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OCCUPATIONAL EXPOSURE OF APPRENTICES IN RADIOLOGY IN THE FIELD OF PROFESSIONAL TRAINING

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ABSTRACT

The good economic moment of our country has been providing an increase of courses in technical and technological area mainly in the field of radiology, which has raised the number of apprentices in the field of stage in clinics and hospitals. However, the shortage of placements and the fact that many of these students are workers, has forced the institutions of technical education to seek alternatives for the students to meet the workload of the stage in a time as short as possible. For this reason, often the students are obliged to comply with up to 10 hours of internship in a single day, in companies that often are not in accordance with the standards of radiological protection. What has worried the authorities of Goiânia, because they believe that this exposure can raise the dose received. It is known that every person who works with x-ray diagnostics should use, during their work day and while stay in controlled area, individual dosimeter reading indirect, changed monthly. However, in practice these apprentices do not use the meter for monitoring of doses in probationary period. In This way, we measure the doses received us trainees using monitors TLDs in the thoracic region with and without plumbiferous apron on stage with total workload of 150 hours, performed daily from Monday to Friday for 6 hours per day during 5 weeks and performed to Saturday and Sunday for 10 hours daily in 7.5 weekends, with X-ray equipment conventional. The results reveal that in none of the cases the dose reached the value of 0.2 mSv, which is the minimum limit of reading dosimeter. We conclude then that the stages of weekends, taken the preventive measures of radiological protection are safe and can be performed without any prejudice with regard to the dose received, when compared to those of lower daily hourly load.

1. INTRODUCTION

The good economic moment of Brazil has been providing an increase of courses in technical and technological area mainly in the field of health. Technical Courses in nursing and radiology are among the most sought after, in addition, the radiology technician is considered one of the seven professions of the future [1]. The who has raised the number of apprentices in the field of stage in clinics and hospitals. The field of stage is the teaching-learning context that most closely approximates the effective professional exercise and characterizes a privileged status of integration and consolidation of professional skills. A student of the technical course in radiology can perform depending on the educational

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institution until 500 hours of internship supervised professional. The stage should be carried out in specialized environment of health, which provides radiology services, such as clinics, services of diagnostic imaging and hospitals that offer the necessary conditions for the fulfilment of their educational function and will be accompanied by a teacher, who is responsible for evaluation of the student. However, the shortage of placements that meet the above requirements and the fact that many of these students are workers, has forced the institutions of technical education to seek alternatives for the students to meet the workload of the stage in a time as short as possible. For this reason, often the students are obliged to comply with up to 10 hours of internship in a single day, in companies that often are not in accordance with the standards of radiological protection. The lack of appropriateness of the radioprotection service can lead to unnecessary exposure of professionals and patients and caretakers. The system of radiological protection should commit itself to maintain exposures below the thresholds recommended, thus limiting the stochastic effects, since the biological effects produced by radiation are cumulative. Therefore it is essential the use of personal protective equipment (Ppe) and individual dosimeter for monitoring doses [2].

For the purposes of the application of regulatory standards, it is considered EPI, every device or product, for individual use used by the worker, intended for risk protection susceptible to threaten the safety and health at work. All EPI, fabrication national or imported, can only be put up for sale or used with the indication of the Certificate of Approval (CA), consigned by competent national body in matters of safety and health at work of the Ministry of Labor and Employment (MTE) which is responsible for monitoring the quality of the equipment. They should be available for free and in good conditions of use in radiodiagnostic services, and the health team professionals must be able to use and retain appropriately such equipment [3].

The EPIs should be used in the following cases in protection of professionals involved in radiological procedures:

1) The professional who is with any part of the body exposed to the primary beam, must use bulkhead with at least 0.5 mm lead equivalent;

2) The professional and the companion to protect yourself from scattered radiation should make use of bulkhead with at least 0.25 mm lead equivalent [4].

The secondary or scattered radiation is the main source of irradiation of professionals. Lead Aprons with 0.5 mm of thickness can intercept up to 98% of the secondary radiation and with 0.25 mm holds up to 96 %, thereby protecting the gonads and approximately 80% of active bone marrow. Thyroid protectors may reduce gland exposure in up to 10 times. Lead surgical gloves, have an attenuation factor against the radiation that varies from 5 to 20 %, depending on the [5]. In addition to the equipment listed above, all fluoroscopy equipment should have lead curtain or drape, inferior and lateral, as well as screens or shields mobile lead, with a thickness not less than 0.5 mm lead equivalent to protect the operator against the radiation scattered by the patient [2,4,5,6,7].

The lead clothing at any time must be folded and when they are not in use should be kept in horizontal surface or on an appropriate support, since folding, the coating of lead can fracture and violate the radioprotection system [2,4]. Rarely a failure of protection of lead clothing can be detected visually, and that the same shall pass by fluoroscopy annually to verify their integrity. When not using the lead IPE during vascular catheterization, the professional increases exposure dose by a factor equal to or greater than 10 [5]. AND the effective dose received by the thyroid gland of doctors, also increases by the same factor for the case of those who are working without protection of lead [8].

