RISKES IN RADIOLOGY

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Abstract: *The paper presents and analyzes the risks in the hospital sector (the radiology and imaging department) to which the employees of the company are exposed, and also their patients. The case study is fundamented on and is based on the following documents: injury risks and occupational diseases assessment at a Craiova hospital, specific medical procedures, own work health and safety instructions, on-site findings and work health and safety reports, drafted by the Internal Work Health and Safety Service, and also the external one.*

Keywords*: radiology, risk, pathogen, medical procedures, medical instrumentation*

1.Introduction

Medical has as main activity the medical and hospital field, being the only medical center specialized in bariatric activities in Eastern Europe. The hospital has double certification for bariatric activities: European and American.At present, Medical Company has approximately 400 workers, offering medical services for the following specialties: Bariatrics, Imaging, Surgery, Pediatrics, Oncology, EU, Otolaryngology, Ophthalmology, Dentistry and Other Specialties.The imaging or radiology activity (Figure 1) involving the use of X-ray (Rontgen) to produce photographic images on materials specifically created for such procedures is an activity found in Annex 5 of the Work Safety and Health Act , having special activity status.

Fig.1. Tomograh

This case study is meant to present those particularities and risks of occupational disease that make the X-ray hospital activity have a special treatment and be considered as a high-risk activity.

2. Generalities

The holder of the authorization or the registration certificate has to:

- consider the information provided by suppliers, identify possible radiological installationfailures and human errors that could result in unplanned medical exposure
- to take all reasonable measures to prevent malfunctions and errors, including the selection of qualified personnel, the establishment of appropriate calibration procedures, quality assurance and compliance with instructions on the use of the radiological installation, the provision of appropriate initial training and the regular training of personnel, including safety and security aspects;
- to take all reasonable steps to minimize the consequences of the deficiencies and errors that may arise;
- to draw up appropriate emergency plans to respond to events that may occur, to show plans in readily visible places, and to conduct regular practical exercises as appropriate.

The radiology laboratory shall be composed, as appropriate, of at least: RX room for the radiology installation;control room for the control console, as appropriate; development room; dressing room and waiting room for patients, as appropriate; Image interpretation room;medical consultation room; room for medical staff; archive of films and permanent recordings; dressing room, toilet for the personnel and toilet for the patients, as the case may be.The surface of the RX room must meet the manufacturer's minimum surface requirements for setting and mounting the respective radiological installation.It is not justified to mount the radiological installation in rooms smaller than those recommended by the manufacturer or to limit the technical capacities of the installation due to insufficient surfaces. The radiological installation for diagnosis will be placed in the center of the room.The radiological fluoroscopy installtion will be mounted with the RX tube axis - an image receiver parallel to the short axis of the RX room.In the case of fluoroscopic radiological installations, the minimum distance between the focal point of the RX tube and the nearest lateral wall shall be at least 150 cm.The design of the RX room must be such that the useful RX beam cannot be directed to any surface that is not properly shielded.The RX room must be designed in such a way as to avoid the direct incidence of the RX beam on the access doors.The doors must meet the requirements of a shielded screen for the scattered radiation and must be closed when the RX beam is emitted.

2. Experimental research

Risk factors specific to radiology activity. Physical risk factors are below described.

Ionizing radiation (Rontgen) emitted by the Rontgen tube conventional radiography apparatus. In the event of special malfunctions at the X-ray machine's emergency unit and unexpected blockage of the protection systems and STOP GENERAL - risk of irradiation above the permissible maxim limit of the patient, but also of the nurse and the radiologist in the enclosure.

Environmental risk factor

Potentially radiant (X-ray) environment in the radiology room if the sensor protection system is malfunctioning allowing the personnel to enter while the X-ray machine is in operation with the patient exposed to the X-ray.As we can see in figure 2.

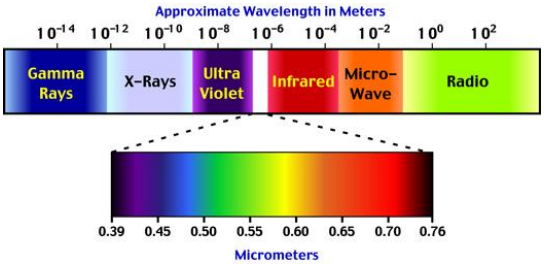

Fig. 2. Radiations Spectrum

Protection measures. Organizational measures

- The periodic verification required by the National Commission for Nuclear Activities Control (CNAC) shall be strictly observed and all the statistical records required by the legislation shall be reported. [5]
- Elaboration of execution technical procedures both for the current operation and unexpected situations, emergency situations
- Training radiologist assistants for knowledge and observance of these technical procedures and operating and maintenance instructions from the technical specifications of the equipment incorporating the radiation source
- Regular check of the doctor and nurses for health monitoring.
- Developing of own Work Health and Safety Guidelines and displaying themin the radiology rooms
- The technical status and findings will be registered daily in the tracking records of parameters and operating mode,
- Workplace health and safety signage displayed in a visible place

