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Repeat analysis program in radiology departments in Mazandaran province- Iran; Impact on population radiation dose

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Background: The rejected films in radiography may be responsible for an unnecessary increase in the radiation dose to the population. The effective dose to population is a very important factor in estimation of stochastic risk in radiology. The main goal of this study was to determine the effective dose to members of the public due to rejected films in diagnostic radiology departments in the Northern province Mazandaran- of Iran. ***Materials and Methods:*** A repeat analysis program was set in all radiology departments in Mazandaran province (population = 2976219 person) to determine the total number and type of rejected films. All repeat and discarded films were collected and separated into types according to their etiology leading to be discarded. Considering technical data about various radiological procedures and using the standard dosimetry tables, the annual effective dose per caput as well as annual gonadal dose per caput due to image retake was estimated. ***Results:*** The total number of rejected radiographs in one year period was 73857 (overall reject rate ~ 11.15%) which led to 34.91 µSv and 37.17 µGy as annual average effective dose to a member of the public and annual average gonadal dose per caput respectively. The main reason of retaking the images was improper exposure factors. ***Conclusion:*** The reject rate was in the middle range of similar values in other studies; whereas in the present study the main reason for rejection was improper exposure factors (67.11%), the main reason for radiography repeat film was different in various countries. Comparing to the estimated 2.4 mSv from natural background radiation, the average annual effective dose and annual average gonadal dose per caput due to repeat/retake films are negligible. However, reducing the reject films is economically rewarding. Further national studies are suggested. **Iran. J. Radiat. Res., 2007; 5 (1): 37-40**

Keywords: *Repeat analysis program, rejected films, effective dose, radiology, Iran.*

INTRODUCTION

The increasing use of X-rays in medical imaging has made it an important source of man-made radiation in the population collective dose (1). It is believed that about 90 percents of US community dose originates from diagnostic radiology and nuclear medicine as sources of artificial ionizing radiation (2). An important goal in radiography is to obtain the best diagnostic information by delivering the least radiation dose to the patient (3). Reduction of image quality may cause repetition of X-ray examination which, in turn, leads to extra and unnecessary radiation dose to the patient. Repeat analysis program (RAP) is a helpful element to determine how big is the waste of films and where the sources of the error are (4). Also it can be used as a proper method for quality assurance of radiographic imaging (5). However, there is not any report on the radiation doses received by patients in diagnostic radiology due to repeat/reject films. The main goal of this study was to determine the effective dose to members of the public due to discarded films in diagnostic radiology departments in the Northern Province, Mazandaran of Iran.

MATERIALS AND METHODS

A repeat analysis program (RAP) was accomplished in all radiology departments (47 hospitals and private clinics) in Mazandaran province and the radiographic film wastage, under the aspects number of

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rejected images, the type of radiography and reasons for rejection were analyzed. During a one year period, the waste films were collected and assigned to following main categories: exposure factors, positioning and technical problems, problems due to patients and others. Knowing the number of rejected films, type and technical setting of each diagnostic procedure and using the effective and gonadal dose per examination according to ICRP 80 standard patient dosimetry tables and ICRP-1993 report, the effective dose to population due to rejected radiographs was calculated using the following equation:

$$E_D = \frac{\sum [(D_e / N_{fe}) \times N_{rr}]}{N_p}$$

Where E_D is the effective dose per member of general population, D_e is effective dose per examination, N_{rr} is number of rejected radiographs, N_{fe} is number of film per examination and N_p is the number of total population. N_{fe} is assumed to be 1.5 for conventional plain radiography, 4 for radiography using contrast media and 2 for mammography. According to the census data of 1996 accounting for the population [6] and considering growth rate, N_p is estimated to be 2976219 at study period. So, considering the number of film per examination according to the above assumption, by multiplying the effective dose per examination derived from standard dosimetry tables recommended by ICRP by total number of corresponding rejected films, the total effective dose of a given examination was estimated. By adding the similar values from different examinations, the total effective dose due to all types of examination was estimated. The mean effective dose per member of population was calculated by dividing the above parameters by the number of general population. A similar calculation was used for estimation of gonadal dose per caput by dividing the sum of gonadal dose for procedures by the total number of population. The calculation methods of the present study are adopted from similar reports [7-10].

RESULTS

RAP results showed that the total number of rejected radiographs in one year period was 73857. Taking the total number of 662402 X-ray films at the same period of time, the overall reject rate was about 11.15%. The main reason of retaking the images was improper exposure factors. About 67.11% of all rejected films (49565 from 73857) were due to improper (under/over) exposure. The frequency of over and under exposed discarded films was nearly the same (about 52% and 48% from 67.11% respectively). Also 16832 films (~22.79%) were rejected because of positioning and technical problems. The rest of rejected radiographs (7460~10.10%) were categorized in groups of problems due to "patients" and "others". Figure 1 shows the frequency of discarded films due to different reasons for rejection.

