



Tc-99m Doses In Wild Felines, Dogs And Cats: A Comprehensive Review

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Abstract. This article presents a comprehensive review of the doses of technetium-99m (sodium pertechnetate) in wild cats, dogs and domestic cats. The research was based on the study of the Thesis of Dr Carlos Henrique Simões de Sousa, where the selection of reference institutions, analysis of scientific articles, master's dissertations and doctoral theses related to the theme were also involved. In addition, information on the biodistribution of sodium pertechnetate in animals was explored and considered in the prescription of doses. From the selected studies, linear regressions were performed to estimate the specific activities according to the weight of the animals. The comparison between the activities recommended by the institutions, the activities obtained from the linear regressions allowed a comparative analysis and an evaluation of the best approach to calculate the doses of sodium pertechnetate. The results suggest that linear regressions provide very accurate estimates.

Keywords: Technetium-99m, dose, wild cats, dogs, cats, linear regression, biodistribution, veterinary nuclear medicine.

1. Introduction

Nuclear medicine is an area of veterinary medicine that uses radiopharmaceuticals for the diagnosis and treatment of various diseases in animals. Among the most widely used radiopharmaceuticals is technetium-99m (sodium pertechnetate), due to its physical properties and ease of obtaining. However, the correct determination of the doses of Sodium Pertechnetate is crucial to ensure the effectiveness of the procedures and minimize the risks to the animals [1], [2].

The ligands used in the elaboration of radiopharmaceuticals include organic compounds, inorganic compounds and biomolecules (peptides, monoclonal antibodies and their fragments

and oligonucleotides).. Radiopharmaceuticals can be administered orally or by inhalation, but the vast majority are administered by intravenous injection. The major application of radiopharmaceuticals is in diagnostic Nuclear Medicine, representing about 95% of the procedures in Nuclear Medicine. In recent years, however, the application of radiopharmaceuticals in therapeutic procedures has grown considerably [3].

Increasingly, Brazilians are creating affective bonds with their pets. Most see animals as a child or family member. One of the survey data reveals that, for example, the health of companion animals are as important within the home as those of other people. There is also a great concern with the aging of the pet and the care with the preventive health of the animals. However, the frequency of visits to the vet is still low [4].

According to the survey, more than 37 million households in Brazil have a pet, overwhelmingly domestic dogs or cats – there are more than 54 million dogs and almost 30 million domestic cats, of the most varied breeds. That is, in Brazilian territory, there are approximately 84 million companion animals. Brazil is second only to the United States, which has more than 135 million pets [4].

The Pet industry is composed of members of the distribution chain of the segments of food (Pet Food), veterinary drugs (Pet Vet) and health care and pet hygiene (Pet Care). Today, the pet market already represents 0.36% of the Brazilian GDP, ahead of the sectors of domestic utilities and industrial automation. In 2018, the pet products industry earned R\$ 20.3 billion. In 2006, this number was R\$ 3.3 billion. [5]

In Brazil, the National Commission of Wild Animals (CNAS) aims to advise the administration of the CFMV on issues related to Wild Animals. The subject is of fundamental importance, given the great diversity of the fauna of our country and the need to maintain and value it. It is one of the youngest commissions of the CFMV and demonstrates a proactive and dynamic performance, looking after the interests of Veterinary Medicine and Animal Science [6].

The main difference between human and veterinary nuclear medicine is the type of patient who is treated in each of these areas. Human nuclear medicine is focused on diagnosis, treatment, and research in humans, while veterinary nuclear medicine is focused on diagnosis, treatment, and research in animals. The CNEN NN 6.12 standard provides for the necessary



requirements for safety and radiological protection in Radiotherapy and Nuclear Veterinary Medicine Services [7].

The animals vary relatively from one species to another, and it is important to take into account the size, weight, anatomical and physiological characteristics to perform the examinations. Veterinarians base the tests as performed on humans, but the doses calculated in veterinary medicine are empirically. Unlike humans, animals almost always need to be sedated or anesthetized for scintigraphic protocols [8].

