©EIJEAS 2016 Volume: 2 Issue: 1, 31-51, Ohio, USA
Electronic International Journal of Education, Arts, and Science
http://www.eijeas.com

Knowledge, Attitude and Behavior of Radiology Professionals about the Harmful Effects of Radiation Which is Used for Diagnosis*

Habip Balsak
Selahaddin Eyyubi University, habip.balsak@seu.edu.tr

Gülsen Güneş
İnönü University, gülsen.gunes@inonu.edu.tr

Nilgün Ulutaşdemir
Zirve University, nilgun.ulutasdemir@zirve.edu.tr

Abstract

In this study, the survey was developed in order to identify the knowledge of radiology professionals regarding the ionizing radiation exposure, and their attitudes towards radiology applications. The survey was applied to 202 radiology professionals between March 15 and June 30, 2014. This cross-sectional study was performed in Diyarbakır province and its districts. The mean of age of 202 radiology professionals (111 males and 91 females) was 32,51. 90,6% of the radiology professionals are not aware of the annual MADL (maximum allowable dose limits) for their patients while 83,7% of them do not know that for themselves. Moreover, of all radiology professionals, 90,6% and 83.7% of them were not aware of the annual MADLs (maximum allowable dose limits) respectively for patients and for themselves. Moreover, 82,2% of them did not have any idea about the level of ionized radiation due to abdominal computed tomography (CT) equals to the level of radiation due to PA lung examinations. In case of other techniques in which ionizing radiation is used, 41;%, 32%, 34% and 30.5% of radiation professionals knew that ionizing radiation is used respectively in mammography, CT, angiography and scopy. Of all radiology professionals, 91% and 89.5% of them did not know that ionization radiation is used in respectively in ultrasonography and magnetic resonance imaging. Of all radiation professionals, 21,9% of them stated that they did not use dosimeter. It was specified by radiation professionals that since they did not rely on the results of dosimeter, they did not use it. In order to increase the knowledge and awareness of radiation professionals regarding the radiation safety, in-service training programs are required.

*This study is a summary of the MsC thesis of the correspoondig author

Introduction

For millions of years, people have been exposed to cosmic rays coming from the space. Additionally, human being is continuously exposed to various radioactive sources and they are present either in his/her body or environment (Atakan, 2006). This exposure will continue as long as the radiation sources are present and it is not possible to prevent it. Upon the discovery of X rays by Röntgen in 1985 and after Marie Curie discovered the radioactivity at the beginning of the 20th century, the use of radiation has increasingly been common in medical and industrial fields and it has become an unavoidable part of our life (TAEK, 2014). Radiation technology not only facilitates the social life, it also leads to various health problems. Therefore, the interest in effects of radiation and the ways of protection from radiation has increased through the years (Yaren, 2005).

The use of radiation in medicine starts with the discovery of X rays by Wilhelm Conrad Röntgen (1985). In the first years of the discovery of, precautions were not taken against its harmful effects since its hazards were not known. In 1905, it was already indicated by various medical studies that radiation led to cancer. At that time, various dentists were diagnosed with cancer due to life threatening skin cancer and various radiologists died since they were diagnosed with similar skin cancers (Kaya, et al. 1997). In fact, it is also possible that blood cancer, which led the Curie couple to die, could also be developed due to radiation (Coşkun, 2011).

Radiation can cause various biological effects such as burn, cancer, genetical diseases and hereditary disorders depending on various variables such as its type, energy, penetration power, ionization ability, physical and biological half-life of the radiological matter and the distance between the radiation and tie biological system (Coşkun, 2011). Since the body is exposed to radiation during radiological examinations, these adverse effects can emerge at the cellular, tissue and system levels due to the penetration and absorbation of X rays. Some of these impacts form genetical and some others lead to somatic effects. However, results of genetical effects can be observed in further generations instead of the individual himself/herself (Tuncel, 2011).

Discovery of ionization radiation and radioactive matters guide the striking developments in medical diagnosis and treatment and ensures the common use of them in industry, agriculture and research. However, individuals should prevent the unnecessary radiation since ionization radiation can harm the human body. Thus, the balance of benefits and risks that can emerge due to the radiation exposure should be carefully assessed under the controlled conditions (TAEK, 2009).

