EVALUATION OF CONVENTIONAL RADIODIAGNOSIS SERVICES IN TWO HOSPITALS OF THE STATE PUBLIC NETWORK IN RIO BRANCO, ACRE*

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Abstract **OBJECTIVE: The main objective of the present study was to evaluate radiodiagnosis services in two public hospitals with x-ray equipment in the city of Rio Branco, Acre, Brazil. MATERIALS AND METHODS: Interviews, measurements and direct observation were performed, following the Brazilian legislation in force, especially the Order (Portaria) SVS/MS 453 of 1998 of the Ministry of Health establishing the basic guidelines for radiation exposure protection in medical and odontological x-ray facilities. RESULTS: The data indicated a high rate of non-compliance with the legislation in both radiological services, especially concerning poor equipment operation, and non-compliance with some safety protocols. CONCLUSION: Basically, technical and operational infractions have occurred as a result of a broad unfamiliarity with the legislation, the absence of a preventive equipment maintenance program, besides low investment in training and/or courses for professional updating. Therefore, a considerable number of simple and complex changes are demanded to improve the quality of the investigated radiodiagnosis services.**

Keywords: Radiodiagnosis services; Service evaluation; Exposure risk; Acre State.

Resumo *Avaliação dos serviços de radiodiagnóstico convencional de dois hospitais da rede pública estadual de Rio Branco, Acre.*

OBJETIVO: O objetivo principal deste trabalho foi avaliar os serviços de radiodiagnóstico médico de dois hospitais públicos que fazem uso de equipamentos de raios X na cidade de Rio Branco, Acre. MATERIAIS E MÉTODOS: Foram realizadas entrevistas, medições e observações diretas, usando como referência a legislação brasileira em vigor, com especial ênfase à Portaria SVS/MS nº 453 de 1998, que estabelece as diretrizes básicas de proteção radiológica em radiodiagnóstico médico e odontológico. RESULTADOS: Os dados obtidos indicaram a ocorrência de elevado número de itens em desacordo com a legislação consultada em ambos os serviços radiológicos dos hospitais pesquisados, especialmente equipamentos funcionando de forma parcial e o descumprimento de alguns protocolos de segurança. CONCLUSÃO: As infrações técnicas ou operacionais foram, basicamente, em decorrência do desconhecimento sobre a legislação, a ausência de programa de manutenção preventiva dos equipamentos e da falta de investimentos em treinamentos e/ou cursos de atualização profissional. A melhoria dos serviços de radiodiagnóstico médico das instituições investigadas requer, portanto, uma série de modificações, que vão de simples às mais complexas.

Unitermos: Serviço de radiodiagnóstico; Avaliação de serviço; Risco de exposição; Estado do Acre.

INTRODUCTION

In Brazil, one can say that the necessity to establish more rigorous standards for the sectors of radiodiagnosis and radiotherapy is a relatively recent concern triggered by the incident occurred in Goiânia, GO, in September of 1987, when outsiders destructed with a hammer a powered cesium-137 source obtained from an abandoned private medical facility. This episode was widely divulged both in the national and international media, and several adjustments and new practices started being implemented in the sector[1,2].

For several reasons, the major concern with regards to the standards severity has not led to the immediate publishing of the new legislation; an example is the Portaria (Order) SVS/MS no. 453 dated of June 1st, 1998[3], published only ten years after the incident in Goiânia. Most recently, this Order has been gradually improved by means of supplementary resolutions: RDC Anvisa no. 50, of February 21, 2002, regulating the technical planning, scheduling, elaboration and analysis of physical projects of health care facilities[4], and the RE Anvisa no. 64, of April 4, 2003, including the Guia de Procedimentos para Segurança e Qualidade de Imagem em Radiodiagnóstico Médico (Procedures Guidance for Safety and Imaging Quality in Medical Radiodiagnosis)[5].

In spite of these better regulations, new developments and a more rigorous inspection are necessary for the Brazilian safety and quality standards to achieve minimum levels. In Brazil, some studies demonstrate the extent and magnitude of the negligence of the workplaces managing ionizing radiation sources with safety and quality standards. At Hospital Universitário Clemen-

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tino Fraga Filho of Universidade Federal do Rio de Janeiro, for example, only three of twenty services working with ionizing radiation kept individual dosimetric monitoring of their employees, but there was no control for cases where high doses were found[6]. Another study carried out in dental offices in the city of Bauru, SP, has reported that the patients could receive lower radiation doses if simple precautions, like a better films positioning, were adopted[7]. More serious situations have been observed in the radiology service of Hospital Central do Exército do Rio de Janeiro, like inadequate supplies (for example, films and films developing solutions) storage, wrong positioning of the patient or of the film, use of equipment out of order, and in some cases partially damaged[8]. These and other examples[9–12] reinforce the necessity that legal mechanisms, including educational programs, are employed by the Brazilian sanitary authority to increase safety of the workers in these services as well as of their user-population.