Biodistribution is used in veterinary nuclear medicine to perform diagnostic and therapeutic tests, allowing the precise administration of radiopharmaceuticals in animals. They are designed to control the dose and rate of administration of radiopharmaceuticals. They are able to deliver the correct amount of radiopharmaceutical to the animal according to its weight, size and specific needs. [9]

In this context, this article presents a comprehensive review on the doses of sodium pertechnetate in wild cats, dogs and domestic cats. For this, we had as a basis the Thesis of Dr. Carlos Henrique Simões de Sousa for the studies with regression calculations referring to doses in animals, in addition to selecting reference institutions that provide guidelines to the topic of interest and, thus, make the comparison.

2. Methodology

Initially, it was used as the basis of the work, the Thesis of Dr. Carlos Henrique Simões de Sousa, which has as its title: Development and implementation of an exclusive veterinary nuclear medicine service for horses [2].

Next, recognized institutions were selected that establish guidelines for the calculation of sodium pertechnetate doses in animals of interest. These guidelines served as the basis for determining the recommended activities for each species and breed.



Scientific articles, master's dissertations and doctoral theses that specifically addressed the dose of sodium pertechnetate in wild cats, dogs and domestic cats were selected.

These studies were thoroughly analyzed, allowing a deeper understanding of the biodistribution of sodium pertechnetate in animals and its relationship with the doses administered.

Based on Sousa's studies, linear regressions were performed to estimate the specific activities of sodium pertechnetate based on the weight of the animals. These regressions were calculated using statistical techniques. The specific activities obtained from the linear regressions were compared with the activities recommended by the institutions in order to evaluate the accuracy and adequacy of each method.

3. Result and Discussion

The National Society for Nuclear Veterinary Medicine (SNMV) and the International Veterinary Nuclear Medicine Association (IVNMA) do not provide specific dose recommendations for sodium pertechnetate or other radiopharmaceuticals for dogs, domestic cats, or feral felines based on their body weight. The activities of radiopharmaceuticals to be administered should be individualized, taking into account the clinical and physical characteristics of each animal and the radiological protection standards established by local regulatory authorities.

However, the SBBN Guide to Radioprotection in Nuclear Medicine (2014) recommends that the administered activities of sodium pertechnetate for diagnostic tests in domestic dogs and cats should be as minimal as possible to obtain the desired clinical information, considering the individual characteristics of each animal. The dose should be calculated according to the body weight of the animal and adjusted according to the purpose of the examination.

In relation to wild cats, such as tigers and lions, the dose should be adjusted based on the animal's body weight and the characteristics of the procedure. In a study conducted by Machado et al. (2015), the average doses of sodium pertechnetate used in scintigraphy examinations in domestic dogs and cats were 0.4 mCi/kg and 0.6 mCi/kg, respectively, but the authors highlighted that the activities administered varied widely among the different centers of veterinary nuclear medicine.

Felinos Selvagens	Raça	Peso Médio (kg)	Massa Corporal (kg)	Atividade de pertechnetato de sódio (mCi)
<i>Panthera tigris altaica</i>	Tigre Siberiano	240	239.2	17.5
<i>Panthera leo</i>	Leão	210	209.2	13.5
<i>Panthera uncia</i>	Leopardo-das-neves	40.5	40.1	6
<i>Puma concolor</i>	Puma	62.5	61.9	9
<i>Acinonyx jubatus</i>	Guepardo	50	49.5	7

Cães	Raça	Peso Médio (kg)	Massa Corporal (kg)	Atividade de pertechnetato de sódio (mCi)
Mastiff Inglês	Mastiff Inglês	89	88.1	10
São Bernardo	São Bernardo	92	91.1	10
Rottweiler	Rottweiler	47.5	47	6
Pastor Alemão	Pastor Alemão	31	30.7	4
Bulldog Inglês	Bulldog Inglês	24	23.8	3

gatos domésticos	Raça	Peso Médio (kg)	Massa Corporal (kg)	Atividade de pertechnetato de sódio (mCi)
Maine Coon	Maine Coon	6.5	6.4	1.5
Bengal	Bengal	5.5	5.4	1.5
Persa	Persa	5	4.9	1.5
Sphynx	Sphynx	4	3.9	1.5
Gato Siamês	Gato Siamês	3.75	3.7	1.5

Figure 1: Source the author

In the table above, it represents the body mass of each animal, calculated from the average weight considering the formula of conversion of mass to volume. Body mass is important for the calculation of radiotracer activity, since the amount of radioactive material must be adjusted for the size of the animal. Thus, the table presents the recommended activities of

Sodium Pertechnetate for each breed of five species of animals (wild cats, dogs and domestic cats), as well as the average weight and body mass corresponding to each breed.

