

EXPOSURE OF NURSING STAFF TO RADIATION IN THE OPERATING ROOM: A DESCRIPTIVE STUDY

Exposição da equipe de Enfermagem à radiação em centro cirúrgico: um estudo descritivo

La exposición del personal de Enfermería a la radiación en la sala de operaciones: un estudio descriptivo

Fábíola Monteiro Querido¹, Vanessa de Brito Poveda²

ABSTRACT: Objective: To determine radiation exposure of the nursing staff in the Surgical Centers of seven hospitals in six countryside cities of São Paulo State, Brazil. **Method:** We conducted a quantitative and descriptive study through interviews with nurses working for over a year in operating rooms of seven units belonging to six cities. **Results:** Thirty employees were interviewed, all of whom were women; 8 (26.7%) were older than 40 years, 25 (83.3%) were nursing technicians, and 14 (46.7%) had been working in the Surgical Center from 1 to 5 years. Of these, 28 (93.3%) reported contact with radiation and only 11 (39.3%) used some type of protection, only 2 (7.1%) were using a dosimeter, and 25 (89.3%) did not have different salaries because of dangerousness degree of their activities. **Conclusion:** The radiological protection standards are not strictly enforced by the institutions included in the study. **KEYWORDS:** Nursing. Operating room nursing. Occupational health nursing. Occupational health. Radiation, nonionizing.

RESUMO: Objetivo: Verificar a exposição à radiação da equipe de Enfermagem nos Centros Cirúrgicos de sete hospitais de seis cidades do interior do Estado de São Paulo. **Método:** Realizou-se um estudo quantitativo e descritivo, por meio de entrevista dos profissionais de Enfermagem, atuantes há mais de um ano em sete unidades dos Centros Cirúrgicos pertencentes a seis cidades diferentes. **Resultados:** Foram entrevistados 30 funcionários, sendo que todos pertenciam ao sexo feminino, oito (26,7%) tinham mais de 40 anos, 25 (83,3%) eram técnicos de Enfermagem e 14 (46,7%) atuavam em Centro Cirúrgico entre um e cinco anos. Destes, 28 (93,3%) relataram contato com radiação e apenas 11 (39,3%) utilizavam algum tipo de proteção; apenas dois (7,1%) faziam uso do dosímetro e 25 (89,3%) não possuíam remuneração diferenciada devido ao grau de periculosidade de suas atividades. **Conclusão:** As normas de proteção radiológica não são rigorosamente cumpridas pelas instituições incluídas neste estudo.

PALAVRAS-CHAVE: Enfermagem. Enfermagem de centro cirúrgico. Enfermagem do trabalho. Saúde do trabalhador. Radiação não ionizante.

RESUMEN: Objetivo: Determinar la exposición a la radiación del personal de Enfermería de quirófano en siete hospitales en seis ciudades del interior del estado de San Pablo, en Brasil. **Método:** Estudio cuantitativo y descriptivo, a través de entrevistas a enfermeras que trabajan durante más de un año en el quirófano en siete unidades pertenecientes a seis ciudades diferentes. **Resultados:** Se entrevistaron a 30 empleados, todos los cuales eran mujeres, ocho (26,7%) tenían más de 40 años, 25 (83,3%) eran técnicas de Enfermería y 14 (46,7%) trabajaban en el Centro de Cirugía entre uno y cinco años. De ellos, 28 (93,3%) informaron contacto con la radiación y sólo 11 (39,3%) utilizaban algún tipo de protección, sólo dos (7,1%) estaban usando un dosímetro y 25 (89,3%) no tenían salarios diferentes por el grado de peligrosidad de sus actividades. **Conclusión:** Las normas de protección radiológica no son estrictamente cumplidas por las instituciones incluidas en el estudio.

PALABRAS CLAVE: Enfermería. Enfermería de quirófano. Enfermería del trabajo. Salud laboral. Radiación no ionizante.

¹Nursing Student at Faculdades Integradas Teresa D'Ávila. E-mail: biola_querido@hotmail.com

²Nurse; Professor at the Nursing School of Universidade de São Paulo (USP). E-mail: vbpoveda@usp.br

Avenida Doutor Enéas de Carvalho Aguiar, 419, Sala 358, Cerqueira César, CEP: 05403-000, São Paulo, SP, Brasil, Telephone: (11) 3061-8837.

