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Usefulness of the Colombian technical guide (gtc45) as methods of hazard identification, evaluation and assessment of physical risk in the area of radiology

Abstract

The objective of this article is to validate the way in which the dangers of ionizing radiation are recognized in the work context, its impact on the technical literature and, in addition to this, as the most used tool in Colombia (Colombian Technical Guide GTC45). Where ionizing radiation carries risks, often unknown, especially to patients. For this reason, this article conducted a literature search related to the existing information parameters on GTC45 in relation to physical risk (ionizing radiation in radiology services), dealing with the occupational environment and the effects of interest. This initiative is justified by the increase in the availability of radiological equipment, the advancement of technologies, as well as the increase in clinical indications, where patients are subjected to a greater amount of radiation, in search of a medical diagnosis.

Keywords: safety, methods, dangers, risks, radiology

Volume 11 Issue 2 - 2024

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Received: March 23, 2024 | **Published:** April 10, 2024

Introduction

To talk a little about hazard investigation methods and risk assessments, it is necessary to know a little about the definition of each of these and what they consist of previously. Hazard investigation methods are defined as techniques used to evaluate the risks of a project or process. These methods help make decisions that allow preventive measures to be implemented to avoid potential dangers or reduce their impact,[1] another concept with which this methodology is defined allows for a visualization and estimation of the risks, according to the criteria and needs of the client, in which four by four (4x4) risk matrices can be used; five by five (5x5) and six by six (6x6), which makes it possible to find assessments that are more adjusted to the behavior and definitions of risks in organizations.[2] Now, from the above it can be said that through these methods decisions can be made, thus fully helping situations of danger or risk present in our work environment. Finally, let's define the concept of risk assessment, it is the process aimed at estimating the magnitude of those risks that could not be avoided. Obtaining the necessary information so that the employer is in a position to make an appropriate decision on the need to adopt preventive measures and, if so, on the type of measures that should be adopted.[3]

Now, why are hazard identification methods important? Well, this allows you to identify the dangers derived from working conditions in order to:

- Eliminate risk factors that can be easily eliminated.
- Assess risks that cannot be eliminated immediately.
- Plan the measures to be adopted to correct these risks.[4]

Although we know that this type of methodologies are always closely linked to a standard, that is, there is a standard that is a guide for the identification of hazards and risk assessment. This standard is recognized as GTC 45, in the jargon of those who know it; which is a guide that guides the identification of hazards and the assessment of safety and health risks at work, especially in the area of physical hazards, recorded in table A, page 19, row 6, of the same norm.[5] In the case of radiation exposure, there is a potential development of a secondary neoplasia from a radiation-induced mutation.[6]

Precisely this last pathology is one of the consequences most feared by the population that undergoes a radiological study. The potential risk depends on both the type and number of studies performed, as well as personal susceptibility. Only some of these factors are currently quantifiable, which is why it must be recognized that respondents have three or more radiology exams, a fact that shows the great demand for radiological studies and only confirms the importance of referring to the risks that it entails, especially because this number should increase in the near future, raising the concern of considering a historical record of the radiation dose, as is done in other countries.[7]

This guide aims to build a global overview of risk factors.[5] Already knowing a little about the methods of identifying hazards and assessing radiological risks as a first approach to the reality of those exposed when working with ionizing energy.[8]

Methodology

Documentary type research, consisting of validating the way in which the dangers of ionizing radiation are recognized in the work context, its impact on the technical literature and added to this, as a tool most used in Colombia (Colombian Technical Guide GTC45) provides a useful area of intervention in the way of detecting and preventing invasive processes caused by exposure to ionizing radiation in radiology technicians and professionals. For which a bibliographic search was carried out in different recognized scientific sources, related to the existing information parameters of the aforementioned

standard in relation to physical risk (ionizing radiation in radiology services).

Result

Methodology for identification of radiological hazards and the assessment of their risks with the Colombian standard GCT 45

Within the hazard investigation and risk assessment methodology, there are the following methods for the process carried out in the hazard identification process.

