

Identification, classification and study of risks in diagnostic veterinary radiology in Rio de Janeiro

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ABSTRACT: The simple use of diagnostic X-rays in animals requires a risk assessment for veterinary activity. The objective of this work is to identify the main critical points in diagnostic veterinary radiology in the State of Rio de Janeiro and to elaborate a radiological risk matrix spreadsheet. An online questionnaire was used to collect information and understand how veterinary X-ray services work and a probability x impact matrix worksheet to classify the risks. The study identified 6 major pain points that could increase veterinary and public IOE exposure and ranked them across the worksheet. With this, it is intended to help the veterinarian to understand the main critical points in diagnostic veterinary radiology so that he becomes aware of the risks and, thus, it is expected that he can reduce unnecessary exposure in the area.

Keywords: Small Animal Radiology, Safety, Radiological Protection, Risk.

1. Introduction

Conventional diagnostic veterinary radiology (veterinary radiology), like human radiology, uses ionizing radiation to diagnose, stage and treat disease in animals. It is rapidly developing and has become an increasingly important tool in the veterinarian's daily life. Currently, veterinary radiology has a conventional veterinary X-ray procedure for performing radiography (as) in small animals. It can be compared to human pediatric radiology, where the diagnosis is difficult, as the patient does not report his problem and signs must be interpreted, in addition to the need to contain the patient to perform the X-ray and in some cases, there is the need for chemical containment, with the use of drugs for sedation and/or anesthesia, however, this technique is used only as a last resort. Another very common form is the veterinary radiology wheel where the X-rays are performed in homes, veterinary offices, veterinary clinics that do

not have X-ray equipment, stud farms, ranches and ranches. This activity is not carried out in controlled environments, where adaptations are necessary to carry out the procedures. Unlike the instrumentation of veterinary clinics and hospitals, which are generally fixed or mobile, in mobile veterinary radiology the equipment is portable digital, allowing the performance of radiographic examinations in adverse locations and in large animals such as horses, for example (Figure 1) (NASCIMENTO, 2023).

