



Smith, P. A.D., Burnside, S., Helm, J. R. and Morris, J. S. (2019) Owner perceptions of radiotherapy treatment for veterinary patients with cancer. *Veterinary and Comparative Oncology*, 17(3), pp. 221-233. (doi:[10.1111/vco.12454](https://doi.org/10.1111/vco.12454)).

There may be differences between this version and the published version. You are advised to consult the publisher's version if you wish to cite from it.

This is the peer reviewed version of the following article:

Smith, P. A.D., Burnside, S., Helm, J. R. and Morris, J. S. (2019) Owner perceptions of radiotherapy treatment for veterinary patients with cancer. *Veterinary and Comparative Oncology*, 17(3), pp. 221-233, which has been published in final form at [10.1111/vco.12454](https://doi.org/10.1111/vco.12454). This article may be used for non-commercial purposes in accordance with [Wiley Terms and Conditions for Self-Archiving](#).

<http://eprints.gla.ac.uk/177691/>

Deposited on: 14 January 2019

# **Owner perceptions of radiotherapy treatment for veterinary patients with cancer**

Key words:

Veterinary radiotherapy, perceptions, quality life

## **Abstract**

Veterinary clients may have trepidation about treating their pet with radiotherapy due to concerns about radiation side effects or repeated anaesthetics. The purpose of this study is to assess whether owners' attitudes towards veterinary radiotherapy, including concerns over side effects, change during the course of treatment, and whether radiotherapy was perceived to affect pets' quality of life. A prospective cohort study of clients from 2012-2015 was performed. Pets received palliative or definitive radiotherapy for various tumours. Clients completed questionnaires before, during and after radiotherapy. Questions assessed owner preconceptions before treatment, including side effect expectations, actual side effects experienced, and overall satisfaction with the process. In addition, at each time point the owners assessed their pet's quality of life using a simple numerical scale. 49 patients were included. After completing treatment, owners were significantly less concerned about potential side effects of radiotherapy ( $P<0.001$ ), side effects associated with repeat anaesthetics ( $P<0.001$ ), and about radiotherapy in general ( $P<0.001$ ). Quality of life did not show a significant change at any point during or after treatment. Following treatment, 94% reported the experience was better than expected and 100% supported the use of radiotherapy in pets. This is the first prospective study evaluating client attitudes and satisfaction before and after radiotherapy treatment in pets. The results indicate that radiotherapy is well tolerated, and the anxiety associated with radiotherapy is significantly alleviated after experiencing the process. These results will help veterinarians allay client concerns, and will hopefully lead to an increase in clients pursuing radiotherapy in pets.

## **Introduction**

Radiotherapy is an expanding field of veterinary medicine. There has been significant growth in the number of veterinary centres providing radiotherapy in recent years, with one (US) survey finding a 57% increase in the number of facilities providing veterinary radiotherapy between 2001 and 2010<sup>1</sup>, as well as increased access to more advanced radiotherapy techniques. When presented as a treatment option, veterinary clients may have trepidation about treating their pet due to concerns about radiation side effects or repeated anaesthetics. Many of these concerns may be unfounded and possibly stem from a lack of experience and understanding of radiotherapy.

Side effects associated with radiotherapy are dependent on the protocol used and the area being treated<sup>2, 3</sup>. Definitive intent protocols generally involve using smaller daily fractional doses more frequently (“conventionally fractionated”) and are typically associated with more acute side effects and fewer late radiation side effects. Conversely palliative protocols involve fewer but larger radiation doses separated temporally, often dosed weekly, (“hypofractionated”) and are less likely to cause acute side effects however increase the chance of late side effects. Acute radiation side-effects occur commonly and predictably using conventionally-fractionated protocols and occur in rapidly dividing tissues (skin, mucous membranes, gastrointestinal mucosa etc)<sup>2</sup>. They can usually be well managed with symptomatic treatments including oral antibiotics and anti-inflammatory corticosteroids and although severe in some cases, such effects are usually short-lived and rarely leave permanent damage. Late radiation effects are uncommon, occurring in less than 5% of patients<sup>3</sup>. They are potentially serious and irreversible and are most commonly associated with hypofractionated protocols. Hypofractionated protocols are generally used in palliative settings where animals have a short predicted survival. Late side effects generally develop 1-2 years following radiotherapy in tissues with slow turnover rates (eg bone, connective tissues, nerves etc).

In the author’s experience there is still some reluctance to pursue radiotherapy amongst pet owners, perhaps due to prejudices stemming from a lack of understanding of the procedure or from prior experiences with radiotherapy in the human field, which can lead owners to believe the treatment will negatively impact their pet’s quality of life. Even amongst veterinarians, there is often a lack of understanding about what radiotherapy entails. In a previous survey of referring veterinarians concerning radiotherapy, only 57% had attended education programs for oncology or radiotherapy<sup>4</sup>. Veterinarians that had not attended education programs reported significantly less positive views regarding radiotherapy and estimated a significantly lower quality of life for patients undergoing radiotherapy. These veterinarians also reported significantly fewer situations where they believed radiotherapy was indicated than veterinarians which had attended oncologic or radiotherapy education programs<sup>4</sup>. This suggests that a lack of understanding and education about radiotherapy in pets in both veterinarians and owners could potentially be leading to pets not receiving appropriate treatment.