There are two types of methods: qualitative and quantitative

Quantitative: The quantitative method in risk analysis allows obtaining a numerical assessment of the materialization of an event, whether negative or positive, in terms of the defined criteria, which can be monetary, operational, technical, human, among others. which makes analysis easier in a tangible and objective way; while in the qualitative method it is based on the prior knowledge of the health professional who, by virtue of the information handled, can infer the level of existing deficiency in the face of the hygienic danger detected and contrasted with the indications of the guide, which are partial and require environmental measurements, which confirm the magnitude of the risk.[9]

For this: GTC 45 is the guide for the identification of hazards and the assessment of risks in worker health and safety, which establishes the guidelines for identifying hazards and assessing occupational health and safety risks; This identification is made from the hazard identification, evaluation and risk assessment matrix, where a recognition must be made of the physical risk factors to which workers in companies in the health sector are exposed (involving radiology and imaging assistants.[10]

Definition: The Colombian technical standard GTC45 applies a probabilistic method, based on a mathematical formula, that allows calculating the probability of occurrence of an event and its consequences, more specifically in the area of industrial safety and supported by a qualitative assessment table for the risks of a hygienic nature, which requires the use of additional instruments that guarantee an approximation to the reality of the danger and its repercussions on the reality of work.[11]

This method seeks to identify tolerable work areas based on the subjective knowledge of the person in charge of the inspection, supported by a procedure consisting of the characterization,[12] of the process (approach to the reality of the worker, his surroundings, materials and environment). Where the nature of the damage,[13] can also be taken into account. To then determine the level of deficiency from the severity derived from the dynamics of the danger combined with exposure to risks, combined with factors such as: consequences, exposure and probability, each factor has a value depending on the characteristics of the position, the security systems installed, protective equipment used, times of exposure to risk and severity of the possible injury for each of the risks to be assessed.[14]

Ionizing Radiation in accordance with GTC 45

Low Radiation: Exposure rarely, if ever, occurs.

Radiation of certain wavelengths, called ionizing radiation, has enough energy to damage DNA and cause cancer. Ionizing radiation includes radon, x-rays, gamma rays, and other forms of high-energy radiation. Lower-energy, non-ionizing forms of radiation, such as visible light and cell phone energy, have not been found to cause cancer in people; However, in the radiological service, these emissions must be monitored to be able to classify them as harmless.[15]

Average Radiation: Occasionally and/or neighborhood

When it is suspected that there is exposure to a highly radioactive agent in the work carried out, measurements will necessarily have to be made to determine the level of exposure in reference to the TLV. Corresponding, without ceasing to evaluate it qualitatively while obtaining the measurements, taking into account criteria such as risks present in similar jobs, information from specialized entities, etc. The medical staff, graduates and nursing staff of the imaging department must be trained in the study or radiographic technique to be performed. If there are doubts about carrying out the logical imaging study, support should be sought from the most experienced personnel in the Imaging Department, which guarantees feedback and avoids carrying out studies with technical deficiencies, not useful for diagnosis and, in turn, overestimation. patient exposure.[16]

HIGH Radiation: Regular exposure (one or more times a week).

Unlike visible light, X-rays have sufficient energy to penetrate human tissues and cause ionizing reactions, which brings with them mutagenic potential. It should be considered that the average annual dose of radiation received by a person is around 2-3 millisievert (mSv) per year, while that created by medical sources is more than half of this value, a figure absurdly higher than the maximum allowed limit presented.[17]

The deleterious biological effects produced by ionizing radiation are explained by two reasons: stochastic effect and tissue reactions (previously called deterministic effect). Stochastic is the probability of unrepaired DNA damage, resulting in radiogenic cancer (RC) (usually hematological malignancies).[18]

Very High Radiation: Frequent exposure (one or more times per day or shift).

The name X-ray designates radiation that is not visible; however, it can pass through opaque bodies and print photographic films.[19] These waves have a wavelength between 0.1-10 nanometers (nm), corresponding to frequencies in the range of 30 to 3,000 peak Hertz (50 to 5,000 times the frequency of visible light);[20] The ionizing effects of X-rays occur proportionally to the amount of radiation absorbed (energy) and the radio sensitivity of the cells that absorb it. Radiation transfers energy to the molecules of the cells that make up the tissues. As a result of this interaction, cell functions can be temporarily or permanently impaired and even cause cell death. The severity of the injury depends on the type of radiation, the absorbed dose, the rate of absorption, and the sensitivity of the tissue to the radiation. Exposure to high doses of ionizing radiation can cause skin burns, hair loss, nausea, illness, and death.[21]

