Diagn Interv Radiol 2006; 12:166-170
© Turkish Society of Radiology 2006

GENERAL RADIOLOGY

ORIGINAL ARTICLE

The level of quality of radiology services in Turkey: a sampling analysis

Yelda Özsunar, Meltem Çetin, Füsun Taşkın, Aylin Yücel, Sultan Can, Mehmet Argın, Remide Arkun

PURPOSE
To determine the quality of radiographs, which have been referred from 40 different institutions for consultation, to discuss the causes of wasted resources, and to present possible solutions.

MATERIALS AND METHODS
Five experienced radiology instructors determined the types of radiological examinations referred for consultation (conventional radiography, mammography, computed tomography and magnetic resonance imaging), the institutions at which they were performed (university or state hospital, private health center), and assessed the coverage area, field of vision (FOV), and dosage of x-ray. They also investigated problems in film processing, defects in sequence-printing windows, checked window levels, and checked the amount and timing of contrast material used. According to these criteria, the reviewers subjectively classified each radiograph as: 1. Poor, examination should be completely repeated, 2. Fair, examination should be partially repeated, 3. Good, accepted as adequate, no need for an additional examination, 4. Excellent, examination was as it should be.

RESULTS
We reviewed 120 radiological examinations from 40 different institutions in 4 reference centers. Frequency of problems determined for each category was as follows: coverage area 32.5% (39/120), FOV 16% (14/86), X-ray dosage 16% (15/94), film processing 31% (37/120), sequence or window 65% (53/81), window level 44% (36/81); contrast material 51% (25/49), timing of contrast material 61% (30/49). Only 22% of the examinations were classified as excellent, whereas 47% required complete or partial repetition.

CONCLUSION
Approximately half of the radiological examinations in our sampling required partial or complete repetition. Health, ethical, and economic aspects of the problem necessitates the prompt application of measures to establish radiological quality control and standardization procedures.

Key words: • *quality control* • *radiology* • *standardization*

From the Department of Radiology (Y.Ö. ✉ *yozsunar@adu.edu.tr,* F.T., S.C.), Adnan Menderes University School of Medicine, Aydın, Turkey; the Department of Radiology (M.Ç.), S.B.A.Y. Oncology Training and Research Hospital, Ankara, Turkey; the Department of Radiology (A.Y.), Afyon Kocatepe University School of Medicine, Afyon, Turkey; and the Department of Radiology (M.A., R.A.), Ege University School of Medicine, İzmir, Turkey.

Received 1 July 2006; revision requested 20 August 2006; revision received 5 September 2006; accepted 7 September 2006.

Standardization and quality control has recently gained importance in the healthcare sector, as in all types of business. The number of private and corporate radiology clinics in Turkey has been steadily increasing. Many of these clinics serve with high quality standards; however, unqualified radiological service is not uncommon.

We often encounter unqualified radiological examinations in our daily practice, which lead to repetition of the examinations; therefore, the x-ray dose that the patient is exposed to increases, costs increase, and manpower is wasted. There are several studies on quality management in healthcare, but the radiation damage caused by repeated examinations, and wasted manpower and money because of delayed diagnoses is undocumented in Turkey. To the best of our knowledge, data does not exist on the actual frequency of this common situation in routine daily practice, such as in which patient groups and examinations, or in which centers it occurs. Answering such questions as "What errors are frequently made?'' and "In which stages education or supervision should be required?" could serve as a starting point. Defining the level and extent of the problem may be the first step to solve the problem.

Based on our observations, we aimed to evaluate the quality of radiological examinations, mostly from the clinics in our region. We randomly reviewed the radiological examinations sent to reference hospitals for consultation, in terms of quality, and tried to answer the questions mentioned above. We then discussed the results to expose the causes of wasted resources and to develop possible solutions for the problem.

Materials and methods

We evaluated 120 radiological examinations that were sent to reference centers (state and university hospitals that provide radiology education) for consultation between July 2003 and February 2005, according to 13 features. Evaluators only reviewed examinations made at institutions other than their own. The evaluators had a minimum of 3 years experience in radiology practice and radiology training. A maximum of 3 examinations were sampled from each institution so as to include as many centers as possible.