Recently, medical irradiation has the biggest portion among artificial sources of radiation and diagnostic radiological examinations are the mostly used (TAEK, 2014). Throughout the world, 3.6 billion radiological examinations, 37 million nuclear medicine and 7.5 million radiotherapy applications are performed per year (W.H.O., 2014).

Radiation professionals who are exposed to low doses of radiation in years may experience its long term harmful effects through this chronic irradiation. The reason for this is that even though the doses are low, they are re-current and with repeated irradiations. Hence, this is a severe risk factor for radiology professionals (Saygın et al. 2011).

In Turkey, according to the official statistics of the Ministry of Health, it is detected that there is a prominent increase in the number of both diagnostic radiological examinations and the radiology devices. When we examine the 2012 annual statistics of the Ministry of Health, the number of diagnostic radiological examinations in only 2012 was as follows; Computed tomography (n=9 825 274), direct X-ray (n=43 290 731) and mammography (n=2 042 580) (Turkish Republic Ministry of Health, Health Statistics Annual, 2012-2013).

In 2012, it is known that an individual is admitted to hospital 4.7 times throughout Turkey. When we consider these data, it is obvious that medical ionization radiation exposure not only affects the health professionals but also closely influences the society (Turkish Republic Ministry of Health, Health Statistics Annual, 2013).

Recently, human being receives the 46% of the radiation due to the medical interventions (Kaya, et al. 1997). Therefore, the knowledge, attitudes and behaviors of radiology professionals regarding the human health are extremely important since they are continuously present in an environment with radiation and since they are the responsible employees who should perform the radiological examinations.

In this study, the aim is to determine the knowledge of radiology professionals regarding the harmful biological effects of ionizing radiation. Radiation is most commonly used for diagnostic examinations by radiology professionals such as radiographer/technician and assistant, radiology nurses and radiology specialists

Methodology

Research Type, Population and Sample

This study is a descriptive and cross-sectional study. The participants of the study (population) was composed of radiology doctors, radiology technicians, radiology nurses and assistants who were working in radiology units of hospitals located in Diyarbakır province or its districts. All participants in the population were tried to be reached and no particular sample was selected from the population. The targeted sample size was determined as 238 professionals but only 202 of them were available. Some of the professionals have refused the participation to the study while some others were in a vacation period. Consequently, the participation rate was 85.9%.

The majority of who accepted to participate in our study were radiology technicians (n=142). Besides this, there were 34 radiology doctors, 17 radiology nurses/health officers and 8 assistant technicians. The study was performed in Diyarbakır province and in all districts of the province. The surveys were applied to participants between 15 March and 30 June of 2014.

Survey and Assessment

The survey which was prepared by researchers was used as the data collection tool. This survey is composed of questions related these topics: whether or not participants have knowledge about sociodemographic radiation safety, from where they learn these information, whether they are aware of the annual maximum radiation doses, the amount of radiation received by patient as a result of one CT examination, their own health problems, whether or not they use protective clothes for themselves and whether or not they give these protective clothes to patients, whether or not they use the additional holidays, the reasons for not having dosimetry permission, and their recommendations related to the working conditions.

When the maximum dose radiation limits of radiology professionals are evaluated, it is determined that the radiation doses are 50 µsv for radiology professionals and 5 µsv for others according to regulations and publication of Turkey Atomic Energy Agency (Regulations on Radiation Dose Limits and Working Principles of Personnel Working with Ionizing Radiation Sources in Health Care Services. Supplementary form 1 2012).

Similar to many other studies, when the radiation level (due to abdominal CT) is asked to the participants, also the equivalent level of lung radiograph PA is also asked in order to make the question clearer. The assessment of this question is based on a report published by the Commission of European Radiation Protection in 2008. (European Commission. Radiation Protection 118 Update Mars 2008 2007). In this report, although the equivalent value of 500 PA lung radiograph has been stated as 1 radiation level (due to abdominal CT), the answers which are in the range of 400-600 have been accepted as correct since the exposed radiation during the radiological examinations might exhibit small variations driven by many variables.

Statistical Analysis

In order to analyze the data, SPSS package program was used. Frequency, arithmetic mean and chi-square tests were used for the data analysis. P<0.05 was accepted as a statistical significance.

Variables

Dependent Variables**:** Work satisfaction, knowledge of participants regarding radiation safety, attitudes and behaviors related to the radiation protection. Independent Variables**:** Occupation, duration of the occupation, age and gender.