Received: 28 Oct. 2014 – Approved: 17 Nov. 2014

DOI: 10.5327/Z1414-4425201500010002

INTRODUCTION

Many hospital units, especially the Surgical Center (SC), contain equipment that emits radiation and exposes employees, especially the medical and nursing teams, to its associated risks.

The ionizing radiation is the one that comes from this type of equipment, defined as an electromagnetic particle that, after getting in touch with matter, removes electrons from the atoms and molecules, changing them into ions. On the basis of this definition, some examples of ionizing radiation are alpha, beta, and gamma particles, emitted by sources of radiation such as X-ray devices¹.

In SC units, C-arm and X-ray devices use this harmful radiation, which are necessary for neurosurgeries, orthopedic interventions, and vascular and heart surgeries.

In comparison to the United States, Brazil still lacks investigations on the effects of radiation and radiological protection.

However, the Ministry of Health officially acknowledges that many diseases can be related to the ionizing radiation exposure, such as malignant tumors of the nasal cavity, bronchi, lungs, and skin; thyroid cancer; bone sarcoma; leukemia; myelodysplastic syndrome; bone marrow hypoplasia; purpura and other hemorrhagic manifestations; agranulocytosis; radiation-induced polyneuropathy; gastroenteritis; male infertility; and other acute effects of radiation².

When a person is exposed to high doses of radiation, most of the cells are affected, thus preventing the maintenance of life. However, the effects of exposure to low doses of radiation are still not clear because they can be masked by the genetic predisposition to some diseases, as is the case of cancer³.

Besides the dose of radiation the body is exposed to, the effects of ionizing radiation depend on the rate of absorption, the characteristics of exposure (either acute or chronic), and the type of affected tissue. Therefore, the consequences are not considered so severe if the received dose is fractioned in small amounts for a long period, thus giving the affected cells a chance to regenerate between one dose and the next³.

However, aiming at radiological protection, it is best to consider that any radioactive dose received, regardless of being low or high, is directly related to the occurrence of damage to health³.

Therefore, the radiation doses received by a person are evaluated with a dosimeter, which is an individual monitor able to measure the effective dose of radiation received by the subject while staying in risk areas, or during work hours, thus enabling us to assess if the values of exposure are within the limits established by law to preserve the health of the employee¹.

Respecting the limits of received radiation doses is an important matter in radiological protection programs. However, according to the International Commission on Radiological Protection (ICRP), these levels are often not followed in the health field, both for employees and for patients⁴.

According to the ICRP, the limit for the occupational radiation dose is up to 20 millisievert (mSv) a year. The National Council on Radiation Protection and Measurements (NCRP), which provides the limits of occupational doses for specific organs or tissues, establishes that the annual dose of received ionizing radiation is up to 50 mSv⁵.

Therefore, before a member of the team begins performing activities that involve being exposed to ionizing radiation, it is important to elaborate a specific radioprotection plan, one that contains the characteristics, the methods of storage and transportation of the radioactive source, the calculation memory of location and the relationship of the accessories and instruments, and the plan of action to be used in emergency situations⁶.

It is also worth mentioning that, while the employee is exposed to radiation, not only the individual dose of received ionizing radiation must be monitored, but also the surrounding areas when the emitter source is activated. The activity must be immediately interrupted and the source must be removed in case exposure is superior to the limit established by the National Commission for Nuclear Energy (CNEN)⁶.

The use of ionizing radiation in the hospital environment symbolizes major progress in the health field. However, it has to be used properly, under completely safe conditions, to ensure full protection to health professionals, the public, and the environment against the harmful effects of radiation. However, studies that evaluate the characteristics associated with the exposure to ionizing radiation among health professionals, especially nursing professionals, are still scarce in the national literature. Therefore, it is necessary to know this reality.

OBJECTIVES

The objectives of this study were:

- to verify the exposure to radiation among nursing staff working in SC units of seven hospitals, coming from six countryside cities in the state of São Paulo;
- to define the profile of the SC worker exposed to radiation, in seven hospitals from six countryside cities in São Paulo;
- to describe the time of daily/annual exposure to radiation to which the nursing staff working in SC units of hospitals in the countryside of São Paulo is exposed; and
- to verify the existence of payment connected to the level of dangerousness involved in the working activities of employees from the nursing staff working in SC units in hospitals in the countryside of São Paulo.