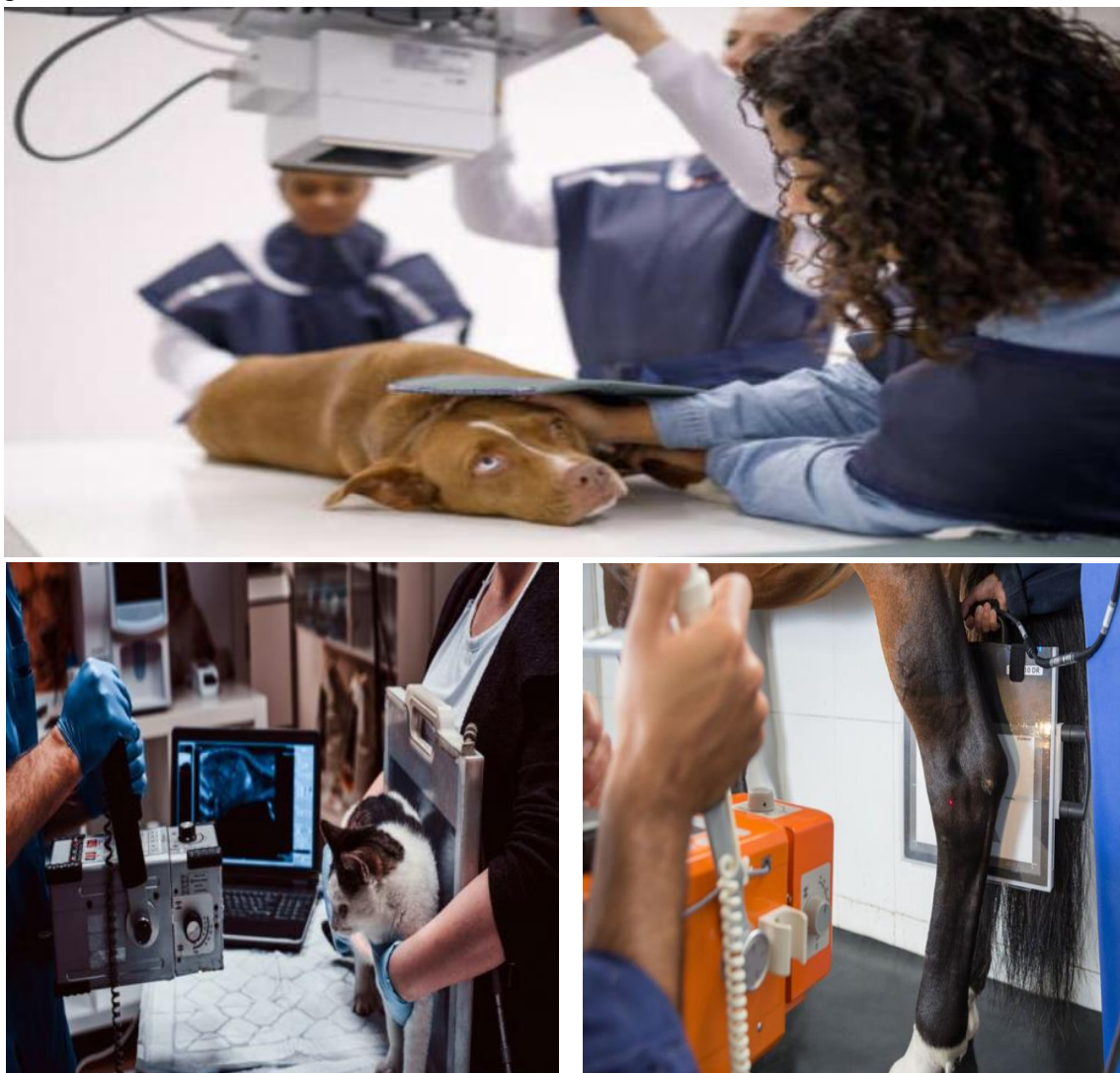


Figure 1 – Diagnostic Veterinary Radiology.

Risks in the work environment can be classified into five types, according to Ordinance No. 3214, of the Ministry of Labor of Brazil (MTE), from 1978. This ordinance contains a series of regulatory norms (NR) that consolidate labor legislation, relating to occupational safety and medicine. We found the risk classification in your MTE NR 5. There are five types of risks, accident, ergonomic, physical, chemical and biological. For diagnostic veterinary radiology, our study interest, the most important risk is the physical risk, which considers the various

forms of energy to which workers may be exposed, such as ionizing radiation, for example, among others, to be a physical risk agent. , also identified with a green circle (Figure 2).

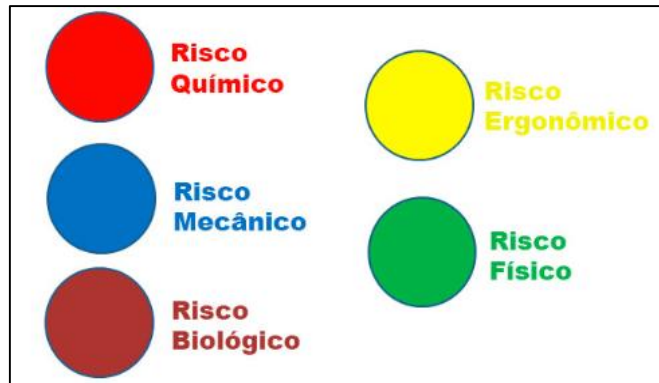


Figure 2 – Classification of risks.

For Navarro, the risk is associated with the possibility of occurrence of an unwanted event and its severity, it must be understood as a theoretical elaboration, which is historically constructed with the objective of mediating the relationship between man and dangers, aiming to minimize losses and maximize benefits. , which cannot be represented by just a number, as it is not a magnitude, it has a multifactorial and multidimensional character within a political, economic, and social context (NAVARRO, 2009).

Probability is the possibility or chance of a given event occurring, represented by a number between 0 and 1, that is, it is associated with numbers that will indicate the chance of that event occurring. The probability defines the occurrence and not the damage, for example: if 2 events X and Y occur, respectively, with probabilities of 0.1 and 0.9 of occurring, event Y is classified as 9x more likely than event X, but we cannot say that he is at greater risk than X (NAVARRO, 2009).

Risk identification comprises the process of searching for, recognizing and describing risks, that is, risk sources, forms of interaction and potential consequences. May involve historical data, secondary data from scientific publications, expert opinions, information and stakeholder needs (ANVISA, 2018 e GPA, 2022).

High rating or high risk (red): They represent a potential threat to GPA's business and priority actions must be taken to reduce or eliminate the risk component. Medium classification or medium risk (yellow): They represent a threat and can be monitored and managed through preventive control measures that can maintain the degree of exposure or risk acceptance. Low rating or low risk (green): Represents an acceptable threat with minor impacts, not requiring continuous monitoring and can be accepted (ANVISA, 2018 e GPA, 2022).