The types of radiological examinations referred for consultation (conventional radiography, fluoroscopic examination with contrast media, mammography, computed tomography [CT], magnetic resonance [MR] imaging) and the types of centers in which the examinations were performed (university hospital, state hospitals of the Ministry of Health, or private health centers) were recorded.

Examinations were evaluated for appropriate coverage and field of view (FOV), x-ray dose (kVp and mAs) used, problems with film processing, any deficiencies (related to sequencing, bony windowing, etc.), appropriate windowing values, and in cases in which contrast mate-

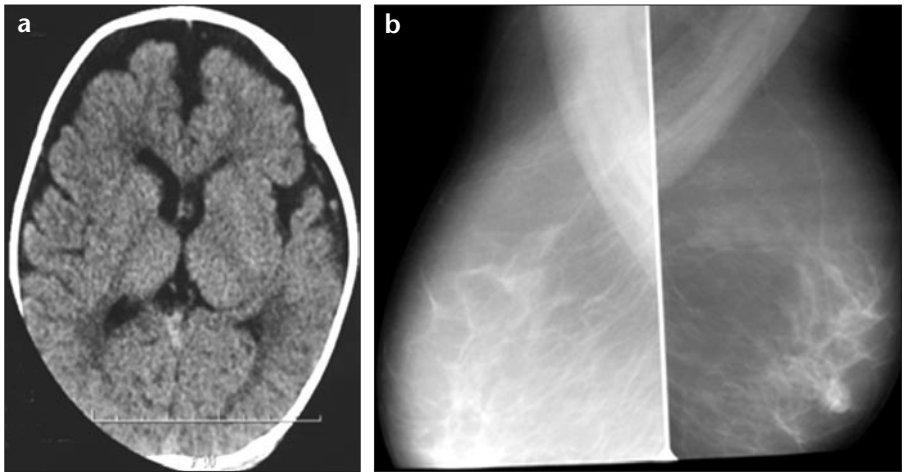

Figure 1. a, b. The right temporal lobe is out of the coverage area on a non-enhanced cranial CT image **(a)**. In mammograms **(b)**, both breasts are not completely included in the projection. It was decided to repeat the examinations due to these problems.

Figure 2. A non-standard, direct urinary system radiograph. Bone and soft tissue cannot be differentiated because of inappropriate x-ray dosage, and also insufficient coverage is noted. The examination was very poor and needed to be repeated.

rial was used, the level of contrast enhancement obtained and timing were assessed. Overall assessment was based on these investigations.

Appropriate coverage was defined as complete inclusion of the target organ or system in the Z-axis in the covered area with centralization and compliance to the positioning techniques for the examination. If the investigated area fell out of the picture, for example, in a CT examination where the head was not in the covered area (Fig. 1a) or where axilla was not included in the mammography film (Fig. 1b) covering area, the examination was classified as unsatisfactory. Also, a prematurely terminated cranial CT not involving the lower cerebellar sections was considered as insufficient for FOV.

FOV was also evaluated in CT and MR imaging examinations. FOV was accepted as adequate if axial sections included the target organ or system in the X and Y axes with sufficient spatial resolution.

X-ray dosage was considered inappropriate if contrast resolution (fat, soft tissue, and bone could not be clearly differentiated) and signal-to-noise ratio prevented visibility of the lesion, or if the optical density of the film was more or less than the optimum level (Fig. 2).

Film processing was considered inappropriate if failure was due to processing or if an artifact or fog on the film prevented a diagnosis from being made.

The presence of all sequences (fat suppression and contrast material) or windowing (i.e. bone windowing in head injury or metastases), which were necessary to establish a diagnosis, was determined to define any deficiencies in sequence or windowing.

A window level sufficient for visualizing the target organ or system was accepted as the criterion to evaluate windowing. For example, white-gray matter discrimination in cranial examinations and sufficient contrast of parenchymal-vascular structures in hepatic examinations was assessed

Timing of contrast material was evaluated for abdominal CTs and dynamic examinations. If the portal and hepatic veins were not visualized, or hepatic parenchymal and vascular structures could not be distinguished, contrast material timing was classified as unsuitable.