The Ethics of the Research

The study was initiated upon obtaining the consent form from Inonu University, Medical Faculty, and Research Ethics Board (25.12.2013).

All participants such as radiology doctor, nurse, technician and assistant technicians were informed about the study and their oral consents were obtained.

Results

The mean age of the radiology professionals (n=202) was 32.51. The rate of participants who were between 20 and 29 years old was 34.7%, the rate of those between 30 and 39 years old was 45.5% and the rate of those who were older than 40 years old was 19.8%. When the educational levels of participants were examined, it was found that 85.4% of them were graduated from a university and 14.6 of them from a high school. Of all participants, 64.4% of them were married, and there were 111 male and 91 females. Assistant technicians were not government employees and they were radiology employees who were working for private services of radiology units of local hospitals (Table 1).

Table 1. *Radiology Professionals; Age, Gender, Educational Status, Marital Status and Occupational Information*

Characteristics	(n)	(%)
Age groups		
20-29	70	34,7
30-39	92	45,5
40+	40	19,8
Gender		
Male	111	55
Female	91	45
Educational status		
High School	29	14,6
University	170	85,4
Marital Status		
Married	130	64,4
Single	70	34,7
Occupation		
Radiology technician	142	70,3
Nurse/health officer	17	8,4
Radiology Doctor	34	16,8
Assistant technician	8	4,0
Total	202	100

Of all radiology technicians, 73% of them stated that they had the sufficient knowledge about the protection from the radiation. It has been found a significant relationship between their answers of this question and their occupations ($p<0,05$). This rate was 55.9% for radiology doctors. Of all nurses and assistant technicians, 79.2% of them specified that they did not have sufficient knowledge regarding this issue.

It was observed that most of the radiology professionals gained information about protection ways from radiation mostly by their effort (73.6% of them) and some of them learned this information from the school (68.7% of them). There was a significant relationship different between the occupational groups of radiation professionals and their knowledge, gained from an educational institution (p<0,05).

It was observed that majority of radiology professionals (83.7%) were not aware of the yearly maximum radiation dose limits. There was no significant difference between the occupational groups and the status of being aware of the maximum radiation dose limits. Besides, 81.8% of radiology technicians, 92% of radiology nurses and assistant technicians, and 83.7% of doctors had knowledge about the yearly maximum radiation dose limits (Table 2).

Table 2. *Knowledge levels of radiology professionals about maximum allowable dose (MALD) limits (for radiology professionals)*

Occupational group (P0,429)	Who knows right		Who knows wrong		Total*	
	n	%	n	%	n	%
Radiology Technician	26	18,2	117	81,8	143	70,8
Radiology nurse/assistant technician	2	8,0	23	92,0	25	12,4
Radiology Doctor	5	14,7	29	85,3	34	16,8
Total**	33	16,3	169	83,7	202	100

Of all radiation professionals, 90.6% of them did not know the yearly maximum radiation dose limits, which are allowed for individuals except radiology employees. Besides, none of the radiology nurses and assistant technicians had knowledge regarding this issue. Furthermore, 90.2% of radiology technicians and 85.3% of radiology doctors did not have any knowledge on this issue.

Table 3. *Knowledge levels of radiology professionals about maximum allowable dose (MALD) limits (for individuals whose occupations are not related to ionizing radiation)*

Occupation	Right answer		Wrong answer		Total	
	n	%	n	%	n	%*
Radiology technician	14	9,8	129	90,2	143	70,8
Radiology nurse/assistant technician	**0**	**0**	**25**	**100**	**25**	**12,4**
Radiology Doctor	**5**	**14,7**	**29**	**85,3**	**34**	**16,8**
Total	**19**	**9,4**	**183**	**90,6**	**202**	**100**

82.2 % of the radiology professionals did not know the equivalent level of radiation doses between 1 chest radiograph and 1 abdominal tomography. Radiology technicians were the most successful group in answering this question. Nurses and assistant technicians had no information on this issue.

Table 4. *Knowledge levels of radiology professionals about the levels of radiation during one abdominal tomography*

Occupation	Right		Wrong		Total	
	n	%	n	%	n	%*
Radiology technician	31	21,7	112	78,3	142	70,8
Radiology nurse/assistant technician	0	0	25	100	25	12,4
Radiology Doctor	5	14,7	29	85,3	34	16,8
Total	36	17,8	166	82,2	202	100

% 85,2 of the radiology technicians, 64% of the nurses and assistant technicians, 58.8 % of the doctors stated that they were using dosimetry during the work. The remaining 21.9 % of the employees either very rarely or never used dosimetry. There was a statistically significant relationship between dosimetry usage and occupation groups. (p<0,05).