General risk factors for hospital activity. Biological Risk Factors

- Bacteria, viruses, pathogens of contagious diseases with which the doctor can come in direct contact by touching the clothing or the body of some patients - a risk of illness. [4]
- Airborne microorganisms - pathogens of contagious diseases some patients suffer from and that can be transmitted by air through sneezing, coughing, communication, etc. - Chronic illness risk. Protection measures
- the existence of disinfectant solutions, plastic shoe covers and disposable particle filtering masks at the entrance of each room at which patients can have access and which they are required to wear.
- the existence and the duty of physicians or nurses in contact with patients to wear protective masks and disposable gloves and, in some cases, special protective equipment for single use.
- constant disinfection of medical instruments and work equipment, using the latest disinfection techniques.
- the existence of anti-bacterial and anti-pathogens mats in the hallways of the hospital as well as of various medical equipment for cleaning patients'clothes or footwear.

- the existence of storage containers and special chutes for emptying and storing materials which may be have biological agents

Adverse effects

Radiations may affect the skin (causing pigmentation disturbances, atrophy and cutaneous sclerosis), eyes (favoring the appearance of conjunctivitis, cataracts or keratitis), hematopoietic tissue from which blood cells form (blood, white blood cells and platelets) and gonads. Irradiation can also cause genetic mutations or favor cancer. The risk of developing cancer after exposure to radiation is rather low, according to specialists, but it should not be ruled out. The effects of irradiation depend on several factors: the radiation dose, the frequency of exposure, the exposed organ, and the age of the patient. The human embryo and children, for example, are very sensitive to radiations, there being the risk to influence their development. [3]]

Irradiation doses

"Of all the investigations, conventional radiography is the least irradiating, but we must keep in mind that this examination provides only basic information in two dimensions, "says Prof. Dr. Gheorghe Iana. The unit of measurement for radiation doses that reach the body is the milisievert (mSv). Experts from the American College of Radiology and the North American Radiology Society believe that the maximum admitted dose of radiation accumulated over a year should not exceed 20 mSv.The amount of radiations emitted by a pulmonary radiography is 0.1-0.6 mSv. The radiography of a bone segment is more irradiating than a pulmonary one. This is so because the compact bone is a dense material, hence the radiation dose is higher, while the lung is a structure that contains a lot of air and therefore requires a lower dose for execution, explains the specialist.A dental radiography is the least irradiating of all the X-ray investigations; the radiation dose emitted by it is only of 0.02 mSv. Radioscopy, the real-time examination of organs such as the lungs or digestive tract is equivalent to approximately ten lung radiographies. In mammography, the radiation dose is of 1-2 mSv, and in the case of bone densitometry, the dose is 0.01-0.05 mSv. [2]

Tomography

Computerized tomography (CT) is the most irradiating medical investigation, but also the most complex of all, because the number of information obtained is significantly higher than in the other investigations. The radiation dose resulting from a thoracic or pelvic CT is of 4-8 mSv, whereas a complete human body tomography, which is usually performed in multiple trauma patients, reaches a dose of 10-12 mSV , according to US specialists.To reduce the patient's irradiation, it is recommended that the tomography be performed for two, at most three body segments: the chest and abdomen or the abdomen and the pelvis, and in the spine no more than three vertebrae.

An exception to this rule are oncological patients, in whose case the benefits of diagnosis are considerably higher than the risks, says prof. Dr. Gheorghe Iana. In such cases, a correct assessment should include more than two segments, for the detection of possible metastases or adenopathies.In the case of a lung cancer patient, for example, the radiologist investigates the chest for the pre- or post-operative assessment of the tumor, but also tracks the possible metastases in the abdomen, pelvis or the brain.However, any oncologist will try to exclude an additional exposure to radiations, knowing that the patient will need further investigations in the next year or even the next three to six months. [7,8]

The irradiation dose varies with a tomography, as with radiography, depending on the segment under investigation.Thus, the examination of a bone segment is more irradiating than that of the chest, and brain examination is the most irradiating of all because of the skull,

which is a bone structure. In addition, when having a CT, the eyeball, hypophysis and thyroid are also exposed to irradiation.[12]

The body receives radiationsfrom medical investigations and also from the environment. From the maximum admitted dose of 20 mSv per year, approximately 3 mSV come from the environment and should not be ignored when calculating the annual irradiation dose.[9,10,11] Pregnant women and children.