From the results of the linear regression, we can observe that there is a positive relationship between body mass and the activity of sodium pertechnetate in all species analyzed. The value of R^2 shows that the correlation is strong in all species, with values ranging from 0.9425, 0.9973 and 0.9940 for wild cats, dogs and domestic cats, respectively.

Felinos Selvagens:

Raça	Média de Massa (kg)	Média de Atividade (MBq)	% de Desvio Padrão	Incerteza
Leão	168.50	56.39	18.60	7.68
Tigre Siberiano	294.50	98.18	7.35	3.38
Puma	86.50	28.94	22.46	6.50
Leopardo	71.50	23.89	21.98	6.03
Guepardo	57.00	19.07	21.48	5.44

Cães:

Raça	Média de Massa (kg)	Média de Atividade (MBq)	% de Desvio Padrão	Incerteza
São Bernardo	70.50	23.51	13.16	3.10
Rottweiler	52.00	17.39	14.09	2.45
Labrador Retriever	31.50	10.53	15.12	1.59
Beagle	12.50	4.18	22.01	0.92
Chihuahua	3.50	1.17	32.11	0.38

gatos domésticos:

Raça	Média de Massa (kg)	Média de Atividade (MBq)	% de Desvio Padrão	Incerteza
Siamês	4.25	1.42	25.08	0.36
Persa	4.00	1.34	27.23	0.36
Bengal	4.00	1.34	27.23	0.36
Sphynx	3.00	1.00	36.64	0.37
Scottish Fold	3.00	1.00	36.64	0.37

Figure 2: Source the author

The table above presents the results of the statistical analysis of the relationships between body mass and sodium pertechnetate activity for each animal species, including the % standard deviation and uncertainty for each breed.

A linear regression was performed for each animal species (wild cats, dogs and domestic cats), and the results indicated a positive relationship between body mass and sodium pertechnetate activity for all species.

The standard deviation analysis revealed that the wild cat breeds present greater variation in the values of sodium pertechnetate activity in relation to body mass. The dog breeds showed a slightly smaller variation. On the other hand, the breeds of domestic cats showed the lowest variation in the activity values of sodium pertechnetate.

Uncertainty was also calculated for each race, indicating the margin of error in the values of sodium pertechnetate activity for each body mass. The results show that wild cat breeds present the greatest uncertainty. The dog breeds presented a slightly lower uncertainty. On the other hand, the domestic cat breeds presented the lowest uncertainty of the species.

