HERCA

HEADS OF THE EUROPEAN RADIOLOGICAL PROTECTION COMPETENT AUTHORITIES

HERCA Working group on Veterinary Applications

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Guidance document on Veterinary Radiation Therapy

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This document has been approved by the Board of HERCA in December 2021

Title: **Guidance document on veterinary radiation therapy**

Summary: This guidance aims to provide an overview of the different veterinary radiation therapy procedures that are performed in the different HERCA member countries. It also gives practical advice on safety measures on the matter.

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HERCA Guidance
Veterinary radiation therapy

1. Introduction

This guidance document gives information about the different veterinary radiation therapy procedures that are performed in the different HERCA member countries. It also gives practical advice on safety measures in order to minimise the radiation risks for workers involved in these procedures and can also be used as a guidance for countries that don't have any experience with veterinary radiotherapy or countries that want to update/clarify their own existing requirements. This documents will not discuss these safety measures in detail, as the IAEA has recently produced a document that discusses this into detail for all veterinary applications, including veterinary radiotherapy (IAEA safety guide n° 104, Radiation Protection and Safety in Veterinary Medicine).

In general, the protection of members of the public and the exposed workers can be guaranteed by the application of the principles of **justification, optimisation and dose limitation.** These principles are well-known within the radiation protection community and won't be explained in detail within this report.

Considering the limited number of countries that have experience with veterinary radiotherapy procedures, this document does not contain an exhaustive list of all possible procedures and safety measures, but rather an overview of what is currently happening within the HERCA countries.

This document will only discuss the use of sealed sources for radiotherapy as well as the use of linear accelerators and X-ray equipment for therapeutic applications. The use of non-sealed sources for radiotherapy (veterinary metabolic therapy) is not part of the scope of this document, as this has already been discussed in het *HERCA Guidance document on the Protection of members of the public and the workers during veterinary nuclear medicine procedures (2019)*.

2. Evolutions in veterinary applications

In human medicine, the use of ionising radiation to treat malignancies has been proven justified and has been one of the standard treatment modalities for cancer for decades. It is therefore not unexpected that radiotherapy is also making headway in veterinary medicine, primarily on small domestic animals such as cats and dogs. In recent years, the number of countries that have veterinary radiotherapy facilities have increased, although the number of facilities per country stays relatively low when compared to the application in humans. This primarily has to do with the high cost of building such a facility, the high cost of treatment, the lack of (pet-insurance) re-imbursement for this type of treatment, and the limited number of veterinary oncologists.

One of the biggest differences between radiotherapeutic treatments in humans versus animals, is that in veterinary medicine, these types of treatment always happen under sedation or anaesthesia. This will be discussed further in the document.

In 2013, the HERCA Task Force on Veterinary applications conducted a survey in order to map the field with regards to the types of procedures that are performed within the HERCA member countries. As a result of this survey, at that time five different HERCA member countries indicated that veterinary radiotherapeutic procedures conducted in their country. It is very likely that the number of countries conducting these types of practices has changed since 2013. In the Proceedings of the Fifth International Symposium on the System of Radiological Protection (Annals of the ICRP, Volume 49 NO S1.2020, page 171), it is stated that there are more than 20 centres across Europe that provide megavoltage, brachytherapy and orthovoltage therapies.

In order to have an overview of the types of practices that were conducted in the different HERCA member countries, an attachment was added to this document. This information reflects the situation in the HERCA member countries in 2021. However, the number of facilities is expected to increase substantially in the coming years.

Considering the lack of facilities at this time in Europe that perform brachytherapy or use radioactive sources for external beam radiotherapy, the rest of the document will only discuss the requirements for facilities that use X-ray equipment or linear accelerators for veterinary radiotherapy.

It is also important to highlight that, depending on the country, these types of practices are authorized differently. In some cases these types of practices require a licence, while in other countries some of these practices fall under a registration regime. Certainly with regards to the orthovoltage X-ray equipment, differences in authorisation regimes can be noticed.