Based on these criteria, examinations were classified as:

1. Very poor, examination should be completely repeated;
2. Poor, examination should be partially repeated;
3. Good, considered sufficient without the need for an additional examination;
4. Excellent, examination was just as it should be. No problems were recorded.

Data were entered into SPSS (Statistical Package for Social Sciences, Chicago, IL, USA), a data processing and statistical software program. This program was used for descriptive statistics and non-parametric tests (ANOVA, correspondence analyses, Chi-square test). P value < 0.05 was accepted as statistically significant.

Results

The study included 4 reference hospitals, one of which was a teaching hospital of the Ministry of Health. Examinations were evaluated by 5 reviewers, which were either academic staff of radiology department in university hospitals or chiefs of radiology departments in state hospitals.

Sampled radiological examinations, in order of frequency, were as follows: 57 CTs (47.5%), 24 MR images (20%), 20 mammographies (16.7%), 18 conventional radiographies (15%), 1 contrast enhanced radiography (0.8%).

Distribution of the examinations according to center at which they were performed was as follows: Private doctor`s office, diagnostic centers, and

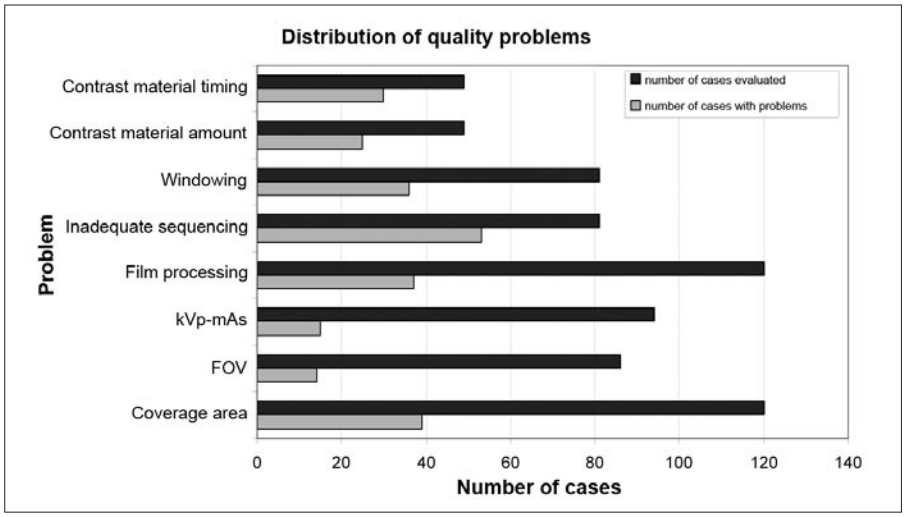

Figure 3. Distribution of factors used to define quality problems. Total number of assessed examinations and the number of exams with problems are shown for each characteristic.

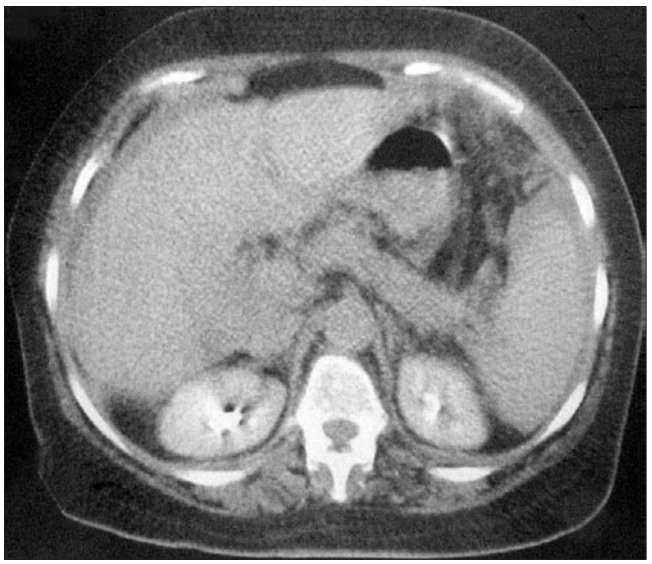

Figure 4. Abdominal CT image in which contrast material timing is inappropriate. Fog on the background of the film is evidence of a film processing problem.

private hospitals 55 (46%); state hospitals of the Ministry of Health 45 (37%); university hospitals 20 (17%).