METHOD

A quantitative study, with nonexperimental, prospective, and descriptive design was conducted in seven hospitals located in six countryside cities of the state of São Paulo, which had SC units and used radiation-emitting devices.

The participants of the study signed the informed consent form, after the researcher provided them with information regarding the objectives of the study, clarifying that they could give up at any time and that they would not be submitted to any type of risk or damage.

The nonprobability convenience sample was chosen and included all nursing employees (nurses, technicians, and nursing auxiliaries) who accepted to take part in the investigation by signing the informed consent and who had been exposed to radiation in their work activities, working in an SC for at least a year.

Data were collected by the researchers through interviews conducted from February to March, 2013, using one data collection instrument that included information on professional category and sociodemographic characteristics, time of work in the SC area, use of radioprotection equipment, frequency of exposure to radiation, and receiving wage benefits for insalubrity.

The instrument for data collection was submitted to apparent and content validation by professionals in the

health field, experienced in SC and occupational health. The judges evaluated the instrument as to its ability to achieve the objectives proposed in the research. The evaluators suggested minor changes, which were accepted.

The data collected were descriptively analyzed, and there was also a mathematical-statistical analysis using absolute numbers, mean, and percentage.

The study met national guidelines established in resolution 466/2012, from the National Health Council⁷, and international principle of human research ethics, being approved under number CAAE 12324813.7.0000.5503.

RESULTS

The research counted on the collaboration of 30 professionals in the nursing staff, working in SC units from seven hospitals, located in six countryside cities in the state of São Paulo. Therefore, 33% nursing professionals working in the included SC units agreed to participate in the investigation.

All individuals were women, and 8 (26.7%) subjects were older than 40 years. Most participants (25 or 83.3%) were nursing technicians, and 14 (46.7%) had worked in an SC for 1–5 years (Table 1).

Almost all of the interviewed employees reported having contact with radiation-emitting equipment, such as X-ray devices and C-arms (28 or 93.3%); 26 (86.7%) subjects declared that the walls in the operating room (OR) were not coated with radioprotection material (Table 2).

Among the 28 employees who reported having contact with radiation, only 11 (36.7%) mentioned the use of radioprotection equipment, wearing the thyroid protection collar, and the lead apron in 7 (23.3%) cases. As to weekly contact with radiation, the answers varied because they were presented according to the surgery shift of the services in which the employees were working (Table 3).

The regular use of the dosimeter was mentioned by only 2 (7.1%) of the individuals, and only 3 (10.7%) reported earning differentiated wages due to the frequent contact with radiation (Table 3).

Only 1 (3.6%) interviewee mentioned health problems caused by the excessive exposure to ionizing radiation, referring “back pain” as a factor associated to that condition. However, only 7 (25.0%) professionals who

reported having contact with radiation undergo routine examinations (Table 3).

Finally, participants who claimed to be exposed to radiation were asked about a shift, which maintained fixed employees

to work in surgeries that use radioactive devices; 6 (21.4%) employees worked on a differentiated shift from Monday to Friday, and only 4 (14.3%) mentioned the shift was also established on weekends (Table 3).

Table 1. Distribution of the sociodemographic variables of the investigated subjects

Variables	n	%
Sex		
Male	–	–
Female	30	100.0
Age (years)		
22–25	6	20.0
26–30	5	16.7
31–35	7	23.3
36–40	4	13.3
Older than 40	8	26.7
Professional category		
Nursing auxiliary	2	6.7
Nursing technician	25	83.3
Nurse	3	10.0
Time of work (years)		
Less than 1	3	10.0
1–5	14	46.6
6–10	6	20.0
11–15	2	6.7
16–20	1	3.3
More than 20	4	13.3

Table 2. Distribution of interviewees according to type of exposure to radiation

Variables	n	%
Use of X-rays and/or C-arm		
Yes	28	93.3
No	2	6.7
Wall of the operating room coated with radioprotection material		
Yes	2	6.7
No	26	86.7
I don't know	2	6.7