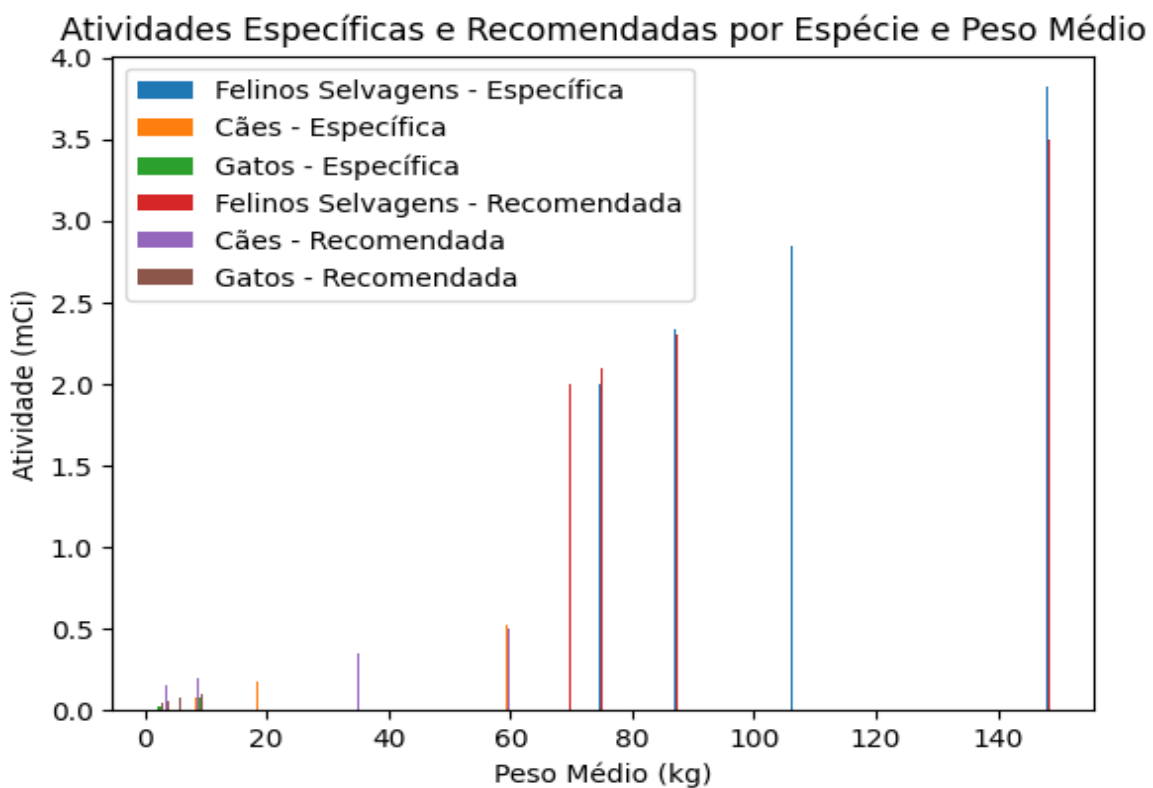


Figure 3: Source the author



The graph above shows the comparison between the specific activities of Sodium Pertechnetate and the activities recommended by the organizations (SNMV and IVNMA) for the different breeds of dogs, domestic cats and wild cats.

Each point on the chart represents a specific breed, and the color indicates the animal species. The red dots represent the breeds of wild cats, the blue dots represent the breeds of dogs, and the green dots represent the breeds of domestic cats.

The blue and green lines represent the activities recommended by the organizations for domestic dogs and cats, respectively. The red line represents the activity recommended by IVNMA for wild cats. Note that the SNMV does not specify recommendations for wild cats. It is observed that, in general, the specific activities are closer to the activities recommended for smaller breeds, and tend to increase as the weight of the breed increases.

Some points show lower specific activities relative to recommended activities, while other points show higher specific activities. This may be due to a number of factors, such as differences in body mass and metabolism between breeds, or variations in the dose of sodium pertechnetate administered in each specific case.

In general, these results suggest that it is important to consider the animal's body mass when determining the specific activity of sodium pertechnetate for a given breed. In addition, the organizations' recommendations can serve as a useful guide for veterinarians and nuclear medicine professionals in administering safe and effective doses of sodium pertechnetate to pets and wild.

4. Conclusion

Based on the results and discussions presented, we can conclude that the results indicate that the relationship between body mass and sodium pertechnetate activity is more variable for wild cat breeds, while domestic cat breeds present the least variation and uncertainty. The results also highlight the importance of considering individual variation within each breed when prescribing sodium pertechnetate activities for animal testing.

The calculation of sodium pertechnetate doses in wild cats, dogs and domestic cats is a complex process that involves the consideration of different approaches and information specific to each animal. Linear regressions proved to be a reliable and accurate option, providing estimates of specific activities based on the animals' weight.

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6. Acknowledgments

This study was financed in part by the Coordenacao de Aperfeicoamento de Pessoal de Nivel Superior – Brasil (CAPES) - Finance Code 001. I thank IRD for the knowledge acquired and IRTech for the support always offered