Assessing quality of life in veterinary patients has been discussed in numerous studies<sup>5-9</sup>.

Traditionally veterinary studies have inferred the impact of treatment on an animal’s quality of life from objective measurements of physical side effects. Recently however there has been an increase in specifically assessing pet quality of life in response to treatments. A 2017 article reviewed quality

of life measurement in studies with cats or dogs receiving chemotherapy, and identified 11 studies which included quality of life measurements as part of the study<sup>10</sup>.

While there is no widely accepted definition of quality of life in veterinary patients, most agree that quality of life assessments encompass a continuum of an animal's physical and mental well-being. As animals are unable to self-report, proxies are needed to assess their quality of life. Owners are frequently chosen as proxies as they are invariably the most familiar with the pet, including its normal behaviours and routines. Several studies have assessed the validity of using questionnaires with the owner of the pet acting as a proxy and these found that a simple questionnaire design is a useful tool to assess a pet's quality of life<sup>6,8</sup>.

Numerous previous studies have assessed owner perceptions and patients' quality of life in pets undergoing specific treatments for cancer<sup>4,11-15</sup>. However only three previous studies have specifically addressed the use of radiotherapy in pets<sup>4,14,16</sup>. All three studies were retrospective cross-sectional studies using questionnaires or phone interviews completed between one month and eight years after completing radiotherapy. These studies relied on owners' recollections of subjective perceptions and would have been susceptible to response bias. Patient quality of life was perceived to improve in 60-78% of cases in two studies<sup>14,16</sup>, and remain stable/improve in 87% of cases in the third study<sup>4</sup>. In these same studies, 79-96% of clients responded that they would go through the process again. The majority of patients in these surveys received palliative radiotherapy, with one study<sup>16</sup> focussing solely on patients receiving palliative radiotherapy. This is likely to positively impact owners' perceptions, as palliative radiotherapy is used to directly reduce morbidity associated with cancer, and so improve quality of life.

No previous studies have assessed the owners' attitudes towards radiotherapy prior to commencing treatment, and all studies have relied on memory to assess how the owners' views had changed after the experience.

The aim of the current study was to assess how clients' attitudes regarding the use of radiotherapy in their pet changed over the course of treatment, using questionnaires completed contemporaneously throughout the treatment process. A secondary aim was to assess how the perceived quality of life changed over the course of treatment. Based on our subjective experience, we hypothesised that clients would become less anxious concerning possible complications after

they had experienced the process, and that there would be no reduction in the perceived quality of life of their pets throughout the process.

### **Materials and methods**

Ethical approval was given by the College of Medical, Veterinary and Life Sciences ethics committee at University of Glasgow in 2012.

From April 2012 to April 2015, all owners of animals referred to the radiotherapy service at University of Glasgow Small Animal Hospital were invited to participate in the study if their animal was to be treated with radiotherapy as an out-patient. Questionnaires were completed at time of visit by owners while waiting for their animal to be treated or at a subsequent recheck appointment. For inclusion in the final analysis completion of both the first and final questionnaire and at least one inter-treatment questionnaire was required. Patients were assigned a number for the study and questionnaires were matched by number to blind the attending clinicians to responses.

#### Radiotherapy protocols

Radiotherapy was delivered using a Siemens OncorExpressionPlus linear accelerator with multileaf collimator using 6MV photons or an electron beam of varying energy as determined appropriate in the planning process. A variety of radiation protocols were used depending on the disease being treated and goals of therapy. Palliative-intent radiotherapy was defined as radiotherapy aiming to reduce morbidity associated with the disease, while definitive intent radiotherapy was defined as radiotherapy aiming to achieve a durable complete response.

For microscopic residual disease around superficial surgical scars radiotherapy fields were manually planned to depth dose, using bolus as appropriate, including a 2-3cm margin surrounding the surgical scar and either a single or parallel-opposed fields. The field coverage was planned to 95% total dose. For non-superficial structures of the head, neck and spine, patients were positioned in dorsal or sternal recumbency using personalised beam directional shell and vacuum cushions to immobilise the head along with larger vacuum cushions and/or radiography cradles as necessary to immobilise the body. Position was verified using megavoltage electronic portal imaging, with alignment to skull or other anatomy prior to each dose of radiotherapy with a 2mm tolerance. Individualised treatment plans were generated using a 3D conformal computer planning software (Prowess Panther) and multiple coplanar beams with multileaf collimator, based on CT images of affected region (with contrast as necessary to view the lesion), and dosed to isocentre. Gross

tumour volume (GTV) was outlined using CT images and 0.5-1cm margin added for planned treatment/target volume (PTV) depending on tumour location and suspected/confirmed histological type. Radiation dose was conformed to the PTV as precisely as possible while attempting to exclude normal tissues. Ninety five percent of the total dose was prescribed to the planning target volume. Variations up to a maximum dose of 107% were considered acceptable.