Pregnant women are prohibited from exposure to radiation during pregnancy. However, if such an investigation is absolutely necessary, it can be done in the last month, but still not without risks. Children are also forbidden X-rays investigations. Irradiation is not recommended to young people in general because they are growing, and irradiation may influence their development by affecting organs sensitive to X-rays such as the thyroid gland, hypohysis, pituitary gland, gonads, ovaries and eyeballs. However, when there are no other possibilities for investigation, account must be taken of the benefits and the information that an irradiating investigation might entail. In the case of a fracture, for example, a conventional radiography may be indicated, its irradiation being rather small.[1]

Tab.1. Exposure doses:

RadiationSource	Dose
Dental X-ray	0.02 mSv
Bone densitometry	0.01 – 0.05 mSv
Mamography	1 -2 mSv
Thoracic CT	4 – 8 mSv
CompleteCT	10 – 12 mSv
EnvironmentRadiations	3 mSv / an

* Maximum admitted dose: 20 mSv/an

3. Conclusions

In the past, radiologists were much more exposed to irradiation, and that was because they were working in the same room with the patient during the examination, and did dozens of investigations in one day. Currently, the radiologist is isolated from the patient through a lead screen that protects against radiation. The exceptions are the physicians practicing interventional radiology, such as coronary angiography or angiography. In these cases, the presence of the doctor in the same room with the patient is necessary for performing fine interventions.

Radiologists have the obligation to ask patients what examinations they had in the past and the period since the last examination. "It is useless to perform a new pulmonary radioscopy in a patient who performed the same examination two weeks ago, and the exam was normal, especially if it is just an interhospital or interclinical transfer. It is not acceptable to perform the same type of examination unless it brings anything new to the diagnosis ". The physician needs to opt for a different type of examination to supplement the information obtained at the first investigation but which should not irradiate the patient. However, it is important that the patient retains what investigations he has done over the past few months and tells the doctor about these. The radiologist must in turn communicate to the patient what type of investigation he is to carry out and what risks and complications are likely to occur.

The irradiation dose for a mammography is lower than the annual dose coming from the environment. The benefits of early diagnosis and treatment of breast cancer far outweigh the risks this investigation has, experts say. However, it is recommended only after the age of 40

and only once a year, precisely to prevent the possible risks of irradiation. Up to this age, non-irradiating breast tests, such as the ultrasound, are preferred.

The state-of-the-art appliances irradiate less than the old ones. Specialists have created new techniques for X-ray tube construction, performing better than those built in the past. The amount of radiation emitted by the old X-ray devices may be even twice higherthan that of newer devices.

References

[1]. **Darabont , Al., Pece St**- *Protectia muncii, Editura Didactică şi Pedagogică* , Bucureşti 1996

[2]. Lg. 391 / 2006 *Legea Securităţii şi sănătăţii înmuncă.*

[3]. H.G. 1048 / 2006 privind cerinţele minime pentru utilizarea de către lucrătoriae chipamentului individual de protecţie.

[4]. H.G. 1146 / 2006 privind cerinţele minime de securitate şi sănătate pentru utilizarea în munca de către lucrătoria echipamentelor de muncă.

[5].H.G. 1218 / 2006 privind stabilirea cerintelor minime de Securitate şi sănătate în muncă pentru asigurarea protecţiei lucrătorilor împotriva riscurilor legate de prezenta agentilor chimici.

[6]. H.G. 243 / 2010 privind cerinţele minime de securitate şi sănătate în munca pentru prevenirea ranirilor provocate de obiecte ascuţite în activităţile din sector spitalicesc şi cel al asistenţe imedicale.

[7]. **L. Niculiţă,***Managementulşiingineriacalităţii***,**EdituraAcademieiRomane, Bucureşti, 2005.

*[8]***K. Ohmae,***The Invisible Continent: Four Strategic Imperatives of the New Economy*, Nicholas Brealey Publishing, London, 2000

[9]. **S.Lache, D.M. Barbu, M.C.Luculescu, B.Popovici, R.Necula,E. Secară**,"*Boli profesionale datorate influenţei vibraţiilor asupra organismului uman*", Editura Universităţii Transilvania din Braşov, 140 pagini, 2008.

[10]***.S.Lache, D.M. Barbu, M.C.Luculescu, I. Barbu***,"*Modele şi sisteme avansate pentri protectia organismului uman la vibraţii şi prevenirea bolilot profesionale*", Editura Universităţii Transilvania din Braşov, 153 pagini, 2009

[11].**C. Leadbeater***, It's not the economy, stupid, New Statesman, Special Supplement on the theme Knowledge is Power*!, 27 September 1999, pp.: iv-vi.

[12].***E.A. Locke and G.P. Latham,*** "*New Directions in Goal-Setting Theory*" in Current Directions in Psychological Science, Vol. 15, No.5, 2006, pp.: 265-268.