Incomplete coverage of the target anatomic region occurred in 39 (32.5%) of the examinations (insufficient coverage). FOV was evaluated in 86 examinations, and in 14 of these (16%), FOV was inadequate. All examinations, except for MR imaging and totaling 94, were evaluated for x-ray dosage. In 15 of these examinations (16%) kVp and mAs values were inappropriate. Film processing was problematic in 37 (30%) of the reviewed examinations. Sequencing, contrasted examination, and windowing were absent in 53 (65%) of 81 examinations (i.e., no bony window in cranial CT). Windowing was inappropriate in 36 (44%) of 81 examinations. The amount of contrast material used was insufficient in 25 (51%) of 49 exams in which intravenous contrast material was used, whereas contrast material timing was inappropriate in 30 (61%) (Fig. 3). An abdominal CT image in which contrast material timing was inappropriate was given in Fig. 4.

Overall quality of the evaluated examinations were as follows: 12 examinations (10%) were poor, requiring complete repetition; 45 examinations (37.5%) were partially insufficient, requiring partial repetition; 36 examinations (30%) were good, accepted as sufficient without the necessity of repetition; 27 examinations (22.5%) were classified as excellent, performed just as they should be.

Centers in which the examinations were performed were categorized into 3 groups; university hospitals, state hospitals, and private health centers (Table 1). These groups were compared for overall quality of the examinations. Results showed statistically significant differences between all 3 groups ($P = 0.011$). In paired comparison of the groups, significant differences were found between university and state hospitals ($P = 0.03$), and between university hospitals and private health centers ($P = 0.04$). There was no difference between state hospitals and private health centers. Partial or complete repetition of the examination was required in 47.5% of all examinations (Table 2).

Other common problems encountered were the absence of patient name and examination date on the film, (n = 10), opposite placement of the radiograph emulsion surface (n = 2), absence of direction mark on the mammography (n = 2), insufficient compression (n = 4), premature termination of examination (n = 4), and lack of contrast material use in routine abdominal CT examinations (n = 2).

Discussion

This study showed that in Turkey only 22% of all radiological examinations sent to reference hospitals had acceptable quality, and 47% needed to be repeated (partially or completely), or required an additional examination for diagnosis. Incomplete sequences, unsuitable contrast material timing and windowing were the main quality problems.

Almost 25% of the radiologists in Turkey think that lack of standardization of radiological examinations is a major problem (Table 3); however, there is no statistical data published on this specific subject. There are various data on the amount of repeated radiological examinations (1–4). These data usually reflect the figures of individual institutions and the problem is managed by repeating the examination.

Quality control and standardization is gaining importance in radiological service, as in all other businesses (5, 6). Studies of the American College of Radiology on mammography may be a

guide for radiological quality standardization and can be adapted to Turkey (7). Based on our data, the main causes of the problems encountered in Turkey were as follows:

a. Policy of health centers and economic concerns: Classification of examinations according to the center in which performed showed that university hospitals had the least need for repeating exams, whereas and the most need was in state hospitals (Table 2). This finding may have been due to inadequate equipment and the need to conduct procedures faster, which is because of an insufficient number of radiologists. The definition of "patient per physician" may be adapted to "procedure per radiologist" by a workgroup to determine the recommended numbers. Thus, numbers of radiologist and technician employment in an institution can be recommended for state and university hospitals. It has been reported that radiologists and technicians employed in state hospitals and private health centers participate in educational organizations less frequently than their colleagues (8). It would be wise to establish a new approach that rewards participation in educational activities (such as recording educational activities and examination results) and incorporating them into the calculation of performance payments. Insufficient number of cross-sections, and insufficient amount of x-ray and contrast material used may arise due to economic concerns of the center. High maintenance costs charged by manufacturers may potentially decrease the frequency of periodic service or cause these services to be performed by unauthorized persons. Although devices do not function properly and artifacts can be seen, hospital management may not want to pause the devices. Payment policies for radiological services should use quality rather than quantity as an outcome measure. Quality control measures should be established as well as billing controls, both of which should be continuously monitored. The observed concentration of these problems in private health centers may have been due to their need to discount pricing as a result of competition. This problem can be solved if social security organizations demand quality control certification, instead of only being concerned about per examination pricing. Under these circumstances, we think the most important problem is the lack of a central organization, which would inspect quality control, and the absence of radiological quality standards.