The effects will depend on the amount of ionizing radiation received and the duration of irradiation, and personal factors, such as sex, age at exposure, health status and nutrition. Increasing the dose produces more serious effects.[22]

Advantages in application of the GTC45 Standard

- They help weigh the estimated cost and effectiveness of the devised corrective action against the risk.
- It assesses the effectiveness of the corrective action using a Justification Factor, which will depend on the magnitude of the risk (R), a risk reduction factor (F) and a factor dependent on the economic cost of this operation or cost factor (d).[23]

- It is too simplified, since in the same workplace, workers may or may not be allowed to use work equipment or chemicals or be exposed to different risks depending on where the initial workplace is located.[24]
- It is more affordable to carry out an evaluation of the workplace (taking into account the universal protection measures versed in the physical risk (ionizing radiation) to be considered,[25] thus being much more specific and seeking to provide recommendations for possible intervention.[26] Systematic activities applicable depending on the case.[27]

Disadvantages in application of the GTC45 Standard

- Not many times you do not have enough information, as the method requires, to be as objective and not lose precision,[28] it is very necessary to use explicit methodologies for the assessment of radiation, which in this case is an invisible enemy but with a broad spectrum and considerable effects on the future health of the patient who undergoes this type of radiation.[29]
- Risk tolerance levels are subjective assessments that are sometimes very difficult to interpret.[30]
- An audit based on a checklist can cause tasks that are too repetitive and even duplicated, which can cause demotivation of the auditor and, therefore, generate a loss of efficiency, with an approach so focused on the tasks of the checklist can lead to a loss of the general vision of the company and the environment.[31]

Relevant effects

Induction of cancer: Any dose of ionizing radiation is capable of inducing cancer in people exposed to it (Hypothesis of linear dose-effect relationship without threshold), so that the probability of its appearance grows with the radiation dose received.

Exposure to ionizing radiation below the current limit values:

– It will NOT imply a risk of the appearance of deterministic effects

– Probability of stochastic effects at values similar to the risk existing in the work activity considered safest.

However, the protection criteria for exposed workers are based, among other criteria, on the idea of the existence of some degree of risk regardless of the level of exposure to DNA (sometimes reversible).

About GENES: mutations directly proportional to the dose.

About CHROMOSOMES: aberrations.

Lymphocytes as a "biological dosimeter",

• About CELLULAR SURVIVAL: Inhibition of mitosis.

• About TISSUES: Dividing cells are more sensitive.

Effects: Acute radioepidermitis

– >10 Gray for a few minutes

– Appears in a maximum of 2 months.

• Alopecia

– >3 Gray for a few minutes

– Minimum free interval of 15 days

– Maximum appearance period: 2 months

• Oligospermia, azoospermia

– >0.3 Gray for a few minutes

– Maximum appearance period: 2 months

Late effects: Waterfall

– Duration of exposure: It can be brief.

– Cumulative dose: >10 Gray (RX) and 0.8 Gy (neutrons).

– Minimum free interval: 1 year.

– Maximum period of appearance: 5 years.

• Chronic radiodermatitis

– 6 months of exposure >10 Gy cumulative dose.

– Period of appearance: 5 years.

• Effects on the fetus after maternal irradiation

– Brain malformations (>0.3 Gy in organogenesis).

– Mental retardation (>0.5 Gy after the 8th week).

They take years or decades to manifest.

Indistinguishable from tumors of other causes.

• Cutaneous squamous cell epithelioma

– Minimum free interval: 10 years.

• Leukemia

– Minimum free interval: 3 years

• Lung cancer

– Minimum free interval: 5 years

• Osteosarcoma

– Minimum free interval: 5 years

International Regulations

• ILO Convention 115

– Protection of workers against radiation ionizing.

• Directives 96/29, 80/836 and 84/467/EURATOM

– Basic rules relating to the health protection of workers and the population against risks that result from ionizing radiation.

• Directive 90/641/EURATOM

– Protection of external workers by intervention in controlled area.

Population Groups

• Professionally exposed workers:

Risk of having annual doses greater than 1/10 of the annual limits.

• Students: They receive training in relationship to RX exposure.

• MEMBERS OF THE PUBLIC: any individual of the population except TPE

Exposed Personnel

Categories.