Table 3. Distribution of the variables associated with the occupational exposure to radiation

Variables	n	%
Use of protection		
Yes	11	39.3
No	17	60.7
Type of protection		
Only apron	2	18.2
Apron and collar	7	64.6
Apron, collar, and glasses	2	18.2
Frequency of contact with radiation		
Variable	8	28.6
Once a week	6	21.4
Twice a week	3	10.7
Three times a week	6	21.4
Four times a week	4	14.3
Five times a week	1	3.6
Use of the dosimeter		
Yes	2	7.1
No	26	92.9
Differentiated payment (insalubrity)		
Yes	3	10.7
No	25	89.3
Periodical exams		
Yes	7	25.0
No	21	75.0
Health problem related to working in a surgical center		
Yes	1	3.6
No	27	96.4
Differentiated shift to “take turns” in surgeries using radiation during the week		
Yes	6	21.4
No	22	78.6
Differentiated shift to “take turns” in surgeries using radiation during the weekends		
Yes	4	14.3
No	24	85.7

DISCUSSION

This study comprised nursing professionals working in seven SC units, in six countryside cities in the state of São Paulo. Despite the limitations regarding the number of included subjects, it is worth to mention that these professionals represented, in average, 33% of the nurses working in the SC units included in this investigation, considering the total-ity of health institutions available in the analyzed region.

The results of this study pointed out to the nonuse of protection devices by most of the participants, as well as the lack of differentiated payment for insalubrity, which shows the lack of awareness of these professionals in relation to their occupational rights and risk to health caused by excessive exposure. Another important aspect is that most members in the nursing team included in this investigation have been working in SC units for 1–5 years; therefore, it is possible to consider that, if there was exposure, as mentioned by the interviewees, this is a recent period and may not yet have caused damaging effects to their health.

However, it is worth to emphasize that, during interviews, only one employee mentioned presenting a health problem caused by exposure to radiation, referring “back pain.” This aspect leads us to the following reflection: the probable unawareness regarding the damages to health caused by exposure to radiation, as well as its more frequent signs and symptoms, which shows the lack of preparation, associated with the poor education for work, because not only this employee but most interviewees refer as to the nonuse of protection, such as the apron and the thyroid protection collar.

However, this aspect also reinforces another occupational risk to which nursing workers are exposed, that is, the development of osteomuscular conditions resulting from the characteristics of the work activity, such as the manipulation of heavy weight by a team that is predominantly composed of female members; then, back pain stands out often in this population⁸.

Brazil has guidelines for radiological protection that defend the health professional against ionizing radiation exposure. Among them, Ordinance no. 453/98 established basic guidelines for radiological protection⁹, and the CNEN, by NN 3.01/11, defines them for those who are exposed to ionizing radiation¹⁰.

In this sense, the Ministry of Labor and Employment, by Regulation 32 (NR 32), which approaches matters of safety and health in Health Services, refers to situations of exposure to physical agents, such as ionizing radiation in the workplace¹¹.

Even though the law exists, the results in this study show that employees are unaware of the risks to which they are submitted during radiation exposure. Besides, the occupational rights to protection, in relation to ionizing radiation, have been observed to be ignored by health institutions. It is important to point out that radiological protection is necessary whenever radiation is used⁵.

The lack of awareness regarding the risks associated with the exposure to radiation among the professionals may be one of the factors explaining its negligent use. Therefore, the scientific literature emphasizes the importance of providing the team with safety trainings against radiation¹².

It is mentioned that the unawareness of the risks associated with radiation is not dependent on the class of the health workers, which may be proven by an investigation conducted with resident doctors of urology, observing that half the interviewees did not know that some devices could cause cancer. The authors concluded that the level of awareness regarding ionizing radiation was very low in the studied sample, as well as the knowledge about the importance of protection against the ionizing radiation, therefore emphasizing the need for the medical team to attend safety courses for working with radiation¹³.

This aspect should also be expanded to courses addressed to the nursing staff. Then, students would get more detailed orientation as to the necessary care around radiation-emitting sources, thus raising awareness about the involved risks for themselves and the patients.

The adoption of procedures to reduce radiation exposure, such as protection devices, leads to a significant reduction in mortality and morbidity of the tissues that are sensitive to radiation, such as the thyroid and the eyes¹².

