting and Data System

must be isolated and there must not be light or radiation exposure; however, among the centers that completed our questionnaire, 25% had light and 15% had radiation exposure (4).

Even though we accepted use of the same brands as the only criterion for the compatibility of screen and film, 48.4% of centers had film-screen incompatibility. It is well known that film and screen compatibility can be badly affected, even if the film and the screen are of the same brand, according to different models. Therefore, the actual film-screen incompatibility rate is expected to be much higher than the rate we determined based on the answers to this particular question. According to the answers we received, it is assumed that control tests were not performed at 40.4% of the centers.

Despite the insufficiency of mammography quality revealed by this study, the majority of individuals indicated a high degree of satisfaction concerning the mammograms made in their own centers (71.5% very good and good). There is a serious uncertainty and lack of education about what one should understand from high quality mammography.

In conclusion, the results of this study, which evaluated the quality and quantity of mammography examinations in Turkey, showed that quality was the main problem, rather than the quantity. Nonetheless, residents did not have a mammography rotation in at least 26% of the education hospitals that participated in this study.

First of all, technicians and radiologists that specialize in mammography and work exclusively with breasts are needed in order to improve the quality of mammography examinations, and to bring about standardization, uniformity, and to maintain the constancy.

Oversight of the increasing number of mammography devices, in terms of performance quality, rewarding good performance and penalizing bad performance, and improving mammography education supported with continuing education at centers providing mammography education must become mandatory. The institution best equipped to handle such an endeavor seems to be the TSR.

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