Of all radiology professionals, 54.7% of them stated that they did not rely on dosimeter results, 21.9% of them specified that they did not have any opinion on this issue. Besides, 23.4% of them stated that they relied on dosimeter results.

Even though 74.5% of radiology professionals stated that they achieved to use their holidays regularly, 25.5% of them specified that they could not use their additional holidays either sometimes or always.

Once we analyze the reasons for not using their additional vacations, the reasoning varies significantly across occupational groups. (p<0,05). According to our findings, 66.7% of radiology technicians and 50% of radiology doctors stated that they did not use the additional vacation due to the discontinuation of their additional payment. Besides, 63.9% of nurses and assistant technicians specified that they did not have such additional vacations due the exposure to overdose radiation.

There was a significant association between occupational groups and the knowledge of ionization radiation containing medical examinations ($p<0.05$). Accordingly, radiology doctors and technicians were more informed compared to others. Among radiological examination techniques in which ionization radiation is used, direct X-ray was the one which was mostly known by radiology professionals. Of all participants, 73% of them knew that ionizing radiation is used during direct X-ray examinations. In case of other techniques in which ionizing radiation is used, 41;%, 32%, 34% and 30.5% of radiation professionals knew that ionizing radiation is used respectively in mammography, computed tomography, angiography and scopy (Table 5).

Table 5. Knowledge of radiology professionals about the right levels of ionizing radiation exposed due to radiological examinations

Occupation	Direct X-ray (P:0,000)		Mammography (P:0,000)		CT (P:0,000)		Angiography (P0,001)		Scopy examination (P:0,000		Toplam	
	n	%	n	%	n	%	n	%	n	%	n	%*
Radiology technician *	106	75,2	82	58,2	98	72,1	89	63,1	98	69,5	141	70,5
Radiology nurse/assistant technician	8	32,0	4	16,0	5	20,0	12	48	10	40,0	25	12,5
Radiology Doctor	32	94,1	32	94,1	33	97,1	31	91,0	31	91,2	34	17

Total	146	73.0	118	59.0	136	68.0	132	66,0	130	69,5	200	100

* The percentage of the column

Of all radiology professionals 91% and 89.5% of them did not know that ionization radiation is used in respectively in ultrasonography and magnetic resonance imaging.

It was observed that radiology units had lead cloth (96%), thyroid protective (80.2%), lead screen (67.3%), lead gloves (22.8%), lead glasses (37.1%), and gonadal protective tools (43.6%).

Of all protective clothes and tools, mostly lead screens (54.5%) and lead coats (51%) were used by radiology professionals. The rates of the use of thyroid protectives, lead gloves and lead glasses were respectively 32.7%, 5% and 14.4%.

Discussion

Of all radiology professionals, the 2/3 of them who participated in the study, think that they have solid knowledge about radiology security. When the questions related to the professions of participants are analyzed statistically, radiology technicians are observed to be the ones which recognize themselves as having the most adequate capabability. When the source of their knowledge on radiation security is questioned, it was understood that the majority of the nurses and technicians learned them from their ungraduated studies. This, indeed, explains why they see themselves as incapable. It was understood the importance of the graduated university in grasping knowledge on protection against radiology. Moreover, the nurses and technicians who have never taken any classes on radiology security see themselves as inadequate in this context. It was observed that the majority of the participants (%82,2) were not aware of the radiation exposed during an abdominal examination. It was also detected that the radiation levels stated in their answers were always below the true levels.

In a similar vein, Koçyiğit et al. (2014)'s study confirms this fact (Koçyiğit et al., 2014). In their study, 72.9 % of the participants stated in their answers the exposed radiation level below the true levels.