#### Anaesthesia

Anaesthetics were performed by a board certified anaesthetist or anaesthesia resident. Anaesthetics typically lasted 20-45 minutes and animals were discharged once they were able to walk without assistance. Admission to discharge times were typically 60-90 minutes.

#### Adverse effects

Adverse effects were graded according to the Veterinary Radiation Therapy Oncology Group (VROG) radiotherapy side effects guidelines<sup>17</sup>. They were treated according to clinician preference, typically with oral anti-inflammatory prednisolone (usually 0.5mg/kg) and antibiotics.

#### Questionnaire Design

Four questionnaires (appendix 1) were designed to assess the owner's perceptions of radiotherapy at different points during treatment: prior to commencing radiotherapy ("pre-treatment"); at the time of a treatment during the radiotherapy protocol ("mid-treatment"); at the time of the final radiotherapy treatment ("end-treatment"); and at the standard check-up appointment two to four weeks following the final radiotherapy treatment ("post-treatment"). To ensure all answers were scored from one (low impact of radiotherapy) to five (high impact of radiotherapy) in analysis, some negatively-phrased questions were included. The questionnaire was trialled on approximately 10 clinicians and nurses within the University of Glasgow Small Animal Hospital prior to commencement and feedback was used to modify questions to minimise ambiguity. The attending clinicians were blinded to the responses during the radiotherapy treatment however the author was unblinded for data analysis in order to correlate responses with case records.

The "pre-treatment" questionnaire was given to the owner at the initial consult when radiotherapy was first recommended for the patient or on the day of the first radiotherapy treatment. This questionnaire had 16 questions which included demographics, perceived quality of life, owner's prior knowledge of radiotherapy, insurance status and questions to gauge owner's perceptions and anxiety with regards to radiotherapy.

The “mid-treatment” questionnaire was given at the half way point of treatment and had three questions assessing side effects of radiotherapy, side effects of concurrent medications used during radiotherapy and the perceived quality of life of the patient at this point. The “end-treatment” questionnaire was the same design as the mid questionnaire but given on the final day of treatment.

The “post-treatment” questionnaire was given at the check-up appointment between 2 and 4 weeks after the final radiotherapy treatment. This included the questions in the mid and post questionnaires but also included comparable questions to the pre-treatment questionnaire to allow for direct comparison of attitudes before and after undergoing treatment

Quality of life was measured using a simple numerical scale from 1-10, with one indicating quality of life could not be worse and 10 indicating quality of life could not be better.

#### Statistical analysis

Quality of life was measured at four time points and was analysed using an ANOVA with repeated measures test. Discrete statements (ordinal variables) were measured twice, before treatment and at follow up and were analysed using a Wilcoxon signed rank test. Responses were assigned a value (1-5) for analysis. Values of  $P < 0.05$  were considered significant.

#### **Results**

128 patients were referred for radiotherapy during the study period (April 2012 – April 2015). Of these, the owners of 96 patients (74%) completed at least one questionnaire. 47/96 (49%) patients were excluded from the study as they did not complete both the first and last questionnaires. 49/96 (51%) animals met the inclusion criteria; 42 patients had all four questionnaires completed and seven patients had three out of four questionnaires completed. The reason for non-completion of questionnaires was not recorded.

Of the 128 patients treated in the study period, 17/128 (13%) did not complete the originally prescribed protocol. One of these patients was treated with two courses of radiotherapy during the study period. This patient successfully completed the first protocol however did not complete the second protocol due to disease related morbidity. 9/17 did not complete the protocol due to radiotherapy-unrelated factors (most commonly disease related morbidity or discovery of metastasis). 6/17 received reduced doses due to acute radiotherapy adverse events. 4/6 received a reduced number of fractions (and reduced overall dose) and 2/6 received a reduced overall dose

however the planned number of fractions. All six of these patients suffered grade two adverse events (4/6 cutaneous, 2/6 mucous membrane). 2/6 of these patients were included in the study. 2/17 stopped treatment due to acute gastrointestinal clinical signs and morbidity suspected to be due to undergoing general anaesthesia.

### Owners

44/49 (90%) of patients undergoing treatment were insured and so had all or part of the cost of treatment paid for them; 30/44 (68%) reported they would have pursued radiotherapy even if not insured; 8/44 (18%) would not have pursued treatment without insurance and 6/44 (14%) did not submit a response to the question. 15/49 (31%) of owners reported having prior experience with radiotherapy. The vast majority (14/15) had experience from human medicine, with 7/15 having known someone who had been treated with radiotherapy, 6/15 working in human health care and one who had received treatment themselves. Only one owner had prior veterinary radiotherapy experience with a previous pet.

Only 28/49 (57%) of respondents were aware radiotherapy was a treatment option available to pets prior to their pet becoming ill.