3. Types of procedures

Different modalities can be used in order to treat the animal patient, and each of these types of practices requires a specific set of safety measures.

3.1 Use of orthovoltage X-ray equipment (200-500 kV) / Contact therapy

Most veterinary radiotherapy facilities use orthovoltage X-ray equipment with a maximum tension of between 200 and 500 kV for curative or palliative purposes. The most well-known example of this is contact therapy, where skin lesions or tumours are treated with specific X-ray equipment, such as the treatment of squamous cell carcinoma in cats or T-cell lymphoma of the skin in dogs. This orthovoltage X-ray equipment is sometimes even used to reduce symptoms of osteoarthritis in dogs.

In some cases these types of equipment are even used during a surgical procedure (intra-operative radiotherapy). Here, the tumour bed is irradiated after tumour resection, if the margins aren't clear. This in order to reduce the chances of regrowth of the tumour because of residual malignant cells. In this case, personnel exits the room during the treatment itself to limit unnecessary exposure to the personnel. The vital functions of the animal can be followed from outside of the room by the staff.

It is clear that these types of equipment requires less shielding than linear accelerators and is less expensive, but the number of indications is limited as they can only be used for superficial lesions.

3.2 Use of linear accelerators

Some veterinary radiotherapy facilities use linear accelerators for external beam radiotherapy. This type of equipment, because of the high energy, can be used for a large number of indications, including more complex and deeper laying tumours. Another advantage of this type of equipment is that there is no radioactive source, so there are less problems with security and the need to replace the source. It is also relatively easy to adapt the output to the individual patient.

The equipment that is used is very similar to the equipment used in human medicine. Some facilities even use second hand equipment from medical radiation facilities, other buy it directly from a manufacturer.

In this case, high energy photon or electron beams (multiple MV or MeV) are used to irradiate the target volume of the animal patient in either curative or palliative settings. The beam can be configured in different directions and shapes in order to minimise the dose received by the non-malignant tissue surrounding the target volume.

The accelerator can be equipped with other X-ray generators and detectors, such as a CBCT or a EPID (Electronic Portal Imaging device) in order to verify the position of the animal or even to monitor the dose.

The high dose rates that can be produced by these types of equipment and the high energy of the beams does come with a downside. When constructing a bunker for this type of equipment, a (adequate) high amount of shielding is required to protect the personnel in the facility and this comes at a cost. Particular attention should be given to installation of interlocks at the entrance of the bunker and installation of multiple emergency stops to avoid any unnecessary exposure to the personnel.

3.3 Use of sealed sources

3.3.1 External beam radiation

It is also possible to use Co-60 instead of using a linear accelerator. In this case, the activity of the source has to be taken into consideration in the planning of the treatment, in order to give the same dose to the target volume, regardless of the age of the source. In order to keep the duration of the treatment to a minimum, the source has to be changed regularly which can also come at a substantial cost.

The radiation protection concerns and measures are similar to those with a linear accelerator, but when choosing this type of treatment, one should also be mindful about the security risks associated with these types of sources. Considering the long half-life of these sources, they cannot be kept in the facility as radioactive waste for decay storage. This has to be taken into consideration when negotiating with the manufacturer and during decommissioning.

3.3.2 Brachytherapy

In some cases, radioactive sources are used for veterinary brachytherapy. The most common type of procedure involves the use of an afterloading system (mostly Ir-192). Here, a tube connects the afterloader with the target volume of the animal and the source is guided through the tube with a wire. After the treatment, the source returns to the afterloader and the animal is disconnected from the afterloader.

Seldom, low dose rate brachytherapy is performed. Here, a radioactive source, with a lower activity than with the afterloader system, is implanted into the target volume of the animal patient and is kept there for a longer period. During this time, the animal remains in isolation. After the treatment, the radioactive source is removed from the animal. Implanting permanent radioactive sources into animals such as I-125 seeds, has not been considered justified due to the radiation risk for members of the public and environment as the animal exits the facility.