(Risk of external irradiation)

• Category A:

– It is not impossible for them to receive doses >3/10 of the limit of the annual dose (cumulative annual dose >15 mSv).

• **Category B:**

– Very unlikely to receive doses >3/10 of the limit of the annual dose (cumulative annual dose 5-15 mSv).

Ionizing Radiation

Dosimetry

Category A

• Individual dosimeter (thermoluminescent)

• Upper left pocket

• After lead apron (if worn)

• Accumulated monthly dose assessment

• Additional dosimeters (ring, etc.) if a specific part of the body is exposed to high doses.

Category B

• Area dosimetry.

SURVEILLANCE of workers

• **Dosimetric Report**

- Monthly. Confidential.

– Cumulative calculated dose of the previous 11 months.

– And the reading of the current month.

• **Medical Protocol**

– Mandatory prior medical examination.

– Annual periodic medical examination.

– Complete dosimetry history.

– Archive 30 years after cessation of activity

Dose Limit

• Stochastic effects: annual limit of 50 mSv. Of dose effective.

• Deterministic effects: 500 mSv. For any organ in equivalent dose, except the lens with 150 mSv.

• Women of childbearing age: dose in the abdomen quarterly less than 13 mSv.

• Pregnant women: dose to the fetus less than 10 mSv.

Results

Based on the study carried out and reflected above, it is necessary to affirm that the identification, analysis and evaluation of risks allows defining objectives and prioritizing actions regarding the control of radiological hazards within the work environment, where there are different parameters that do not exist. What to ignore, such as not failing to consider any significant risk or any viable improvement, we have to take into account whether the teams we work with have some level of acceptable risk or not, and in order not to have a world of risks at Studying it is important to reduce these in order of importance and feasibility, where the physical risk from ionizing radiation should never be overlooked.

Followed by the previously described, there are different types of risk analysis, where the GTC45 is not the only one in the options arena, but it is the most widespread in Colombia. These are qualitative where descriptive forms or scales are used to describe the scale, and/or consequences if that event occurs, semi-quantitative in which values are assigned to quantitative scales, and quantitative which, as its name indicates, clearly expresses numerical values. It is expressed in probabilistic terms including a critical analysis with calculations, and structures to establish the probability of some complex event.

On the other hand, it is important to mention that the risk management models used in the administrative, financial, technical, labor, internal control aspects, among others, allow the formulation of the proposed model, since the components of physical risk management, allowing From the planning process, in the risk assessment part, mechanisms are established to improve, more efficient controls, focused on preventing the manifestation of risk, in this case work accidents and occupational diseases.

Discussion

Exposure to ionizing radiation can come from both natural sources, such as radon in the soil and air, and man-made sources, including medical procedures such as x-rays and radiotherapy. It is important to take into account the risks associated with radiation and follow appropriate protective measures to minimize exposure and its possible negative effects on health, although the Colombian technical guide (GTC 45) is not sufficient to determine with certainty the degree. Of affectation and deficiency in the exposure area, can serve as a real approximation to what the physical risk due to radiation can represent in the work area of diagnostic imaging technicians and professionals.[15] It is confirmed with other authors that exposure to a highly radioactive agent at work can have serious effects on the health of workers.[16] Such effects of exposure to ionizing radiation, such as that produced by highly radioactive agents, may include irreversible tissue damage, increased risk of cancer in later life,[17] acute irradiation syndrome, radiation skin lesions, and prenatal health risks for exposed pregnant women.

In accordance with different studies consulted, it can be indicated that radiation diseases are serious conditions that result from exposure to high doses of ionizing radiation.[5] These diseases can manifest in different ways, such as radiation sickness syndrome, which is a serious illness caused by exposure to high doses of certain types of radiation, usually for a short time. Symptoms of this syndrome can include nausea, diarrhea, weakness, hair loss, and in severe cases, it can lead to cell death and tissue or organ failure.[7] Recognized that high doses of radiation, such as those that can result from extreme events such as a repeated explosion or imaging processes,[17] can cause serious acute health effects, such as skin burns, acute irradiation syndrome and even death in cases extremes, which have been documented in the past.[18,19,21]

Acknowledgments

None.

Conflicts of interest

Authors declare that there is no conflicts of interest.

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