### Animals

47 dogs and two cats were included in the study. Both cats were domestic short hairs. Of the dogs there were nine cross breeds, eight Labradors, five Staffordshire bull terriers, four golden retrievers, three labradoodles, two border collies and one each of cocker spaniel, Bichon frise, German shepherd dogs, rottweiler, shih tzu, Lhasa apso, saluki, Border terrier, boxer, weimaraner, bearded collie, lurcher, Shetland sheep dog, beagle, spinone and grey hound.

The median age of animals was 8.8 years (range 1.3-14.2 years). There were 22 and six neutered and entire females respectively, and 15 and six neutered and entire males respectively.

### Tumours treated

Tumours treated are listed in Table 1.

### Protocols

47/49 animals were treated with a protocol that was considered definitive, while 2/49 animals were treated with a protocol that was considered palliative: a Labrador with oral melanoma treated with



36Gy delivered weekly over four treatments of 9Gy and a Rottweiler with histiocytic sarcoma treated with 20Gy delivered daily over 5 treatments of 4Gy.

Various protocols were used (table 1). The most common protocols used were 48Gy divided into 12 fractions of 4Gy (n=23), 40Gy divided into 8 fractions of 5Gy (n=17), 48Gy divided into 16 fractions of 3Gy (n=4) and five other protocols each used in a single animal.

41/49 protocols used photons and 8/49 protocols used electrons. Electrons were used when superficial lesions were being treated and/or radiosensitive organs were located deep to the radiation field. 20 animals had gross disease and 29 had microscopic disease at the time of radiotherapy.

#### Additional treatments

31 patients had surgery as part of their treatment prior to radiotherapy (including one prophylactic enucleation to avoid ocular radiotherapy side effects). Radiotherapy was commenced two to three weeks post-surgery. 11 patients underwent chemotherapy as part of their treatment. 4/9 received intravenous chemotherapy concurrently with radiotherapy (three received vinblastine for mast cell tumour (MCT), one received carboplatin for anal sac adenocarcinoma), 1/9 received metronomic cyclophosphamide prior to radiotherapy and 6/9 received chemotherapy after radiotherapy (including two patients who received toceranib). One patient received a course of melanoma vaccination.

#### Adverse effects

Acute adverse events were recorded by the highest grade adverse effects reported at any point during/after treatment (for example if an animal had grade one skin adverse effects and grade two mucous membrane adverse effects it was recorded as a grade two). These are listed in Table 1. Nine animals had no adverse effects, 14 patients had grade one, 24 had grade two, and two had grade three. Location of all reported adverse effects were skin (n=37), mucous membrane (n=10), ocular (n=3), and lower gastrointestinal (n=1).

Of the six animals that suffered no acute radiotherapy adverse effects, 5/6 were being treated with conventionally fractionated protocols for brain or spinal neoplasms and one was being treated palliatively with a hypofractionated protocol for histiocytic sarcoma.

45/49 (92%) either “strongly agreed” or “agreed” with the statement “My pet did NOT have problems with repeat anaesthetics”. Only three owners responded “disagree” to the statement and none “strongly disagreed” or were neutral. One owner did not complete this question.

### Questionnaire answers

Six questions present in the “pre-treatment” and “post-treatment” questionnaires were available for analysis. One question was excluded (“My partner/other family felt radiotherapy is the best option for our pet but I am unsure”) as the respondent was not standardised between visits, which made the results difficult to interpret. The remaining five questions were selected from the “pre-treatment” and “post-treatment” questionnaires for analysis (Table 2 and 3).

### **Quality of life measurement**

Quality of life was assessed for change in the 42 patients which had all four questionnaires completed. The quality of life measurement showed no significant change throughout the four time points measured during the treatment process ( $p=0.246$ ). The median quality of life scores recorded in the “pre”, “mid”, “end” and “post” questionnaires were 8/10 (range 1-10), 8/10 (range 4-10), 8/10 (range 4-10) and 9/10 (range 2-10).

### **Post-treatment questions**

44/49 (90%) of respondents “agreed” or “strongly agreed” with the statement “My pet has not had excessive side effects from radiotherapy”. One client each disagreed and strongly disagreed with the statement. The remaining 3/49 respondents were “neutral”.

47/49 (96%) of respondents “agreed” or “strongly agreed” with the statement “I am happy I chose to treat my pet with radiotherapy”. 2/49 respondents were neutral and none “disagreed” or “strongly disagreed” with the statement.

Most owners (46/49, 94%) reported both that overall the radiotherapy experience was better than they expected, with 27 and 19 owners responding they “strongly agreed” and “agreed” with the statement “The radiotherapy experience was better than I expected”, respectively. Two respondents “disagreed” with the statement and one was “neutral”.