In the state of Acre, a process was initiated in 2001 for updating the register of health care facilities with conventional and dental radiodiagnosis services, In this process, 29 conventional x-ray equipment and about 200 dental x-ray equipment (Pereira Filho T, Visa-Acre: personal communication). However, these services have not been evaluated under the criteria established by the legislation in force. So the objective of the present study was to evaluate the services of conventional radiodiagnosis of two hospital of the state public network in the city of Rio Branco, in compliance with the Brazilian guidelines[3–5].

MATERIALS AND METHODS

In the period between February 2 and 27 of 2004, the services of conventional radiodiagnosis in two institutions of the public state network in the city of Rio Branco, AC were evaluated. For the present study purposes, these institutions hereafter will be named "institution 1" and "institution 2". Institution 1 provides specialized attendance in 21 medical areas, and 159 hospital beds, distributed throughout four ambulatories and one intensive care unit, all of them dedicated to the Sistema Único de Saúde – SUS (Brazilian Unified Health System). The institution's staff includes 157 professionals with superior educational level[13]; among them, four physicians specialized in radiology, and nine technicians classified in this same area. This hospital is also accredited by the Ministry of Education as an ancillary teaching hospital, where residency programs are developed in the areas of pediatrics, medical clinical practice, obstetrics and gynecology, general surgery, and communitarian general medicine. Recently, institution 1 was included in the Projeto Hospitais-sentinela (Sentinel-Hospitals Project) created by Anvisa[14]. In this institution, the mean monthly number of hospital admissions is 650, and in 2002 about 24,000 conventional x-ray studies were performed[15].

Institution 2 is an emergency hospital with 200 hospital-beds registered at SUS. Of these hospital-beds, 39 are assigned to general surgery, 98 to medical clinical practice, two to psychiatry, 31 to pediatrics, and five to phthisiology. The institution also counts on services considered as non-urgency in the area of infectious and parasitary diseases, and its staff includes 272 professionals[16] of superior educational level; among them one physician specialized in radiology, and nine technicians classified in this same area. Seven hundred hospital admissions, on average, occur per month, with a mean monthly hospital occupation rate of 75%. In 2002, 67,952 x-ray studies were performed in the institution 2[17].

The following aspects were taken into consideration in the analysis of the radiodiagnosis services of institutions 1 and 2: professional education, working-day, technicians and ancillary personnel routine and time of experience, documentation of the services; physical structure as a whole, exam rooms, individual protection equipment, conventional x-ray equipment, dark chambers, report rooms, procedures with patients, procedures with films and films development, and services protocols. This evaluation was performed in compliance with criteria established by the Brazilian legislation currently in force[3–5].

The characterization of technicians and ancillary personnel, and the evaluation of physical and operational facilities of the medical radiodiagnosis services were made by means of visits to the facilities, interviews with the head of the service (or a representative indicated by the management of the unit), interviews with technicians and ancillary personnel, and direct observation, with quantitative and qualitative descriptions. Previously to the data collection, the proposed interviews questionnaires were applied to 10% of the target-public for validation. Once validated, visits were performed to both institutions as necessary, until the two questionnaires were completely answered by both institutions. (Pacheco JG, unpublished data: Master's Dissertation, Universidade Federal da Bahia). Additionally, whenever possible, photos were taken from the equipment and facilities.

In the qualitative analysis, comparisons were made between expected situation (according to the referred legislation) and the actual situation found during the visits to the health care facilities included in the present study[3–5]. In the quantitative analysis, whenever possible, means and frequency calculations were performed.

For practical reasons, all the professionals developing activities at the level of technicians in radiology, in this study were named "technicians". However, according to the Law no. 7394, of October 29, 1985, regulating the practice of the profession[18], only those professionals holding a diploma issued by a technical radiology school are legally recognized as "technicians".

The research project was approved by the Committee for Ethics in Research of Fundação Hospital Estadual do Acre (Report no. 049/2003). All the workers who proposed to collaborate in this project were given all the necessary explanations before being asked to sign the Term of Free Informed Consent (Pacheco JG, unpublished data: Master's Dissertation, Universidade Federal da Bahia). Previously, the study had been authorized by the titular managers of both institutions, and also by the Secretary of Health for the State of Acre.