Thus, we can observe the importance of using EPIs in radiological procedures, however, the dosimetry in occupational exposure is fundamental, to verify whether the dose received is within acceptable limits by international standards for radiological protection. The

measures of doses are made through the use of dosimeters these devices has as main objective monitor if the exposures, which the workers are subjected, are being kept low, in addition to ensure that the dose constraints are not exceeded [4,9]. There are several types of dosimeters inviduais, however, the most frequently used are the thermoluminescent (TLDs) which are composed of crystals that accumulate energy when irradiated and emit in the form of light when subjected to a thermal heating rate, this property is called thermoluminescence. The emission of light of the crystals is represented by a curve that relates light emitted as a function of heating temperature and this relationship determines the dose that focused previously on the detector. This way, you can determine the dose received by the professional and check if the limit was exceeded. The dose limits for occupational exposure of workers and apprentices are described in basic guidelines for radiological protection in diagnostic radiology medical and dental care, which offers about the use of X-ray diagnostics in the entire national territory [4]. The annual dose limits for occupational exposure of workers and apprentices are presented in table 1, in units of millisieverts (mSv) and rem sleep.
Table 1- Annual dose Limits for occupational exposure of workers and apprentices.

Professional	Workers		Young apprentice	
Units of measures	mSv	Rem	mSv	Rem
Annual effective dose	50	5	6	0,6
Equivalent dose for the lens	150	15	15	1,5
Equivalent dose to the ends	500	50	50	5

The monitoring of doses in occupational exposure is made through the use of an individual dosimeter reading and indirect control of areas of service says that:
1) Every person who works with x-ray diagnostics should use, during their work day and while stay in controlled area, individual dosimeter reading indirect, changed monthly.
2) The compulsory use of individual dosimeter may be waived, at the discretion of the local health authority and upon normative act, for dental services with equipment periapical and maximum workload less than 4 mA min/week.
3) The individual dosimeters intended to estimate the effective dose should be used in the region more exposed tronk.
4) During the use of plumbiferous apron dosimeter, the individual should be placed on the bulkhead, applying a correction factor of 1/10 to estimate the effective dose. In cases in which the ends may be subject to significantly higher doses, you should make additional use of extremity dosimeter.
5) The individual dosimeter is for exclusive use of the user of the dosemeter in service to which he was appointed.
6) During the absence of the user, the individual dosimeters should be kept in a secure location, with mild temperatures, low humidity and away from sources of ionizing radiation, beside the standard dosimeter, under the supervision of the SPR.
7) If there is suspicion of accidental exposure, the individual dosimeter should be sent for reading in an emergency situation.

It is the responsibility of the owners of the radioprotection service through the measurements of doses made by individual dosimeter[4]:
8) Arrange the investigation of cases of effective doses per month higher than 1.5 mSv. The results of the research must be seated.
8.1)Communicate to local health authority monthly results above 3/10 of the annual limit, along with a report of the steps that were taken.

8.2) When the monthly values reported for effective dose is greater than 100 mSv, must arrange a special investigation and, where there is a probable exposure to the user of the dosemeter, must submit the user to an assessment of cytogenetic dosimetry.

In Brazil the values of monthly doses lower than 0.2 mSv are not considered for logging level [4,10]. The logging level was defined as being the value from which must be carried out the numerical recording of the measured value of the greatness of interest. Lower Values for it are of little importance for radiological protection, being considered as zero [11].

Recent Research has shown that the majority of professionals who work with radiology in the city of Goiania demonstrate does not have the knowledge of occupational doses of control. That could be related to the fact that many companies do not have an interest in the disclosure of such information, because they believe encumber the expenses related with protective equipment, training courses and specialized human resources to supervise the service [12]. In another study it was found that almost 76 percent of the professionals in radiology at the city of Goiania, never participated in annual training, confirming failures in training programs for professionals in the field of radiological protection [13]. Other studies emphasize the importance of evaluating the services under the criteria of the guidelines for radiological protection [14], as well as there is a need to maintain a permanent education with the professionals who are exposed to ionizing radiation [15], since a greater knowledge and obedience to the rules of radiological protection would increase the protection of the patient and professional [16]. We observed that there are several relevant studies with respect to the protection and the exposure of workers to ionizing radiation. The determination of the doses received by professionals is of utmost importance for assessing the safety of services and if the scheme of work is not exposing the professionals to excessive doses of radiation, so we feel relevant monitor exposures received by apprentices in radiology in stages performed daily and on weekends, with and without plumbiferous apron. And in this way compare these doses with the annual ceilings allowable and thus check whether the doses received may transcend the limits laid down in the guidelines for radiological protection.