### **Discussion**

To the authors' knowledge this is the first study specifically evaluating the evolution of owners' attitudes towards radiotherapy in pets before and after gaining first-hand experience of the treatment modality. The results clearly show that client anxiety regarding the side effects of radiotherapy and repeat anaesthetics decrease after experiencing the process. This indicates that much of the anxiety surrounding radiotherapy in pets may be based on incorrect preconceptions regarding the expected side effects from radiotherapy and repeat anaesthetic procedures. Importantly, most owners (46/49, 94%) reported that overall the radiotherapy experience was better than they expected, 44/49 (90%) reported that their pet did not experience excessive side effects, and no owners reported being unhappy with their choice to treat their pet with radiotherapy.

Quality of life is of paramount concern for owners when making treatment decisions for pets. This is particularly true in oncologic cases where often the intent of treatment is not to cure the pet, but to extend good quality of life. Minimising side effects of treatment is therefore a primary goal. Surrogate assessment of quality of life in pets has been assessed in numerous studies<sup>5-9</sup>, and it is generally agreed that an animal's owner is an appropriate surrogate. The current study utilised a simple numerical scale to estimate patient quality of life, which may not reflect the true quality of life of the patient. A more comprehensive questionnaire, such as the Canine Owner-Reported Quality of Life (CORQ) questionnaire<sup>18</sup> may have allowed more accurate measurement of patient quality of life. The primary aim of the current study, however, was to assess owner perceptions, rather than actual quality of life, and therefore the more simple scale was chosen. The current study showed that undergoing radiotherapy did not significantly reduce quality of life in patients\*, as judged by the pet's owner.

The current study is the first prospective study assessing client attitudes of radiotherapy in pets. It is also the first using multiple time points. The prospective study design and completion of questionnaires at the time of treatment will have reduced response bias which is likely to have been present in previous retrospective studies. Also, previous studies assessing owner perceptions of radiotherapy in pets had significantly higher proportions of animals receiving palliative radiotherapy<sup>4, 14, 16</sup>. As palliative radiotherapy is used to directly reduce the morbidity associated with cancer, we expect the owners of these patients to have reported relatively fewer adverse effects. This is because the benefits of the treatment (for example the reduction of pain associated with an osteosarcoma) will usually greatly outweigh the side effects of the treatment hence owners perceive a net improvement in their pet's quality of life, even if they develop side effects.

In the current study 43/49 (88%) of patients developed side effects according to the VCOG-RT guidelines. Interestingly, only 2/49 (4%) of respondents perceived the side effects to be “excessive”. In previous studies, owners have reported their pets suffered adverse effects in 33-65% of cases, however also reported an improvement in quality of life in 60-78%<sup>4,16</sup>. This indicates that while side effects may be common, they are often perceived to be tolerable and not negatively impact the patients overall quality of life.

A limitation of the study was the inclusion of four patients receiving chemotherapy concurrently during their radiotherapy protocols, as concurrent treatment may have impacted perceived side effects. However, none of the owners of these animals felt their pet suffered excessive side effects of treatment, ie none “disagreed” with the statement “My pet has NOT had excessive side effects from the radiotherapy treatment”, indicating that this would not have impacted the results. Only one of the owners of a pet receiving chemotherapy concurrently with radiotherapy (vinblastine for MCT) reported concerns about the side effects of radiotherapy following treatment (“disagreed” with the statement “I do NOT have any concerns about the side effects of treatment”). This patient had grade two skin side effects.

Only 2/49 (4%) patients suffered grade 3 side effects. The first was a dog with an oral sarcoma which had its protocol reduced (from a planned total of 48Gy to a total of 46.9Gy) due to the development of grade three mucous membrane and grade two skin side effects which were deemed unacceptable. Interestingly this owner did not report that the side effects had been excessive, and in spite of these side effects at the end of treatment they responded that they felt it was the best treatment for their pet and were not apprehensive about the procedure, anaesthetics or potential radiotherapy side effects. The other patient was being treated for perianal fibrosarcoma with electron therapy and suffered grade three skin side effects. This owner reported having concerns about the side effects of radiotherapy and repeat anaesthetics following treatment, and was one of the two clients who did not “agree” or “strongly agree” that they were happy they chose to pursue radiotherapy.

Only two owners reported that their pet suffered excessive side effects. Of these two cases, the first was a pituitary macroadenoma which suffered no adverse effects according to the VRTOG guidelines, making the questionnaire response difficult to explain. It is possible the negative responses were due to severe neurologic impairment due to the tumour or due to side effects from

concurrent steroid use. The second patient had a perianal fibrosarcoma and, prior to radiotherapy, had post-operative complications including a draining-sinus. During radiotherapy this patient suffered grade 3 skin side effects and the owner also felt their pet did not tolerate repeated anaesthetics well.

The majority of patients did not have problems with repeat anaesthetics, with only 3/49 perceiving that their pet had problems with repeat anaesthetics. Specific anaesthesia protocols were not included in the study and future investigations would be required to determine if variables related to the anaesthesia (for example the choice of anaesthetic drugs) influences a pet's perceived quality of life during treatment.