Table 1. Results for quality of examinations according to centers in which the examinations were performed

Quality of examination	Center where examinations were performed					
	University hospitals		State hospitals		Private health centers	
	n	%	n	%	n	%
Very poor	1	5.0%	6	13.3%	5	9.1%
Poor	3	15.0%	21	46.7%	21	38.2%
Good	5	25.0%	14	31.1%	17	30.9%
Excellent	11	55.0%	4	8.9%	12	21.8%
Total	20	100%	45	100%	55	100%

Table 2. Rate of examinations that needed to be repeated, according to the centers in which the examinations were performed

	Total	Repeated	
	n (%)	Yes [n (%)]	No [n (%)]
University hospitals	20 (16.7%)	4 (20%)	16 (80%)
State hospitals	45 (37.5%)	27 (60%)	18 (40%)
Private health centers	55 (45.8%)	25 (45%)	30 (65%)
Total	120 (100%)	56 (46%)	64 (54%)

Table 3. Distribution of the responses to the question "What is the main problem of Turkish Radiology?" posted on the Turkish Society of Radiology website December 28, 2005 (http://www.turkrad.org.tr)

What is the main problem of Turkish Radiology?	n (%)
Standardization of radiological examinations	68 (24.6%)
Standardization of radiology education	68 (24.6%)
Employee rights of radiologists in Turkey	125 (45.3%)
Cooperation of radiology subspecialty societies	7 (2.5%)
Opening of new branches of Turkish Society of Radiology	8 (2.9%)
Total answers	276

b. Lack of knowledge and curiosity among radiologists: The one and only quality control step in Turkey is implemented by radiologists; therefore, any quality problem produced by technicians or the health center itself is undersigned by the radiologists. Thus, the contribution of radiologists to the problems defined in our sampling pool cannot be denied (Fig. 1). We think that education of radiologists on radiological quality and standardization could play a key role in solving these problems. The lack of standardized radiology education and the lack of quality control measures for all radiological examinations are the primary problems awaiting solution (8).

Radiology board examination is one important step in the standardization of radiology education. This examination should measure knowledge of quality control and ways to solve the possible problems, as well as knowledge of radiodiagnostics and physics. The Turkish Society of Radiology (TSR)

should play an important role in defining quality control measures, as it is the only meeting point of radiology instructors. Workgroups formed under TSR, especially for standardization of mammography, should be supported. Workgroups formed for any subject should define "adequate radiological examination" and open it to discussion with radiologists. After defining the standards, supervision of these standards should be commenced by committees established in cooperation with the Turkish Ministry of Health. These committees should periodically supervise radiology centers in their region. Any center that fails to meet these quality standards should be required to meet them, through the cooperation of the Ministry of Health, Retirement Fund, Chamber of Medicine, and Consumer's Rights Association.

c. Lack of knowledge and interest among radiology technicians: Technicians seem to be responsible for such observed problems as deficient FOV, inappropriate x-ray dosage and processing, and insuitable contrast material timing. We think that these problems arise mainly from lack of knowledge, skill, and supervision. In Turkey, the clinical education of technicians is provided by the radiologist in their institution; therefore, deficits in radiologist knowledge and supervision are reflected in technicians. There are numerous problems with technicians regarding their clinical education and periodic postgraduate education. There are no available periodic educational activities for technicians. Reference educational resources for technicians in the Turkish language are scarce. Standardization of their education and national board examination should be steps promptly taken. Medical associations are more organized and financially independent, thus, TSR may take a leading role in these activities. Positive outcomes would primarily affect the radiologists.