To reaffirm the mentioned aspect, a previous experimental study tried to measure the exposure to radiation coming from the C-arm in relation to susceptible organs, in a mannequin with dosimeters installed in the eyes, thyroid, chest, hands, and gonads, simulating the situation of a surgeon during a back surgery procedure. The authors measured the radiation emitted by the device and received

by the mannequin in four positions that are conventionally used in such surgical procedures. The results showed that the longer the distance from the emitting source, the lower the radiation doses received; these are always higher on the hands of the surgeon, when compared to the other assessed organs. Besides the hands, higher doses affect, respectively, breast and gonads¹⁴.

Therefore, in accordance with the shown results, it is worth to mention that a single dosimeter, under a protection apron for the whole body, is not sufficient to measure the doses of radiation received by some parts of the body, such as eyes, head, hands, neck, and thyroid. It would be ideal to use at least two dosimeters, one over the apron and another one under it, to get more accurate measures of the doses among employees that are strongly irradiated¹⁴. However, this last aspect is frequently implanted in the reality of different health institutions, and, in this study, more than 90% interviewees who had frequent contact with radiation were not using this equipment.

First, it is important to raise awareness in the team about the importance of using the dosimeter to control the received rates of radiation. Considering there is no dose of radiation that is considered safe, even if the worker is exposed to a low dose for a long period, there will be risks to health¹².

Even though the members of the nursing teams, circulating in the room, are further from the operating field, it does not reduce the cumulative effect of the exposure to radiation throughout the years. On the other hand, the surgical technicians, also members of the nursing team, are close to the operating field and often receive the same doses of radiation as those received by the surgeons. Usually, because they are not employees in the hospital institutions, they do not get the benefits they would be entitled to due to insalubrity of the exposure.

The risks associated with the exposure of pregnant women to radiation, which, according to gestational age, can cause abortion and even some types of malformations¹⁵. Considering that most nurses are women, at productive age, as shown by this investigation, this aspect must be evaluated by the people in charge of the nursing staff.

Finally, the benefits resulting from the use of diagnostic and therapeutic methods, by using the ionizing radiation, are unquestionable; however, it is important

to observe the ethical features related to the use of excessive doses of radiation for health professionals and patients. Therefore, the discussion of the theme involving health workers, regulatory agents, institutions, or societies addressed to studying this theme is essential to ensure the involvement of all subjects who manipulate or request the use of these devices. It is necessary to provide health professionals with a minimum training, which can generate more knowledge regarding safe manipulation measures¹⁶.

The SC environment is filled with occupational risks for the multiprofessional health team, especially nursing, due to its constant presence. Such risks range from temperature of the environment, quality of the air in the OR¹⁷, and also the one that is most frequently described in literature: the occupational biological risk, which, despite being the most clear one, to which the nursing staff is exposed, is still under-notified, which suggests the need for raising awareness and preparing the professionals as to the importance of notification in these events¹⁸.

Therefore, it is observed that the nursing team must be better oriented regarding all occupational risks related to the SC activities, showing the importance of using protection equipment, of undergoing regular exams, among others, aiming at maintaining the health and the quality of life at work.

CONCLUSIONS

By analyzing the exposure of the nursing team to radiation in SC, in different hospitals from six cities in the countryside of the state of São Paulo, it was observed that the 30 interviewed participants were women; most of the sample comprised nursing technicians, aged between 31 and 35 years, who had been working from 1 to 5 years in SC units.

Among the assessed subjects, 28 reported having contact with radiation; however, 11 employees used some sort of protection. The frequency of contact ranges, depending on the number of surgeries that are conducted every week, but most are exposed between one and three times a week to ionizing radiation sources. Only 11% employees reported earning more due to the

level of dangerousness associated with the exposure to radiation, and only 7% used the dosimeter.

The data shown suggest the need to train all professionals working in SC units regarding the safe and conscious

use of radiation, thus minimizing future health-associated problems, as well as more control coming from health services as to the use of safety devices, being in charge of providing safe work conditions to the staff.