Importantly, the vast majority of owners (46/49, 94%) reported that the radiotherapy experience was better than they expected. These results indicate that for most owners the procedure exceeds their expectations. Of the two respondents who reported the process was worse than expected (one other respondent was "neutral"), one was the previously mentioned dog with an oral sarcoma which suffered grade three side effects related to the oral location of the tumour. The other was a cat with central nervous system lymphoma which suffered significant disease-related neurological symptoms throughout treatment. Interestingly, in both the cases the owners still "strongly agreed" with the statements "I support the treatment of radiotherapy in pets" and "I feel radiotherapy was the best treatment for my pet". This indicates that even when the experience was not as positive as expected, it was still considered worthwhile by the owners.

In the current study the most common definitive radiotherapy protocol involved 12 fractions of 4 Gy (total of 48 Gy) given on a Monday, Wednesday, Friday basis. Other centres may use more hyperfractionated protocols (eg daily fractions) which may have more severe acute adverse events or anaesthetic complications which would impact on client attitudes.

The current study is in agreement with previous studies<sup>4, 14</sup> in that the majority of clients reported that, if given the choice, they would go through radiotherapy again. This repeatable finding indicates that overall veterinary radiotherapy is considered beneficial and worthwhile to clients who have gone through the experience with pets with cancer. Crucially, all respondents in the current study supported the use of radiotherapy and none felt that radiotherapy was not the best treatment choice for their pet.

This study has several limitations. Firstly the study naturally selected for clients willing to proceed with radiotherapy, a group that may have been more likely to report a positive view of the procedure. Also, not all questionnaires were completed by the same owner of patients, which may have introduced some variability in responses. Finally, only acute adverse events were included in the study (due to the period of sampling), so the impact of late effects on client attitudes was not assessed.

Another limitation was the exclusion of patients that did not complete the full radiotherapy course, as they could not be included if they did not complete a “post-treatment”. Of the 17 patients which did not complete their originally prescribed radiotherapy course during the study period, only 6/17 were due to acute radiotherapy adverse events. Of these six patients, two completed the questionnaires and were able to be included in the study, mitigating this limitation to some extent. Of the 11/17 patients which did not complete the radiotherapy protocol for non-radiotherapy adverse event related reasons, one patient was still able to be included in the study as they had previously completed a full course of radiotherapy, including questionnaires, successfully.

Our study measured owner opinions while treatment was ongoing. Previous studies have used retrospective surveys which have numerous inherent limitations, particularly when measuring subjective responses. The current study showed a clear improvement in owner attitude towards radiotherapy in pets as their pet went through the procedure.

## **Conclusion**

The results of this study indicate that radiotherapy is well tolerated by pets as judged by owners and the anxiety associated with undergoing radiotherapy and repeat anaesthetics is significantly alleviated after going through the process. These results will help veterinarians allay client concerns when discussing radiotherapy with clients, and will hopefully lead to an increase in clients pursuing radiotherapy for appropriate diseases in pets.

## **Funding/ Declarations of Interest**

Funded by University of Glasgow. No conflicts of interest to declare.

## **References**

1. Farrelly J and McEntee MC. A Survey of Veterinary Radiation Facilities in 2010. *Veterinary Radiology & Ultrasound*. 2014; **55**(6): 638-43.
2. McEntee MC. Veterinary radiation therapy: Review and current state of the art. *Journal of the American Animal Hospital Association*. 2006; **42**(2): 94-109.