RESULTS

Evaluation of the services

The Table 1 includes the results of 15 items researched in each institution studied.

In summary, in the institutions 1 and 2, 87% (15/2) and 80% (15/3) of the items, respectively, were in disagreement with the legislation in force. The Table 2 includes the conditions of hygiene and cleaning of the x-ray rooms, as well as the technical limitations observed in at least one of the fixed x-ray equipments and furniture observed in each institution. Both the institution 1 and institution 2 have two x-ray rooms. In the institution 1, the rooms are identified with number plates (1 or 2). In the institution 2, there is no identification plate for the rooms (for practical effects, the room at left side in the radiodiagnosis unit was named "A", while the room at right side was named "B"). Overall, the rooms evaluated in both institutions satisfied less than 7% of the requirements (Table 2), except for the room number 1 of the institution 1 that satisfied 5 of the 15 requirements (Table 2). Among the 15 interviewed professionals (six from the institution 1, and nine of the institution 2), only two of

Table 1 Evaluation of the conditions of radiological protection in two services of radiology at two institutions in the city of Rio Branco, AC.

Researched items	Institution	
	1	2
1. There is a radiological protection supervisor	No	No
2. There is a technical expert in charge	No	No
3. There is a Committee for radiological protection	No	No
4. There is a calculation for shielding of radiological facilities performed by an accreditated specialist	No	No
5. The unit holds a functioning permit for the radiodiagnosis service, issued by Visa-Acre	No	No
6. The basic architectural project was aproved by Visa-Acre, in compliance with radiological protection standards	No	No
7. There are individual dosimeters for the personnel in the radiodiagnosis unit	Yes	No
8. Individual monitoring data on the occupationally exposed personnel are registered and updated*	No	—
9. Public circulation inside the facility is restricted	No	Yes
10. There is a copy of Portaria (Order) SVS/MS 453/1998 available in the unit	No	No
11. Radiological studies are appropriately registered, with date and identification data of the patients	Yes	Yes
12. The clinical indication for the study is included in the register	No	No
13. The corridors allow an adequate circulation of people and stretchers	No	Yes
14. There is a documentation on the routine work procedure, including those regarding radiological protection	No	No
15. The unit has already been radiologically inspected by Visa-Acre	No	No

* Individual monitoring is not undertaken.

Table 2 Conditions of x-ray rooms and radiodiagnosis equipment evaluated in Rio Branco, AC.

Researched items	Institution			
	1		2	
	Rooms		Rooms	
	1	2	A	B
1. X-ray rooms present a good hygiene and cleaning standard	Yes	No	No	No
2. The electrical installations of the rooms are in good order and functioning	No	No	No	No
3. The hydraulic installations of the rooms are in good order and functioning*	—	—	No	No
4. When closed, the doors offer a perfect isolation	Yes	No	No	No
5. The bucky mural is good condition	Yes	No	No	No
6. The command cabin localization allows observation of the room door	No	No	No	No
7. The spotlight localization system opens symmetrically and the light intensity is sufficient to allow visualization of the field	Yes	No	No	No
8. There is a visible noticeboard warning women on the necessity of infoming the physician or technician on the existence or suspect pregnancy, before the examination	No	No	No	No
9. There is a warning noticeboard: "Entry prohibited while red light is on"	No	No	No	No
10. The protocol for radiographic technique (exposure table) is beside the control panel of the equipment	No	No	No	No
11. There is a quality control and preventive maintenence program in force, assuring that the equipment is in compliance with performance standards	No	No	No	No
12. The unit runs a performance reevaluation test after equipment maintenance	No	No	No	No
13. There are radiation protective gonad and thyroid shields for patients	No	No	No	No
14. There is sufficient number of lead aprons	No	No	Yes	Yes
15. The dark chamber is appropriately sealed to avoid natural light entrance	No	No	No	No
16. There is a quality control for post-processing water	Yes	Yes	No	No

* Institution 1 does not have a WC or washbasin in the x-ray room.