The overall annual average effective dose to members of the public, and overall annual average gonadal dose per caput in Mazandaran province (population=2976219) due to the rejected films was estimated to be 34.91 µSv and 37.17 µGy respectively. Table 1 shows summary of the results of RAP and corresponding delivered dose to public.

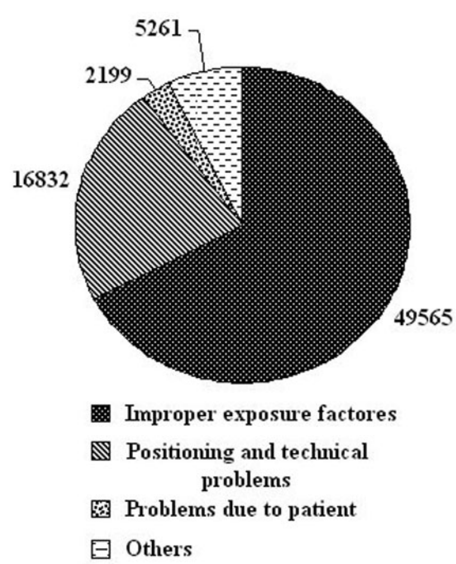

Figure 1. Frequency of discarded films due to various reasons for rejection.

Table 1. The results of RAP and corresponding delivered dose to public.

Type of X-Ray Procedure	Number of discarded films	Effective Dose (µSv)			Gonadal Dose (µGy)		
		Average Dose per Examination	Average Dose per Film (D_e/N_{fe})	Annual Average Dose per Head of Population	Average Dose per Examination	Average Dose per Film (D_g/N_{fe})	Annual Average Dose per Head of Population
Conventional plain Radiography	14317	920	613	2.95	1060	707	3.40
Radiological Procedures with Contrast Media	58949	6450	1613	31.95	6820	1705	33.77
Mammography	591	100	50	0.01	*	*	*
Total	73857	7470	2276	34.91	7880	2412	37.17

* Gonadal Dose was less than 0.01 mGy.

DISCUSSION

In this study, some information about the rejection of radiographic films using Repeat analysis program (RAP) was obtained during one year period in Mazandaran province in Iran. RAP is a common technique to provide useful information about reject/retake rate as well as the sources of error. There are many reports that have used this technique in different countries, such as Austria [11], Belgium [12], Germany [4] and USA [13], for repeat/ reject analysis. It can also play an important role for quality assurance and quality management of radiographic imaging [4, 5, 12, 14, 15]. In spite of converting conventional film to digital radiography in recent years, there are some reports indicating the importance of repeat analysis program in digital and computed radiography, as well [16, 17]. The results of the present study show that the overall reject rate has been about 11.15%. Which is in the middle range of other values in similar reports: 9-13.2% in Germany [4], 27.6% in Austria [18], 6.6-9.9% in UK [19], 6.4-15% in Norway [20]. However, the distribution of the number of discarded films according to the etiology leading to their being discarded has not been exactly the same. Whereas, in the present study the main reason for rejection was improper exposure factors (67.11%), the main reason for retaking in various countries has been different. For example, it is "positioning" in Germany [4], "exposure" and "others" in Austria [18]. Although, it seems that the main reason for film retaking is a function of multi-parameter, such as using automatic exposure control system (photo timers), working experience of the personnel, workload of the department, etc. However some report indicate that the proportion of discarded films in relation to the total number of films should not exceed 8% [4]. In the present study the RAP also enabled us to estimate the annual effective dose to the population of northern Iran due to the rejected films. There are many reports indicating that the population effective dose from medical diagnostic examinations is a very important factor in estimation of risk [21, 22]. In the present study, the overall annual average effective dose to member of the public and overall annual average gonadal dose per caput due to the rejected films was estimated to be 34.91 µSv and 37.17 µGy respectively. In publication No. 60 of the ICRP (1990), it is recommended to limit the annual dose of 1 mSv be set for the general population [23]. We didn't consider dental radiography in the estimation of population dose, because they didn't deliver significant gonadal dose to population [24, 25]. Although, in this study, in comparison with the standard dose limits, the effective and gonadal doses per individual of population due to rejected films are negligible, recent recommendations have identified an increased risk from radiation and contain reduced public dose limits [26, 27]. Therefore, the radiation dose to the public by reducing the rejected films should be as low as reasonably achivable. Apart from the radiation dose to the public, radiographs which must be repeated, represent additional, non-billable costs due to increased film, chemistry, and equipment use as well as increased personnel time. Compounding the overt negative financial impact on the department is an increased burden on the waiting room and support staff, and a decrease in patient throughput [28].