Ionizing radiation is a risk because it has unique characteristics such as being invisible, odorless, inaudible and tasteless, as its action is microscopic and acts as a projectile aimed at the molecule, considered the molecule of life, of deoxyribonucleic acid in the nucleus of cells (DNA), although it does not always reach it. When hit, it can cause damage, leading to cell death, depending on the degree of damage. However, if the damaged cell does not die, it can

continue to replicate. At high doses, the acute radiation syndrome appears hours, days, weeks depending on the dose rate. At low doses the effects can appear years later (OKUNO, 2018). The biological effects of ionizing radiation can be classified according to their mechanism (direct or indirect) and according to their nature (tissue reactions or stochastic effects) (OKUNO e YSHIMURA, 2010).

X-rays are a form of ionizing radiation, when X-rays interact with living tissue they produce electrically charged particles that can damage living tissue. Two types of effects of ionizing radiation may occur, namely stochastic effects and deterministic effects. Figure 16' characterizes the stochastic and deterministic effects. It is important to note that because there is no safe level of exposure to ionizing radiation, any level of exposure can cause cancer (BACKER, 2014).

Table 1 – BACKER, 2014

Effects	Amount of radiation required for the desired effect to occur	Effect of increasing the dose	Example
Stochastic	Any	Increases the odds (Probability)	Cancer
Deterministic	Above a certain level (Threshold)	Increases the severity	Skin damage, cataracts and infertility

2. Objective

Identify the main critical points in diagnostic veterinary radiology in the City of Rio de Janeiro and prepare a radiological risk matrix worksheet identifying the main risks for the veterinary IOE and general public.

3. Material and methods

To identify the main risks in diagnostic veterinary radiology in the State of Rio de Janeiro by conducting an online questionnaire using the forms application (Google Forms®). Elaborate the questions, send the questionnaire to a group of veterinarians working in diagnostic veterinary radiology. Carry out a qualitative analysis to explain reality in terms of concepts, perceptions and behaviors, using applied research, with the aim of generating knowledge for practical applications aimed at solving specific problems (Figure 3).

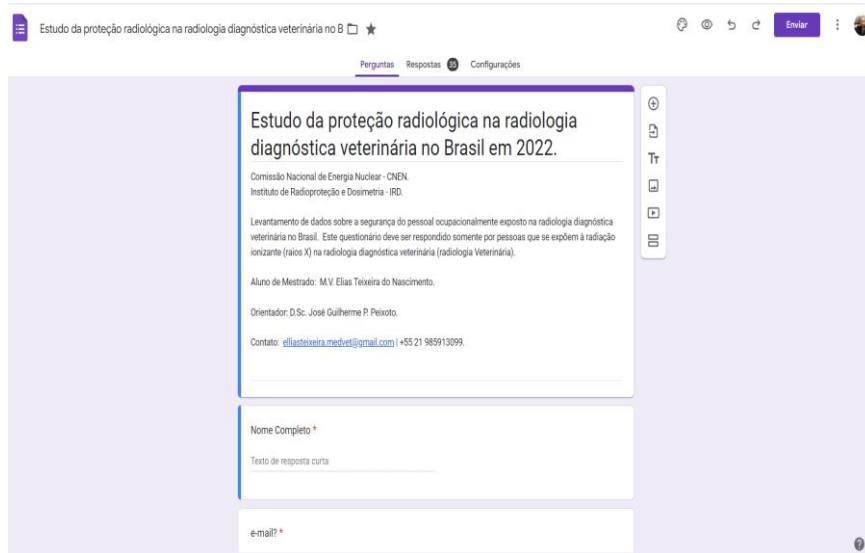


Figure 3 - Application used for the research carried out

Having identified the main critical points, elements that can lead to increased exposure of veterinary IOE and the general public, we prepared a radiological risk matrix spreadsheet in diagnostic veterinary radiology using the Excel application, creating a table of probability x impact, classifying them in green the ideal scenario, yellow which brings an alert and red the undesirable one, to qualitatively study the risks (Figure 4).

Probabilidade	Alta	Média	Alta	Alta
	Média	Baixa	Média	Alta
	Baixa	Baixa	Baixa	Média
		Insignificante	Moderado	Catastrófico
		Impacto		

Figure 4 - Risk Matrix Table

4. Results and discussion

35 people (IOE veterinarians) from a group of 255 (Group N) participants participated in the questionnaire, but we will focus only on the responses of participants from the State of Rio de Janeiro, that is, 9 participants / responses.