REFERENCES

1. Flôr RC, Gelbcke FL. Tecnologias emissoras de radiação ionizante e a necessidade de educação permanente para uma práxis segura da enfermagem radiológica. *Rev Bras Enferm.* 2009;62(5):766-70.
2. Brasil. Ministério da Saúde. Portaria nº 1339/GM em 18 de novembro de 1999. Brasília: Ministério da Saúde; 1999.
3. Xavier AM, Moro JT, Heilbron PF. Princípios básicos de segurança e proteção radiológica. 3 ed. [Internet] Porto Alegre (RS): Universidade Federal do Rio Grande do Sul; 2010 [citado 2014 out. 10]. Disponível em: <http://www.ufrgs.br/spr-cadastro/SegurancaProtRad.pdf>.
4. Holmberg O, Czarwinski R, Mettler F. The importance and unique aspects of radiation protection in medicine. *Eur J Radiol.* 2010; 76(1):6-10.
5. Miller DL, Beth AS, Balter S. New recommendations for occupational radiation protection. *J Am Coll Radiol.* 2012;9(5):366-8.
6. Brasil. Ministério do Trabalho. Portaria SIT nº 200, de 20 de janeiro de 2011. Aprova a Norma Regulamentadora nº 34. Condições e Meio Ambiente de Trabalho na Indústria da Construção e Reparação Naval. Brasília: Diário Oficial da União; 2011.
7. Brasil. Resolução nº 466 de 12 de dezembro de 2012. Brasília. Conselho Nacional de Saúde. Dispõe sobre ética em pesquisas envolvendo seres humanos. Brasília: Conselho Nacional de Saúde; 2012 [citado 2014 jul 4]. Disponível em: <http://conselho.saude.gov.br/resolucoes/2012/Reso466.pdf>
8. Schmidt DR, Dantas RA. Quality of work life and work-related musculoskeletal disorders among nursing professionals. *Acta Paul Enferm [Internet].* 2012 [citado 2013 dez. 19]; 25(5):701-7. Disponível em: http://www.scielo.br/scielo.php?script=sci_pdf&pid=S0103-21002012000500009&lng=en&nrm=iso&tlng=pt
9. Brasil. Ministério da Saúde. Secretaria de Vigilância Sanitária. Portaria nº 453, de 01 de junho de 1998. Aprova o Regulamento Técnico que estabelece as diretrizes básicas de proteção radiológica em radiodiagnóstico médico e odontológico, dispõe sobre o uso dos raios-x diagnósticos em todo território nacional e dá outras providências. Brasília: Diário Oficial da União; 1998.
10. Brasil. Conselho Nacional de Energia Nuclear (CNEN). Diretrizes básicas de proteção radiológica. Brasília: Conselho Nacional de Energia Nuclear; 2011.
11. Brasil. Ministério do Trabalho e Emprego. Norma Regulamentadora nº 32 – NR32. Portaria de 11 de novembro de 2005. Brasília: Diário Oficial da União, Seção 1; 2005.
12. Kesavachandran CN, Haamann F, Nienhaus A. Radiation exposure of eyes, thyroid gland and hands in orthopaedic staff: a systematic review. *Eur J Med Res.* 2012;17:28.
13. Söylemez H, Sancaktutar AA, Silay MS, Penbegül N, Bozkurt Y, Atar M, et al. Knowledge and attitude of European urology residents about ionizing radiation. *Urology.* 2013;81(1):30-5.
14. Lee K, Lee KM, Park MS, Lee B, Kwon DG, Chung CY. Measurements of surgeons' exposure to ionizing radiation dose during intraoperative use of c-arm fluoroscopy. *Spine.* 2012;37(14):1240-4.
15. Alex MR. Occupational hazards for pregnant nurses. *Am J Nurs.* 2011;111(1):28-37.
16. Chem RK. Editorial – Radiation protection in medical imaging: never ending story? *Eur J Radiol.* 2010;76(1):1-2.
17. Poveda, VB, Santos, B, Galvão CM. Análise entre o tempo cirúrgico e as variações da temperatura e da umidade em sala de operação. *Rev SOBECC.* 2014;19(2):61-6.
18. Marziale MH, Valim MD. Notification of work accidents with exposure to biological material: cross study. *Online Braz J Nursing [Internet]* 2012 [citado 17 out. 2014]; 11(1). Disponível em: http://www.objnursing.uff.br/index.php/nursing/article/view/3537/pdf_1