The awareness of the doctors on radiation is more crucial than the other professionals. However, only 14.7 % of the doctors had a correct answer on the equivalent value of radiation exposed during an abdominal tomography to chest. Of all radiology professionals, the 2/3 of them who participated in the study, think that they have solid knowledge about radiology security. When the questions related to the professions of participants are analyzed statistically, radiology technicians are observed to be the ones which recognize themselves as having the most adequate capability. When the source of their knowledge on radiation security is questioned, it was understood that the majority of the nurses and technicians learned them from their ungraduated studies. This, indeed, explains why they see themselves as incapable. It was understood the importance of the graduated university in grasping knowledge on protection against radiology. Moreover, the nurses and technicians who have never taken any classes on radiology security see themselves as inadequate in this context. It was observed that the majority of the participants (%82,2) were not aware of the radiation exposed during an abdominal examination. It was also detected that the radiation levels stated in their answers were always below the true levels.

In a similar vein, Koçyiğit et al. (2014)'s study confirms this fact (Koçyiğit et al., 2014). In their study, 72.9 % of the participants stated in their answers the exposed radiation level below the true levels.

The awareness of the doctors on radiation is more crucial than the other professionals. However, only 14.7 % of the doctors had a correct radiograph examination. Similar results have also been found in the literature on the knowledge of doctors about the level of exposure to radiation of patients.

In the study of Arslanoğlu et al. (2007), 93.1 % of the doctors and interns, in Zhou et al. (2010), 88.9 % of the interns, doctors and medical students failed to know the level of radiation exposure created by one abdominal tomography. (Arslanoglu , et al 2007; Zhou, et al. 2010). Similarly, in another study by Jacob (2004), only 15.4%-25.8 % of the doctors have succeeded to know correctly the level of radiation released in various examinations.

In studies of Bosanquet et al. 2003 and 2010, it has been shown that the awareness on the level of radiation exposure during a medical examination has not been improved over the last 7 years in UK (Bosanquet, D.C., et al 2011). Moreover, the cancer cases due to the radiological examinations are estimated as 100-150 people annually (Shiralkar, 2003). However, radiological examinations are increasing every year. Hence, the problem is clearly getting more severe. Likewise, in the above-mentioned studies, the underestimation and failure of the doctors about the level of radiation exposed, too many radiological examinations are requested (Arslanoglu A, et al 2007). For this reason, it has become crucial to make doctors and other health professionals be well informed on this issue.

In order to reduce the radiation exposure of individuals and health professionals, a maximum annual level of radiation has been imposed by regulations in accordance with international institutions (Regulations on Radiation Dose Limits and Working Principles of Personnel Working with Ionizing Radiation Sources in Health Care Services. 2012). The answers of participants indicate the fact that 83.7 % of the radiology professionals and 90.6 % of the other professionals are not aware of their annual maximum limits. These ratios are clearly very high which shows the overall inadequacy of the awareness of this issue.

Another question on radiation security regards to examinations in which the ionizing radiation is used. The answers are not satisfactory although the knowledge level of radiology technicians is better than nurses and assistant technicians. In mamograghies, the exposed radiation is relatively lower. One may therefore, think that the ionizing radiation is not used in this examination. The same fact is not, however, true for computer based tomography and scopy. The retrospective study of Bindman et al. (2009) has shown that in a tomograpgy examination, patients in California are exposed to a very high level of radiation (2-31 µsv). As another important fact, coronary angiography was shown to cause 1 cancer case in every 270 female and in every 600 male patients (Bindman, et al. 2009).

In a similar study, it was detected that cancer risk may be increased due to a cumulative increase in doses during recurrent CT examinations (Sodickson et al., 2009). From the answers of radiology professionals (other than doctors), it has been understood that ¼ of these professionals are not aware of the high level of ionizing radiation released during the computer based tomography, angiography and fluoroscopy examinations. In magnetic resonance and ultrasound examinations, the ionizing radiation is not used. The awareness of the professionals in these units is above all other profession groups. Similar results have also been found been for medical interns and doctors. (Arslanoglu et al., 2007).

During the examinations, health professionals and patients are exposed to different levels of radiations. The quality of ionizing radiation, thickness of the protective lead, source of the ray, the distance of the patient, the position of the operator are among the important determinants of exposed radiation (Koukorava et al., 2014). In the existing studies, it was emphasized that different parts of body are exposed varied levels of radiation based on the above mentioned determinants. Therefore, the use of protection is necessary. (Kim, et al 2014). In particular, professionals are very directly exposed to radiation during fluoroscopy examinations. So, the use of protective tools such as glasses, clothes etc. is even more important in such examinations. (Theocharopoulos et al, 2003).