3. Harris D, King GK and Bergman PJ. Radiation therapy toxicities. *Veterinary Clinics of North America-Small Animal Practice*. 1997; **27**(1): 37-8.
4. Denneberg NA and Egenvall A. Evaluation of dog owners' perceptions concerning radiation therapy. *Acta Veterinaria Scandinavica*. 2009; **51**.
5. Giuffrida MA and Kerrigan SM. Quality of Life Measurement in Prospective Studies of Cancer Treatments in Dogs and Cats. *Journal of Veterinary Internal Medicine*. 2014; **28**(6): 1824-9.
6. Wiseman-Orr ML, Scott EM, Reid J and Nolan AM. Validation of a structured questionnaire as an instrument to measure chronic pain in dogs on the basis of effects on health-related quality of life. *American Journal of Veterinary Research*. 2006; **67**(11): 1826-36.
7. Wojciechowska JI and Hewson CJ. Quality-of-life assessment in pet dogs. *Javma-Journal of the American Veterinary Medical Association*. 2005; **226**(5): 722-8.
8. Yazbek KVB and Fantoni DT. Validity of a health-related quality-of-life scale for dogs with signs of pain secondary to cancer. *Javma-Journal of the American Veterinary Medical Association*. 2005; **226**(8): 1354-8.
9. Yeates J and Main D. Assessment of companion animal quality of life in veterinary practice and research. *Journal of Small Animal Practice*. 2009; **50**(6): 274-81.
10. Vols KK, Heden MA, Kristensen AT and Sandoe P. Quality of life assessment in dogs and cats receiving chemotherapy - a review of current methods. *Veterinary and Comparative Oncology*. 2017; **15**(3): 684-91.
11. Mellanby RJ, Herrtage ME and Dobson JM. Owners' assessments of their dog's quality of life during palliative chemotherapy for lymphoma. *Journal of Small Animal Practice*. 2003; **44**(3): 100-3.
12. Bowles DB, Robson MC, Galloway PE and Walker L. Owner's perception of carboplatin in conjunction with other palliative treatments for cancer therapy. *Journal of Small Animal Practice*. 2010; **51**(2): 104-12.
13. Tzannes S, Hammond MF, Murphy S, Sparkes A and Blackwood L. Owners' perception of their cats' quality of life during COP chemotherapy for lymphoma. *Journal of Feline Medicine and Surgery*. 2008; **10**(1): 73-81.
14. Hill M, Hirschberger J, Zimmermann K, Dorfelt R, Reese S and Wergin M. Quality of life in primary and adjuvant veterinary radiation therapy. An owner survey. *Tierärztliche Praxis Ausgabe Kleintiere Heimtiere*. 2014; **42**(3): 157-65.
15. Hamilton MJ, Sarcornrattana O, Iliopoulou M, Xie Y and Kitchell B. Questionnaire-based assessment of owner concerns and doctor responsiveness: 107 canine chemotherapy patients. *Journal of Small Animal Practice*. 2012; **53**(11): 627-33.
16. Fan VC, Mayer MN, Sukut SL, Gustafson NR, Mauldin GN and Waldner CL. Retrospective survey of owners' experiences with palliative radiation therapy for pets. *J Am Vet Med Assoc*. 2018; **253**(3): 307-14.
17. LaDue T and Klein MK. Toxicity criteria of the veterinary radiation therapy oncology group. *Veterinary Radiology & Ultrasound*. 2001; **42**(5): 475-6.
18. Giuffrida MA, Brown DC, Ellenberg SS and Farrar JT. Development and psychometric testing of the Canine Owner-Reported Quality of Life questionnaire, an instrument designed to measure quality of life in dogs with cancer. *J Am Vet Med Assoc*. 2018; **252**(9): 1073-83.

**Table 1:** Radiotherapy protocols used, diseases treated, and side effects.

Protocol	Electrons or Photons (6 MeV)	Disease Treated	Disease Location	Adverse Event Score (n)			
				0	1	2	3
48Gy over 12 treatments (Monday, Wednesday, Friday) (n=23)	Photons	FSA (n=2)	Oral, extremity		1	1	
		Carcinoma (n=4)	Nasal (n=4)		2	2	
		SCC (n=3)	Tonsillar, oral, nasal	1		2	
		STS (n=6)	Extremity (n=6)		2	4	
		MCT (n=1)	Extremity			1	
		Chondrosarcoma (n=1)	Nasal			1	
		Sarcoma (n=2)	Retrobulbar, oral		1		1
	Electrons	SCC (n=1)	Extremity			1	
		FSA (n=1)	Perianal <sup>†</sup>				1
		STS (n=1)	Facial <sup>†</sup>			1	
Pilomatrixoma (n=1)		Extremity <sup>¶</sup>			1		
40Gy over 8 treatments (Monday, Friday) (n=17)	Photons	SCC (n=2)	Pharyngeal, oral			2	
		MCT (n=9)	Extremity (n=8), muzzle	1 <sup>  </sup>	5 <sup>   </sup>	3	
		Infiltrative lipoma (n=1)	Extremity	1			
		STS (n=1)	Extremity			1	
	Electrons	Adenocarcinoma (n=1)	Anal sac <sup>†</sup>			1 <sup>  </sup>	
		Fibrosarcoma (n=1)	Truncal <sup>‡</sup>			1	
		MCT (n=2)	Cutaneous muzzle§, axillary‡		1	1	
48Gy over 16 treatments (n=4)	Photons	Glioma (n=2)	Brain (n=2)	2			
		Pituitary adenoma (n=2)	Brain (n=2)	2			
48.6Gy over 18 treatments (n=1)	Photons	Meningioma (n=1)	Spinal	1			
39Gy over 11 treatments (n=1)	Photons	Fibrosarcoma (n=1)	Oral			1	
36Gy over 4 treatments	Photons	Melanoma (n=1)	Oral		1		



(weekly) (n=1)							
20GY over 5 treatments (n=1)	Photons	Histiocytic sarcoma (n=1)	Extremity	1			
32Gy over 8 treatments (n=1)	Photons	Lymphoma (n=1)	Brain		1		

SCC= squamous cell sarcoma, FSA= fibrosarcoma, STS= soft tissue sarcoma, TCC= transitional cell carcinoma, MCT= mast cell tumour

†= 12 MeV, ‡= 10MeV, §= 8 MeV, ¶= 15 MeV, ||= denotes a single animal which received concurrent chemotherapy