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REFERENCES

1. International Commission on Radiological Protection (1996) Radiological protection and safety in medicine. Publication No. 73. Annals of the ICRP 26, Oxford: England, Pergamon press.
2. Ayad M (2000) Risk assessment of an ionizing radiation energy in diagnostic radiology. *Applied Energy, **62**: 321-328.*
3. Bushberg JT, Seibert JA, Leidholdt EM, Boone JM (2002) The essential physics of medical imaging. Williams & Wilkins, 2nd Ed. pp: 109-138.
4. Lewentat G and Bohndorf K (1997) Analysis of reject X-ray films as a quality assurance element in diagnostic radiology. *Rofo Fortschr Geb Rontgenstr Neuen Bildgeb Verfahr, **166**: 376-381.*
5. Glaser SM and Dehn TG (1980) Reject film study. Cost and quality considerations in a radiology department. *QRB Qual Rev Bull, **6**: 19-22.*
6. http://www.mazand-zarrin-book.info/fa/info.htm
7. Regulla D, Griebel J, Nosske D, Baver B, Brix G (2003) Acquisition and assessment of patient exposure in diagnostic radiology and nuclear medicine. *Med Phys, **13**: 127-35.*
8. Brugmans MJ, Buijs WC, Geleins J, Lembrechts J (2002) Population exposure to diagnostic use of ionizing radiation in the Netherlands. *Health Phys, **82**: 500-9.*
9. Kaul A, Baver B, Bernhardt J, Nosske D, Viet R (1997) Effective doses to members of the public from the diagnostic application to ionizing radiation in Germany. *Eur Radiol, **7**: 1127-1132.*
10. Shabestani Monfared A, Abdi R (2006) The estimation of radiation effective dose from diagnostic medical procedures in general population of northern Iran. *Iran J Radiol, **3**: 185-188.*
11. Peer S, Peer R, Walcher M, Pohl M, Jaschke W (1999) Comparative reject analysis in conventional film-screen and digital storage phosphor radiography. *Eur Radiol, **9**: 1693-1696.*
12. Arvanitis TN, Parizel PM, Degryse HR, De Schepper AM (1991) Reject analysis: A pilot program for image quality management. *Eur J Radiol, **12**: 171-176.*
13. Adler A, Carlton R, Wold B (1992) An analysis of radiographic repeats and rejects rates. *Radiol Technol, **63**: 308-314.*
14. Watkinson S, Moores BM, Hill SJ (1984) Reject analysis: its role in quality assurance. *Radiography, **50**: 189-194.*
15. Curtis DJ and Jones RL (1981) Quality assurance in repeat films. *Crit Rev Diagn Imaging, **14**: 281-320.*
16. Honea R, Elissa Blado M, Ma Y (2002) Is reject analysis necessary after converting to computed radiography? *J Digit Imaging, **15** (Suppl 1): 41-52.*
17. Nol J, Isouard G, Mirecki J (2006) Digital repeat analysis; setup and operation. *J Digit Imaging, **19**: 159-166.*
18. Peer S, Peer R, Giacomuzzi SM, Jaschke W (2001) Comparative reject analysis in conventional film-screen and digital storage phosphor radiography. *Radiat Prot Dosimetry, **94**: 69-71.*
19. Weatherburn GC, Bryan S, West M (1999) 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, **72**: 653-660.*
20. Gadeholt G, Geitung JT, Gothlin JH, Asp T (1989) Continuing reject-repeat film analysis program. *Eur J Radiol, **9**: 137-141.*
21. Brugmans MJ, Buijs WC, Geleins J, Lembrechts J (2002) Population exposure to diagnostic use of ionizing radiation in the Netherlands. *Health Phys, **82**: 500-9.*
22. Ludwig RL and Turner LW (2002) Effective patient education in medical imaging: public perceptions of radiation exposure risk. *Allied Health, **31**: 159-64.*
23. International Commission on Radiological Protection (1990) Recommendations of the International Commission on Radiological Protection, ICRP publication 60. Oxford Pergamon Press.
24. White SC (1992) Assessment of radiation risk from dental radiography. Dentomaxillofac. *Radiol, **21**: 118-26.*
25. Saini T, Manoharan V, Al Agil IA (1990) Radiation doses to the Gonadal area in dental radiography. *Odontostomatol-Trop, **13**: 67-71.*
26. National council on Radiation protection and Measurements (NCRP), Report 100, Exposure of the US population from Diagnostic medical Radiation.
27. United Nation scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2000 Report to the General Assembly, Sources, Effects and Risks of Ionizing Radiation.
28. Kofler JM, Mohlke ML, Vrieze TJ (1999) Techniques for measuring radiographic repeat rates. *Health Phys. **76**: 191-194.*