In this study, it is understood from the answers that in majority of the radiology services, protective facilities like lead aprons, thyroid protectors and lead screens are available. However, lead glasses, gloves and protective gonadals are rarely available. Since the glasses and gloves are used intensively in 3rd step hospitals and fluoroscopic investigations, it seems us as natural not to observe these tools in 1st and 2nd step hospitals which are the study field of our study. However, if gonadal region will be exposed to the primary beam, all radiology services should possess gonadal protectives in order to create an effective protection.

In pediatric age groups and individuals in the era of development, the impact of ionizing radiation is higher compared to the adults. Therefore, it becomes even more crucial to provide gonadal protectives to the patients in the era of development. (Gürsu et al., 2013, Dadulescu et al., 2009). However, it is stated that only 43.6 % of the services include gonadal protectives. The ratio of thyroid protective use is 32.7 % among professionals. The radiology professionals are among the high risk groups for thyroid cancer and some studies has shown an increase in this type of cancer among Australian orthopedists which experience long lasting fluoroscopic examinations (Tse et al., 1999).

Radiology professionals should use at least one of the film, pocket or thermoluminescent dosimetry since their work by nature is quite endogenous to the radiation. (Coşkun, 2003). 78.1 % of the participants have declared that they use dosimetry. This ratio is about 95 % in the study of Güden. The gap between the ratios is attributed to the differentiated level of use across various profession groups. The ratio for nurses is low. This might be due to the fact they are mobile in the work and do not possess a personnel dosimetry. Among the doctors, the ratio of dosimetry usage is low compared to other profession groups since they work close to ultrasound in which ionizing radiation is not used.

Since results of dosimeter are mostly unreliable, it is not commonly used. Film dosimeters are not sufficiently sensitive and thus it is expected that individuals do not rely on its results. During the lung radiograph, technician is exposed to radiation doses between 0.5 and 1.0 μSv, and film dosimeter cannot measure radiation doses less than 40 μSv (10). In order to cope with this issue, thermoluminescent dosimeters should be commonly used.

According to regulations, radiation professionals should have additional holidays in addition to their annual permit (Regulations on Radiation Dose Limits and Working Principles of Personnel Working with Ionizing Radiation Sources in Health Care Services. 2012). Of all radiation professionals, 74.5% of them stated that they used their vacations regularly. Nurses and assistant technicians stated that they did not have additional holidays and doctors and radiology technicians stated that they did not want to use their additional holidays due to the discontinuation of their additional payments.

Conclusion and Recommendations

In this study, it has been detected that radiology professionals have lack of knowledge regarding radiation safety. For instance; both radiology professionals and patients do not have sufficient knowledge about the MADL limitations, there is a lack of knowledge about radiation levels that are received by patients during diagnostic radiological examinations, and there is also a lack of using the personal protective clothes, tools and dosimeter. These attitudes and behaviors lead to risks in terms of both patients and radiology professionals. In order to prevent these risks, recommendations can be seen below:

Radiology professionals have lack of knowledge about the radiation levels received by patients during radiological examinations. Particularly radiology doctors should be informed about this issue since they are the authorities in hospitals. Furthermore, courses in the medical faculties and training programs provided in radiology assistant period should be evaluated and lectures related to radiology safety should be more included. Since there is a radiation risk in some parts of the hospital (such as radiology unit, sterilization unit, operation rooms, etc.), all health professionals should be educated in this regard and mandatory or elective radiation safety courses should be included in programs. In this way, this issue can be solved in the long-run.

In this study, 83.7% of the radiology professionals did not know the MADL limits for radiology staff and 90.6% of them did not know about the MADL limits for other individuals. Additionally, it was observed that radiology professionals did not use the dosimeter since they did not rely on its results. When it is considered that majority of radiology professionals use non-sensitive film dosimeters, it is acceptable that these dosimeters do not measure the cumulative dose of radiation. It is recommended that thermoluminescence dosimeters should be used instead of film dosimeters since they can also measure the doses below 40µ sievert (µSv). Besides, trainings and descriptive events in which annual MADL limits are explained will ensure the awareness of radiology professionals regarding the benefits of the appropriate dosimeter use.