d. Incapacity of device and technical equipment: Problems described in Fig. 3, such as inadequate film processing, contrast material timing, and deficient sequence are caused by the inability to effectively use the devices rather than incapacity of the equipment. The extent of the quality problem in Turkey is not concordant with the technology park in our country. The problems described above can be solved by technician education, efficient and cooperative planning in device purchase, and maintenance contracts. Radiologists may play a key role in communication difficulties between hospital management and other hospitals. Use of automatic injectors may help standardize abdominal examinations, picture archiving and communication systems (PACS) and other digital archiving methods may solve problems of x-ray dosage and film processing, and the application of quality control methods, such as modulation and transfer function may be useful in the solution of problems (9–13).

Our study is a small sampling of crowded and relatively developed cities in western Turkey. Thus, it is not possible to construct projections for the entire country. Considering the lack of relevant studies and the importance of the subject, it may be considered useful as it provides a window with which to glimpse the extent of the problem. We think that this problem should be substantial in small cities and in the eastern part the country as well. We limited the number of sampling from each center to obtain a heterogeneous group. The study was offered to the clinics of eastern cities, but contributions from these clinics were restricted. The actual extent of the problem could be determined by collaboration of TSR and the Ministry of Health. Our data include subjectiveness because of the nature of this study however the evaluators were experienced academic radiologists.

In conclusion, the absence of radiological quality standards and supervision in Turkey, which lead to losses and problems, are the main matters recognized commonly. The actual extent of these problems is unknown in Turkey. Our study was a preliminary study to reveal the extent of the problem by sampling the available centers. As the subject is radiological service and primarily concerns radiologists, these problems should be assessed by public and civil organizations especially TSR, the Ministry of Health, and universities, and necessary precautions should be taken.

References

1. Information strategies in health in Turkey in the years of 2000. www.saglik.gov.tr/tsbs/documents/sagliktabilgistratejileri.pdf
2. Tomlinson D, Stapleman K. A new concept in radiology QA in a large setting. Radiol Manage 1998; 20:30-37.
3. Ortendahl TW, Borrman H, Grondahl HG. Quality assessment of lateral cephalograms amongst radiologists and orthodontists. Br J Orthod 1994; 21:45-51.
4. Arvanitis TN, Parizel PM, Degryse HR, De Schepper AM. Reject analysis: a pilot programme for image quality management. Eur J Radiol 1991; 12:171-176.
5. Moore SM, Gierada DS, Clark KW, Blaine GJ. Image quality assurance in the prostate, lung, colorectal, and ovarian cancer screening trial network of the National Lung Screening Trial. J Digit Imaging 2005; 18:242-250.
6. Randal J. FDA considers recommendations on mammography quality. J Natl Cancer Inst 2005; 97:1721.
7. http://www.acr.org/s_acr/bin.asp?CID=549&DID=12208&DOC=FILE.PDF
8. İzmir Chamber of Medicine Specialist Workgroup: Institutions Providing Specialty Education in Medicine, 1st ed., İzmir: Etki Basımevi, 2005; 512-513.
9. Peer S, Peer R, Walcher M, Pohl M, Jaschke W. Comparative reject analysis in conventional film-screen and digital storage phosphor radiography. Eur Radiol 1999; 9:1693-1696.
10. Weatherburn GC, Bryan S, West M. A comparison of image reject rates when using film, hard copy computed radiography and soft copy images on picture archiving and communication systems (PACS) workstations. Br J Radiol 1999; 72:653-660.
11. International Commission on Radiation Units and Measurements. Medical imaging: the assessment of image quality ICRU Report No. 54. Bethesda, Md: International Commission on Radiation Units and Measurements, 1996; 54.
12. Samei E, Flynn MJ, Reimann DA. A method for measuring the presampled MTF of digital radiographic systems using an edge test device. Med Phys 1998; 25:102-113.
13. Veldkamp WJ, Kroft LJ, Mertens BJ, Geleijns J. Digital slot-scan charge-coupled device radiography versus AMBER and Bucky screen-film radiography: comparison of image quality in a phantom study. Radiology 2005; 235:857-866.