them had completed a 3-year technical course in radiology (one in each of the institutions). The other had attended the finished Programa de Reeducação e Avaliação Profissional (Program for Re-education and Professional Evaluation), and 86.6% of the interviewed technicians reported that they has learned to perform x-ray examinations by observing their more experienced colleagues. In the institution 1, the professional who had completed the technical course in radiology had less than one year of experience in this position, while the other had between 12 and 15 years of experience. None of the technicians had undergone any kind of training in radiological protection and quality assurance along their professional career. Additionally, none of the interviewed had received basic information from the institutions on the risks they were exposed to. Among the respondents, there was one technician who had completed post-graduation in a non-related area, one with superior course in physics, eleven technicians who has completed high school, one with complete elementary course, and other with incomplete elementary course. In 100% of cases, the contractual working-day (24 hours/week) was different from the actual working-day in both institutions: 30 weekly hours, on average, in Institution 1, and 65 weekly hours in Institution 2. In institution 1, four (66.6%) of the six technicians worked also for another institution. A similar situation was seen in Institution 2 (55.5% of cases, i.e., five of nine respondents). With the exception of one technician of institution 1, the other technicians in radiology of institution 1 and the technicians of institution 2 did not receive the 40%-additional pay for hazardous duty, although the majority of them (73.3%) had already such additional pay while employed by these institutions. Although they were entitled to have two 20-day vacation periods per year, in both institutions, it was frequent accumulation of vacation periods for more than 3 years. Apparently, this was the solution they found to avoid a decrease in the total value received at the end of each month formed by wage and additional pays resulting from overtime and shifts.

According the workers in both institutions, pre-admission laboratory tests (complete blood test and platelets counting) were not performed, and nor did the half-year blood tests required by the Order (Portaria) GM/SSSTb 24/1994.

The technicians of institution 1 reported that they always worn the personal dosimeter attached to their trunk, and over the lead apron, as necessary. However, they were not given access to dosimetric reports and did not know how to interpret them. Also, a worker in institution 1 was observed wearing the dosimeter of another worker who had been dismissed.

Neither institution 1, nor institution 2 had a protocol for radiographic technique. Consequently, each technician followed his/her own parameter to perform examinations. During the interviews, 26.6% of respondents informed not to be adequately prepared, and nor did they know how to accomplish their tasks safely.

Overall, 15 technicians and six ancillary workers in radiology, respectively, six technicians from institution 1, and nine technicians and six ancillary workers from institution 2 were interviewed. However, the three ancillary workers from institution 1 opted not to participate in this study. Table 3 shows the evaluation of the conditions of individual monitoring in both institutions, as well as their compliance with the law in terms of special vacation periods. As regards individual dosimetry in institution 2, it could not be evaluated, since it is not undertaken.

Procedures of the technicians in radiology with patients and their companions

During the visits to both institutions, the following irregularities were observed: 1) bedside procedures were restricted to immovable patients, but without using a mobile shielding and neglecting the duly minimum 2 m distance to be kept by companions and other patients from the x-ray equipment; 2) in two occasions, the technicians performed the procedures with the x-ray room door open.; 3) the technicians did not offer the lead aprons to companions, although they were available in the room; 4) the possibility of the patients' or companions' pregnancy was not checked in any of the cases observed (n = 45); 5) The most sensitive organs of the patients (thyroid and gonads) were not protected during the radiological examinations, since both institutions did not had this type of individual protection equipment available.

In institution 1, there were occasions where the technician had to operate the mobile x-ray equipment without wearing a lead apron because all the aprons available in the Institution were being used in other radiological procedures. In institution 2, there were situations where the technician could not delimitate the precise site of x-ray beam incidence, because the collimator lamp was broken. In such situations, the collimator remained with its maximum aperture, irradiating a larger area than the

Table 3 Condition of radiological protection of workers in services of radiology of two institutions in Rio Branco, AC.

Researched items	Institution	
	1	2
1. Has the personnel undergone some kind of training on radiological protection and quality assurance along your professional life?	No	No
2. Has the personnel received from the Institution any basic information on the risks to which they may be exposed?	No	No
3. Workers accumulate vacation periods, although they are entitled to have two 20-day vacation periods per year	Yes	Yes
4. Have the workers undergone pre-employment or periodical health exams (for example: complete blood test and platelets counting)?	No	No
5. Personal dosimeters are appropriately stored during the worker's absence*	No	—
6. The workers have regular access to dosimetric reports and know how to interpret them*	No	—
7. The workers always use the personal dosimeters attached to their trunks, and over the lead apron, as necessary*	Yes	—

* Individual monitoring is not performed.

necessary one for the examination; in this same institution, in more than one occasion, a situation was observed where the stretcher handler supported the patients during the radiological procedure without wearing any individual protection equipment. Therefore, the stretcher handler was exposed to several radiation doses during a day. Once during a visit, we observed the simultaneous presence of two patients and two stretchers handlers in the x-ray room during radiological procedures.

DISCUSSION

Comparatively, the problems diagnosed in institution 2 are the same in institution 1. It is important to note, however, that it is expected that, in a very short time institution 1 will have a more efficient radiodiagnosis service, since it has been included in the Projeto Hospitais-sentinela da Anvisa (Anvisa Sentinel-Hospitals Project)[14].