The determined annual MADL limit is 5µSv for individuals who occupation is not related to ionizing radiation. There are various medical examination techniques which contains ionizing radiation levels above this dose. Furthermore, it is possible to exceed this 5µSv dose upon some radiological technique. In some countries, there are cancer cases due to radiological techniques. However, such study has not yet been performed in Turkey. The radiation levels received by radiation professionals are followed by dosimeter whereas the doses received by patients are not measured and followed. In order to prevent the radiation doses received by patients to reach the risk levels, there should be a system which can record the annual total radiation doses due to radiological examinations. In this way, it can be ensured that both the patient and the doctor can follow the cumulative doses.

In our study, it was observed that majority of radiation professionals were not sufficiently using protective clothes and tools for both themselves and for patients. Since majority of the radiological examinations are performed by technicians, particularly protective clothes and tools should be well defined to radiology technicians and in-service trainings should be given to them in order to eliminate shortcomings in this regard.

Majority of nurses and assistant technicians working in radiology units (36%) stated that they did not have additional holidays. Nurses, technicians and doctors particularly in the interventional radiology unit should use additional vacations since they are directly exposed to radiation. Some of the radiology technicians stated that they did not use the additional holidays due to the discontinuation of their additional payments. Therefore, all radiation professionals should be encouraged to use their additional holidays and there should be required regulations in order them to receive the additional payments when they are on vacation. Otherwise, the cumulative radiation dose received by radiation professionals will be more severe since they are exposed to radiation in their entire life.

Bibliography

Arslanoglu, A., Bilgin, S., Kubali, Z., Ceyhan, M. N., İlhan, M. N., & Maral, I. (2007). Doctor's and intern doctors' knowledge about patients' ionizing radiation exposure doses during common radiological examinations. *Diagnostic and Interventional Radiolo*gy, 13(2), 53.

Atakan, Y. (2006). İyonlayıcı Radyasyon, *Bilim ve Teknik Dergisi* ek: 1.

Smith-Bindman, R., Lipson, J., Marcus, R., Kim, K. P., Mahesh, M., Gould, R., ... & Miglioretti, D. L. (2009). Radiation dose associated with common computed tomography examinations and the associated lifetime attributable risk of cancer. *Archives of internal medicine*, 169(22), 2078-2086.

Bosanquet, D.C., Greenb, G., Bosanquet, A.J., Gallandb, R.B., Thomas, K.G., Lewis, M.H. (2011). Doctors' knowledge of radiation d a two-centre study and historical comparison. *Clinical Radiology* 66 (2011) 748e751.

Coşkun, M. (2003). Biyolojik Dozimetri ve İlgili Gelişmeler*, Cerrahpaşa Tıp Dergisi*, Cilt 34, No. 4, Sayfa 207–208.

Coşkun, Ö. (2011) İyonize Radyasyonun Biyolojik Etkileri, *Süleyman Demirel Üniversitesi Teknik Bilimler Dergisi*, 1 (2) 13-17.

Dadulescu, E., Sorop, I., Mossang, D., Pera, C., Patru, E., Bondari, D., & Prejbeanu, I. (2009). Benefit vs. risks in children's exposure to radiation for medical diagnosis purposes. *Revista Romana de Bioetica*, 7(1).

European Commission. Radiation Protection 118 Update Mars 2008 (2007). Referral Guidelines For Images. Final Report to the European Commission for Grant 96 Agreement SUBV99/134996; Luxembourg.

Gazi, Ş. (2010). Radyolojide Hasta ve Çalışan Güvenliği, Sağlık Hizmetlerinde Kalite, *Akreditasyon ve Hasta Güvenliği Dergisi*, Cilt 1, No. 5, sayfa 72–75.

Günalp. M., Gülünay. B., Polat, O., Demirkan, A., Gürler, S., Akkas¸ M., Aksu, N.M. (2014) Ionising radiation awareness among resident doctors, interns, and radiographers in a university hospital emergency department. *La radiologia Medica Journal*. Volume 119 Issue 6, pp 440-447.

Gürsu, S., Gürsu,T., Çamurcu, Y. Yıldırım, Y., Gürsu,A., Şahin,V. (2013) Pediatrik Pelvis Röntgenlerinde Gonad Koruyucu Kullanımının Etkinliği, *Eklem Hastalıkları ve Cerrahisi Dergisi*, 2013;24(2):87-90.

http://www.taek.gov.tr/ogrenci/bolum4_04.html erişim tarihi 17-04-2014.

http://www.who.int/ionizing_radiation/about/med_exposure/en/ erişim tarihi:27-04-2014.