In Table 2 are the main questions to understand the panorama about the basic aspects of radioprotection. It represents the responses of the participants, we have: about the training of these professionals, 6 are veterinary radiologists, 2 are clinical veterinarians, 1 technologist in radiology. 6 people answered that they work with fixed X-ray emitting equipment, 1 with

mobile and 2 with portable equipment. 3 people reported that there is no complete PPE on site for use. 2 people answered that the site does not offer individual dosimeters. 4 People said that the site does not offer radioprotection training. 5 people reported that they never did the training. 4 are unaware of the standard applied to the sector and 7 missed the standard.

Questions/Participants	1	2	3	4	5	6	7	8	9
Do you use Full PPE?	Y	Y	N	Y	N	Y	N	Y	Y
Do you use the Dosimeter?	Y	Y	N	Y	Y	N	Y	Y	Y
Did you do the Training?	Y	N	N	Y	N	N	N	Y	Y
When?	2021	Never	Never	2020	Never	Never	Never	2022	2022
Do you know Norm?	Y	N	N	Y	Y	N	N	Y	Y
Wrong the correct rule		X	X	X	X		X	X	X

Table 2 – Responses from IOE Veterinarians (Rio de Janeiro).

This study helps to identify the main critical points in the veterinary radiology sector and to understand, a little, the panorama of veterinary radioprotection in the State of Rio de Janeiro. This scenario, observed in the questionnaire, makes us think that the panorama is a little worrying, requiring actions to correct the problems found in the research.

In 2019, a work carried out had already identified some problems related to safety in diagnostic veterinary radiology services in the country, a same type of questionnaire using the Google® / Google Forms application was carried out, at the time, 30 people participated, where, 60% of the participating veterinarians assume the role of technical manager (RT) in radiodiagnosis, 67% assume the role of supervisor of radiological protection (SPR), 77% have doubts about current radioprotection standards and recommendations and only 13% had the training in valid radioprotection established by Ordinance 453/98 ANVISA (reference standard at the time) (SOUSA et al., 2021)

Working with X-rays poses a risk to IOE veterinarians and the public, so radioprotection standards help ensure the safety of these personnel.

In Brazil, the RDC 611/22 ANVISA is the standard used as a reference for the veterinary radiology sector (BRASIL, 2022).

SRS 104/21 IAEA is a recommendation, but as a recommendation it does not have the power of a rule, and should only be consulted to resolve doubts and help protect the service and especially workers and individuals from the public. It emphasizes the importance of radioprotection for the sector and establishes basic safety and radioprotection guidelines for the protection of the worker (IOE Veterinarian) and public (tutor and companions) (ÁUSTRIA, 2021).

The International Commission on Radiological Protection has released ICRP 143 Radiological Protection in Veterinary Practice for the intended public involved in Veterinary practice with ionizing radiation (CANADÁ, 2023).

The Municipality of Rio de Janeiro has prepared an Ordinance that defines the sanitary considerations for the operation of veterinary establishments that employ the use of X-rays for diagnostic purposes in veterinary medicine, the Ordinance in question is 01/20 IVISA-Rio in force since November 10, 2020, it mentions imaging diagnosis in its annex V and is very emphatic about radioprotection, and guides the reference standard for the sector and says that all provision of diagnostic radiology or veterinary interventionist services must meet to the provisions of RDC ANVISA No. 330 of December 20, 2019 and/or others that may replace it, regarding the protection of workers and others involved in the procedure (BRASIL, 2020).

Figure 5 is the representation of a spreadsheet that identifies the main critical points that can compromise the functioning of a veterinary radiology service. It is the result of previous studies and its purpose is to facilitate the identification of these critical points for the service so that they can be immediately remedied and the risk reduced by the employer.