Both in institution 1 and institution 2 several items were in disagreement with the referred legislation [3–5]. At least four measures must be adopted by both institutions aiming at achieving compliance with the current legislation: 1) assignment or hiring of a radiological protection supervisor and a technical expert in charge; 2) constitution of a Committee for Radiological Protection, in compliance with provisions of Order (Portaria) SVS/MS 453/1998[3]; 3) periodical training and updating courses; 4) implementation of a program for quality assurance in the institutions, including a routine equipment preventive maintenance.

Experiences with other institutions demonstrate that hiring experienced and skilled professionals, as well as investment in training and updating courses, are effective measures, contributing significantly to improve the quality standards of radiodiagnosis services. In 1999, the laboratories of hormones and nuclear medicine of Hospital Universitário Clementino Fraga Filho at Universidade Federal do Rio de Janeiro presented the lowest indices in monthly personal dosimeters readings[6]. According to the authors, this has occurred mainly as a result of training programs for the laboratories staff, and the presence of a physicist, in the case of nuclear medicine, continuously managing and guiding the personnel on the occupational risk of ionizing radiation[6]. Also, in Hospital Universitário do Rio de Janeiro, the implementation of a quality assurance pilot-program in the mammography unit, in 2002, included training for technicians, a more appropriate mammograph maintenance, and an increase in the mean daily number of patients from 7 to 12, which has contributed to the stability of the films processor[9]. These changes have resulted in an improvement in the images quality, with absence of artifacts; a significant decrease in costs and films rejection indices (from 21% to 7.7%); and, consequently, a significant decrease in radiation doses for patients[9].

A serious problem found, concerning radiodiagnosis procedures, was the examination of women or patients accompanied by women of fertile age. In both institutions, the possibility of pregnancy was by no means investigated, and this is particularly concerning, as it is likely that there may be pregnant women undergoing unnecessary radiation exposure, and a consequent higher risk of mutations-related congenital abnormalities and injury to the fetal central nervous system, besides delayed effects for women[19–21]. Just affixing a notice board on the risks of radiation exposure for pregnant women, according to Order (Portaria) SVS/MS 453/1998[3], does not suffice; however there is a necessity for a reeducation program and guidance for patients and companions in the occasion of the request, scheduling, and also before the radiological procedure performance. However, a limitation to this kind of program is the high rate of functional illiteracy in the Acre State - in 2001, it was 30.2%[22]. Another alternative, provided the clinical situation permits, is to establish a certain period for performing radiological studies in women of fertile age, for example, ten days after the last day of the menstrual period [23].

Another serious problem was stretchers handlers supporting patients during radiological procedures without wearing any type of individual radiation protection equipment. According to the Order (Portaria) SVS/MS 453/1998[3]: 1), the presence of a companion in the room during radiological procedures should occur only on voluntary basis and out of the context of the companion professional activity; 2) a same person is forbidden to go about this activity on a regular basis; 3) it is mandatory for the companions wearing an individual radiation protection equipment compatible with the radiological procedure.

Most probably because the radiation originating from the x-rays is an invisible phenomenon, several other procedures incompatible with the activity of workers in radiodiagnosis services were observed. For reverting this situation, it is necessary not only a significant investment in training, but also the development of systematic activities aiming at stimulating and valorizing the workers in this sector, besides making them aware of the occupational radiation exposure risks.

Although the investigated institutions had two x-ray rooms as well as infrastructure sufficient for two processors, both have been effectively operating with only one room and with a single processor. Since a preventive maintenance does not exist, and both institutions operate 24 hours a day, the immediate consequences are: frequent interruptions of the services as a result of technical problems, and equipment overheating, affecting the images quality. Considering the relevance of the radiodiagnosis services for the population in the Acre State, the lack of a qualified maintenance and spare parts for immediate replacement, the availability of additional x-ray equipment and processor is essential for both institutions.

Considering that these government agencies should not only to inspect and define penalties for infringements observed, but also guide and educate with basis on the Order (Portaria) SVS/MS 453/1998[3], as well as on federal, state and municipal regulations on this matter, the proximity of State and city sanitary vigilance agencies may result in an improvement of the radiodiagnosis services.

Based on the results presented by this study, one may conclude that technical or operational infringements have occurred basically because of unawareness of the legislation, the absence of an equipment preventive maintenance program, and the lack of investments in training and/or professional updating courses. So, the improvement of the radiodiagnosis services in

the studied institutions is highly dependent on urgent changes which, most of times, are simple and easy to be implemented, with immediate effects on the quality of the services.

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