Jacob K, Vivian G, Steel JR. (2004) X-ray dose training: are we exposed to enough? *Clinical Radiology*. 59:928–934.

Kaya, T. Adapınar B., Özkan, R. (1997). *Temel Radyoloji Tekniği*. İstanbul: Nobel Yayın Dağıtım.

Kim, K.Y., Cho. J.H., Lee, H.K.. (2014) Analysis of dose measurement other than the radiation protection during the radiographic examination. *Springerplus*. 2014; 3:250.

Koçyiğit, A., Kaya, F., Çetin, T., Kurban, I., Erbaş,T., Ergin, A., Ağladıoğlu, K., Herek, D., Karabulut. (2014) Radyolojik Tetkikler Sırasında Maruz Kalınan Radyasyon Hakkında Sağlık Personelinin Bilgi Düzeyleri. *Pamukkale Tıp Dergisi*, 2014;7(2):137-142.

Koukorava, C., Farah, J., Struelens, L., Clairand, I., Donadille, L., Vanhavere, F., Dimitriou, P. (2014). Efficiency of radiation protection equipment in interventional radiology: a systematic Monte Carlo study of eye lens and whole body doses. *Journal of Radiologıcal Protectin* 34 (3): 509-528.

Radyasyon Güvenliği Yönetmeliği. (2000). Resmi Gazete Tarihi: 24.3.2000, Resmi Gazete Sayısı: 23999.

Sağlık Hizmetlerinde İyonlaştırıcı Radyasyon Kaynakları ile Çalışan Personelin Radyasyon Doz Limitleri ve Çalışma Esasları Hakkında Yönetmelik. (2012). Resmi gazete tarihi:05.07.2012, Resmi gazete sayısı: 28344.

Saygın,M., Yaşar, S., Çetinkaya, M., Kayan, M., Özgüner, M.F., Korucu, C.Ç. (2011). Radyoloji Çalışanlarında Depresyon ve Anksiyete Düzeyleri, S.D.Ü. *Sağlık Bilimleri Enstitüsü Dergisi*, 2,3(1).

Shiralkar, Rennie, Snow, (2003). Doctors' knowledge of radiation exposure: questionnaire study. *BMJ*, Vol. 327, No. 3, August, pp. 371–372.

Sodickson A, Baeyens PF, Andriole KP, Prevedello LM, Nawfel RD, Hanson R, Khorasani. R. (2009) Recurrent CT, cumulative radiation exposure, and associated radiation-induced cancer risks from CT of adults, *Radiological Society of North America*, Volume:251 ıssue:1.

T.C Sağlık Bakanlığı Sağlık İstatistikleri Yıllığı 2012. (2013). Sağlık Bakanlığı, Ankara.

Theocharopoulos, N., Perisinakis, K., Damilakis, J., Papadokostakis, G., Hadjipavlo A., (2003) Gourtsoyiannis, NOccupational Exposure from Common Fluoroscopic Projections Used in Orthopaedic Surgery. *J Bone Joint Surg Am*, 2003 Sep; 85 (9):1698-1703.

Tse, V., Lising, J., Khadra, M., Chiam, Q., Nugent, R., Yeaman, L., & Mulcahy, M. (1999). Radiation exposure during fluoroscopy: should we be protecting our thyroids? *Australian and New Zealand Journal of Surgery*, 69(12), 847-848.

Türkiye Atom Enerjisi Kurumu. (2009*). Radyasyon, İnsan ve Çevre*, T.A.E.K, Ankara.

Tuncel, E.. (2011) *Klinik Radyoloji*, Nobel Kitabevi, İstanbul.

Yaren, H., Karayılanoğlu, T. Radyasyon (2005) ve İnsan Sağlığı Üzerine Etkileri, *TSK Koruyucu Hekimlik Bülteni*, 4.(4). 200.

Zhou, G.Z., Wong, D.D., Nguyen. L.K., Mendelson, RM.. (2010). Student and intern awareness of ionising radiation exposure from common diagnostic imaging procedures. *Journal of Medical Imaging and Radiation Oncology*, 54 (2010) 17–23.

www.taek.gov.tr/bilgi/bilg erişim tarihi 17-04-2014.

http://www.taek.gov.tr/radyasyon-guvenligi-sss/681-radyoloji-unitelerinde-koruyucu-giysi-kullanilmasi-zorunlu-mudur.html Erişim tarihi:13.07.2014.