P r o b a b i l i t y	H i g h	IOE using personal dosimeter incorrectly	IOE without using the individual dosimeter	IOE without ever having performed radioprotection training
	M e d i u m	IPE correctly using the individual dosimeter	IOE with radiation protection training expired	IOE without wearing PPE
	L o w	IOE with valid radioprotection training	IOE wearing full PPE	IOE wearing incomplete PPE
		Light	Moderate	Critical
Impact				

P r o b a b i l i t y	H i g h	IOE sometimes collimates the exam to the study region of interest	IOE does not collimate the exam to the study region of interest	IOE is always exposed to the primary and secondary beam of ionizing radiation without shielding
	M e d i u m	IOE collimates the exam to the study region of interest	IOE sometimes exposed to primary and secondary beam of ionizing radiation without protection	IOE always holds the portable X-ray emitter and neither the DR cassette or plate
	L o w	IOE is not exposed to primary and secondary beam of ionizing radiation without protection	IOE does not hold the portable X-ray emitter and neither does the DR cassette or plate	IOE sometimes holds the portable X-ray emitter and neither the DR cassette or plate
		Light	Moderate	Critical
Impact				

Figure 5 – Risk classification in diagnostic veterinary radiology.

The classification of risks according to their degree of impact and probability:

- High rating or high risk, in red, represent a potential threat to the business and priority actions should be taken to reduce or eliminate the risk component.
- Medium classification or medium risk, in yellow, represent a threat, which can be monitored and managed through preventive control measures that can maintain the degree of exposure or acceptance of risk.
- Low rating or low risk, in green, represent an acceptable threat with minor impacts, not requiring continuous monitoring and can be accepted.

To prepare the worksheet, the main items that may pose a risk to the proper functioning of the service were considered. They were characterized from mild to moderate according to their degree of impact and probability of occurrence. For this study, elements were taken into account that may lead to increased exposure of veterinary IOE (workers) and the general public (guardians, companions, other workers at the veterinary clinic/hospital who are not IOE), that is, to compromise the protection of those involved as established by RDC 611/22 ANVISA.

In this sense, we focus on 6 points to classify the risks in veterinary radiology, for example: mandatory radioprotection training, use of individual dosimeters, use of complete PPE, exposure to the primary and secondary beam of X-rays, collimation of the exam, practice of hold the X-ray emitter and cassette during exposure.

This may be due to the lack of qualification, capacity and training in radioprotection of the veterinarian who performs radiographs for diagnostic purposes. Radioprotection norms and recommendations, in Brazil and in the world, mention that only really capable people can work with ionizing radiation and that periodic training must be carried out (**BRASIL, 2005; BRASIL, 2022 e IAEA, 2022**).

The use of a dosimeter is important for monitoring veterinary IOE. Neves, in his study, verified that in the fixed X-ray equipment, the estimated doses were higher than the estimated doses in the portable X-ray equipment, considering a single type of examination, an average value for the weight of the most frequent animal and that repetitions were not performed (**NEVES et al., 2020**).

Ellis, Nascimento and Cardoso emphasize the importance of using personal protective equipment in all procedures involving veterinary X-ray practice to reduce veterinary exposure and correct storage (**ELLIS et al., 2018; NASCIMENTO et al., 2019; and COSTA, 2022**). Furthermore, it is important to remember that we must be careful with the PPE and never fold the apron, never sit with it on or bend down to avoid cracks and fractures that will render its use unusable. It is also important to carry out periodic evaluations to verify their integrity.

Self-confidence can lead the veterinary IOE to make mistakes that consequently can result in increased exposure or unnecessary exposures. Such actions are worrying and unwanted, the problems must be known so that they can be managed and eliminated before they become a problem for the service, because if due care is not taken, it can result in extrapolation of the established annual dose limits by CNEN.

The Veterinary IOE should adopt is to perform the collimation of all exams to the region of interest of study to decrease inside the exam room, as it is common to see radiographs of small animals with the presence of hands containing the patient. In large animal radiography, workers who perform X-rays on horses do not use shields properly. It is common for these professionals to be close to the patient and often holding the X-ray tube and cassette (**BELOTTA et al., 2021**). In veterinary radiology, radiation exposure values are higher for the cassette holder than for the radiologist even without the use of PPE (**ELLIS et al., 2018**). The veterinary IOE must avoid restraining the patient, leaving this task to the tutor and companion. Always use the complete PPE inside the examination room or behind the screen, also, always use the individual dosimeter so that your monthly monitoring can be carried out and followed up and never expose yourself to primary and secondary beams of X-rays, especially without protection (**BRASIL, 2022**).

5. Conclusion

In this study, we seek to identify and classify the main critical points that can compromise radiological safety in the diagnostic veterinary radiology service, with this, we seek to alert the veterinarian of the risks of practicing ionizing radiation for diagnostic purposes so that he can

protect himself and also protect the public by helping to reduce unnecessary exposure in veterinary radiographic examinations.

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