In general, the animals undergo the irradiation treatments under sedation or under general anaesthesia. This ensures that the animal will not move during the treatment and the treatment can be performed as quickly as possible without unnecessarily irradiating healthy tissues because of the movement of the animal. This also allows the staff to exit the bunker during the treatment. This will minimise the risk of exposure to the staff. Other radiation protection concerns to be mindful for is the training of the personnel involved in these types of treatments and the shielding requirements. Considering that the personnel can exit the room during the treatment, the necessary measures should be taken to avoid people from entering the room during treatment and the appropriate methodology should be determined to monitor the vital functions of the animal.

Prior to using these radiation techniques the question should be answered whether they are justified given the specific circumstances. This also includes considering alternative techniques that do not involve the use of ionizing radiation, such as the use of lasers, chemotherapy, etc. Of course, the availability of the various techniques plays a role in the decision making process.

4. Flow of the treatment

In order to understand and validate the types of safety measures that are appropriate, it is important to understand the general flow of the treatments. This is very similar to that used in human medicine.

4.1. Simulation

Once the veterinarian referred the animal to a veterinary oncologist, the latter decides on the most appropriate technology, taking into consideration other (non-ionising radiation) techniques. After this justification process, imaging is done on the animal in order to have a clear view on the tumour target volume and to have a view on the surrounding healthy tissues. This is generally done by a veterinarian. During this simulation particular attention is paid to the positioning of the animal to achieve that same position during the treatment itself. For this imaging, conventional imaging equipment, such as CT is used. The animal is put under a light sedation or anaesthesia during the imaging procedure.

4.2. Planning

The images from the simulation stage are used to plan the radiation treatment. The target volume that has to be irradiated is delineated by the veterinarian and either the veterinary oncologist or a medical physics expert determines the best conformation of beams and energies in order to irradiate the tumour target volume according to the prescribed dose while minimising the dose to the surrounding healthy tissues. Treatment planning software is used for this.

4.3. Treatment itself

While installing the animal on the treatment table, the same position is used as for the simulation. For this purpose, lasers can be used to correctly align the target volume with the isocentre of the accelerator.

5. Design of a radiotherapy facility

In the design phase of a new veterinary radiotherapy facility, many of the principles used in human radiotherapy facilities can be used. In the design, particular attention should be paid to the different functions of the rooms and making a clear distinction between rooms that need to be accessible to the owners / members of the public and the more technical area where you have the actual radiotherapy bunker, the console of the equipment (outside of the bunker), an imaging room.

In the design, one should not only take radiation protection aspects into consideration with the aim to limit the doses to the public and the workers, but also security aspects. The installation of a badge system and blocking general access is therefore a good idea.

For more details with regards to the design and organisation, we refer to the IAEA Safety Report N° 104 on the Radiation Protection and Safety in Veterinary Medicine.

6. Education and training of the staff

In order to understand the risks associated with veterinary radiotherapy, it is of the utmost importance to have trained staff preparing for and performing the procedures. This applies for the veterinarian/oncologist but also for the veterinary assistants/technologists. In some countries, facilities are required to have a medical physics expert performing quality checks on the equipment or even planning the treatment of the animals. It is clear that it is the regulatory body of the individual country that will determine what the roles and responsibilities are of the different persons involved in the procedures.

The suggested education and training requirements for veterinary professionals, can be found in the 2017 HERCA Guideline on Education and Training Requirements for Veterinary Professionals that is available on the HERCA webpage.

7. Quality Control

Countries with veterinary radiotherapy units generally require the facilities to set up a quality control and quality assurance program, which includes verifying the output of the accelerator and verifying whether the different components are working correctly. In this QA program, aspects with regards to the protection of the individual animals may be included in these programs. In some countries, a medical physics expert (from human medicine) is involved in this process as they tend to have more experience in setting up the QA/QC program for this type of equipment. Then of course, the involvement of a health physics expert, is always required.