2. MATERIALS AND METHODS

To measure the doses of apprentices in the field of professional traineeship we acquired dosimeters (TLDs). The TLDs were used by students during any probationary period, in the region of the chest on the plumbiferous apron of 0.25 mm thickness of lead and without plumbiferous apron. In the case of apprentices who used dosimeter on the plumbiferous apron reading dose was multiplied by a factor 1/10 [4]. However, for the ends where there was no protection placement the dose considered was that received by dosimeter. Already in the case where there was no use of plumbiferous apron, apprentices if protected if positioning behind the smokescreen of lead. During the absence of the user, the gauges were kept in a safe place, with mild temperatures, low humidity and away from sources of ionizing radiation, beside the standard dosimeter [4]. For the research was necessary that there should be a division of the students participating in two groups. The first group was that in which the internship happened by traditional mode performed daily from Monday to Friday, with hourly load daily for 6 h and total workload of 150 h, during 35 consecutive days, excluding Saturdays and Sundays. Already the second group, the stages were performed only weekends, that is, Saturdays and Sundays with 10 hours a day and the same total workload in 7.5 weekends, with X-ray equipment conventional. The measurements were carried out at an interval of 2 years with the students of an institution of technical education of Goiania and all the trainees of this institution that passed by the field of stage in center of radiodiagnosticos Prefecture of Goiania in this period have been monitored totaling 137 interns.

3. RESULTS

Now we will present the values of doses received by apprentices in the field of professional training, to the situation where the same if exposed to radiation with and without the use of plumbiferous apron on stage for 6 hours a day and 10 hours a day. The monitoring was performed with 137 interns, during two years and the results are presented in table 2.

Table 2 - occupational Exposure of apprentices in radiology in the field of professional training.

Type of stage	Number of participants	Dose in 150 hours
Stage - 6 hours daily without apron	50	0
Stage - 10 hours a day without apron	45	0
Stage - 6 hours daily with apron	20	0
Stage - 10 hours daily with apron	22	0

As we can observe was not detected any dose greater than or equal to 0.2 mSv, in exposure of apprentices, however, this is not to say that the professionals are not exposed. Within the limit of minimum reading of the dosemeter individually, we can say that the maximum dose that each dosimeter received was approximately 0.2 mSv. And whereas the load of internship in radiology can reach 500 h and that this entire stage can be done in 1 year, we can thus estimate the dose received by these apprentices in this range. The Table 3, brings an estimate of the maximum dose received (Dr) in the exposure of the whole body, extremities and crystalline of trainees over 18 years ago, a stage with duration of 500 h, furthermore, shows the percentage of dose that would be achieved, when compared with the maximum permissible exposure annual of a worker(Dp).

Table 3 - Comparison between maximum doses received by apprentices in 500 h of internship (Dr) and the maximum annual allowable doses (Dp), when they expose to radiation using plumbiferous apron.

Trainees over 18 years	Whole Body	Ends	Crystalline
Dr (mSv)	0,6	6,6	6,6
Dp (mSv)	50	500	150
Dr/Dp (%)	1,3	1,3	4,4

Table 4, makes a comparison of maximum doses received by apprentices in a stage with duration of 500 h (Dr) and the maximum annual allowable doses (Dp), showing the percentage of the maximum dose that would be achieved if the young apprentice would be exposed during 1 year in 500 hours of internship.

Table 4 - Comparison between maximum doses received by apprentices (Dr) and the maximum annual allowable doses (Dp), when they expose to radiation using plumbiferous apron.

Trainees minors of 18 years	Whole Body	Ends	Crystalline

Dr (mSv)	0,66	6,6	6,6
Dp (mSv)	6	50	15
Dr/Dp (%)	11	13,2	44

4. DISCUSSION

In Brazil the values of monthly doses lower than 0.2 mSv are not considered for logging level [4,10]. The results presented here show that in none of the cases the dose reached the value of 0.2 mSv, which is the minimum threshold for reading the dosemeter. Same in cases in which the professional if exposed to radiation and made use of plumbiferous apron of 0.25 mm thickness. However, the doses at the ends were not monitored, since they were not subject to high doses significantly [4], but we can deduce that the maximum dose received by them did not reach the 2 mSv, for the case of trainees who used dosimeter on the plumbiferous apron, which would generate a maximum dose of 6.6 mSv, whereas the hourly load stage would be equal to 500 h. These values are well below the maximum permissible doses for the exposure of the whole body, extremities and the crystalline of workers, as can be seen in table 3. However, in the case of apprentices in the field of stage, using plumbiferous apron, a dose of 6.6 mSv is 44% of the maximum dose that they may receive in the lens, which could generate some concern with regard to the exposure of these professionals in training.

5. CONCLUSION

We conclude then that the stages of weekends, taken the preventive measures of radiological protection are safe and can be performed without any prejudice with regard to the dose received, for those apprentices with age greater than 18 years, when compared to those of lower daily hourly load. Already for the minors apprentices, the use of individual dosimeter for monitoring their doses in the field of stage, when the same if exposed to radiation using the plumbiferous apron as protection is relevant, since, when we compare the maximum dose that they would receive in 500 h of internship with the maximum permissible limits for the lens, we see that the dose received by them could reach up to 44 % of the maximum dose, without which the dosimeters had detected any exposure.

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