**Table 2:** Statements which showed a significant change pre- and post-treatment

Statement	Median response pre- and post-treatment	P-value
"I am NOT anxious/apprehensive about radiotherapy for my pet"	Pre-treatment: "neutral" Post-treatment: "Strongly agree"	0.000
"I do NOT have any concerns about the repeat anaesthetics during radiotherapy treatment"	Pre-treatment: "neutral" Post-treatment: "agree"	0.000
"I do NOT have any concerns about the side effects from the treatment"	Pre-treatment: "neutral" Post-treatment: "agree"	0.000

**Table 3:** Statements which did not show a significant change pre- and post-treatment:

Statement	Median response pre- and post-treatment	P-value
"I support the treatment of radiotherapy in pets"	Pre-treatment: "strongly agree" Post-treatment: "strongly agree"	0.317
"I feel radiotherapy is the best treatment for my pet"	Pre-treatment: "strongly agree" Post-treatment: "strongly agree"	1.000

## Appendix 1: Pre-treatment questionnaire

### Radiotherapy Questionnaire – Pre Treatment

Questionnaire Number:

Before your pet became ill, did you know that radiotherapy was available for pets?

Yes

No

Have you previously had any experience of radiotherapy?

Yes

No

If yes, how were you involved with radiotherapy previously? (Leave blank if you do not wish to answer.)

I have received treatment

A family member or close friend has received treatment

A previous pet has received treatment

I know a pet that has previously had treatment

I work/worked in human health care

I work/worked in animal health care

Have you got pet insurance?

Yes

No

If yes, would you have gone ahead with the radiotherapy treatment, if you did NOT have pet insurance?

Yes

No

PTO

Please Tick the box that indicates your opinion about the following statements.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I support the treatment of radiotherapy in pets					
I feel radiotherapy is the best treatment for my pet					
I am NOT anxious/apprehensive about radiotherapy for my pet					
My partner/other family felt radiotherapy is the best option for our pet but I am unsure					
I do NOT have any concerns about the repeat anaesthetics during radiotherapy treatment					
I do NOT have any concerns about the side effects from the treatment					

Please indicate, using the numerical rating scale, how your pet's quality of life was BEFORE it developed cancer?

1   2   3   4   5   6   7   8   9   10

QOL could  
not be worse

QOL could  
not be better

Please indicate using the numerical rating scale, how your pet's quality of life is TODAY? (AFTER being diagnosed with cancer)

1   2   3   4   5   6   7   8   9   10

QOL could  
not be worse

QOL could  
not be better

Please circle the correct description

Male   Female

Age Group (please circle)

18 – 25 years   26 – 40 years   40 – 55 years   56 – 65 years   66 years +

Please select the description which most closely matches where you live

City   Suburban   Rural   Unknown

**Appendix 2: Mid-treatment questionnaire**  
**Radiotherapy Questionnaire – Mid Point**

**Questionnaire number**

**Has your pet had any side effects from the MEDICATION taken during radiotherapy? (If your pet is not on medication please circle N/A)**

Yes

No

N/A

**If yes what are these side effects?**

---

---

---

---

**Has your pet had any side effects from RADIOTHERAPY treatment so far?**

Yes

No

**If yes what are these side effects?**

---

---

---

---

**Please indicate using the numerical rating scale, how your pet's quality of life was YESTERDAY?**

**1    2    3    4    5    6    7    8    9    10**

QOL could  
not be worse

QOL could  
not be better

## Appendix 3: End-treatment questionnaire

### Radiotherapy Questionnaire – End of Treatment

Questionnaire number

Has your pet had any side effects from the MEDICATION taken during radiotherapy since the last questionnaire? (Please describe even if they are the same as before)

Yes

No

If yes what are these side effects?

---

---

---

---

Has your pet had any side effects from the RADIOTHERAPY treatment since the last questionnaire? (Please describe even if they are the same as before)

Yes

No

If yes what are these side effects?

---

---

---

---

Please indicate using the numerical rating scale, how your pet's quality of life was YESTERDAY?

1    2    3    4    5    6    7    8    9    10

QOL could  
not be worse

QOL could  
not be better

## Appendix 4: Post-treatment questionnaire

### Radiotherapy Questionnaire - Check up

Questionnaire Number:

Has your pet had any side effects from the MEDICATION since finishing radiotherapy?

Yes

No

If yes what were these side effects?

---

---

---

---

Has your pet had any side effects from the RADIOTHERAPY treatment, since the last day of treatment?

Yes

No

If yes what were these side effects?

---

---

---

---

Please indicate using the numerical rating scale, how your pet's quality of life was YESTERDAY?

1    2    3    4    5    6    7    8    9    10

QOL could  
not be worse

QOL could  
not be better

PTO

Please Tick the box that indicates your opinion about the following statements.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
During radiotherapy treatment my pet always had good days					
During radiotherapy treatment my pet had more good days than bad					
My pet did NOT have problems with the repeat anaesthetics when it came for treatment					
My pet has NOT had excessive side effects from the radiotherapy treatment					
I am happy I chose to treat my pet with radiotherapy					
The outcome of radiotherapy has been as expected					
The radiotherapy experience was as I expected					
The radiotherapy experience was better than I expected					

Please answer the following questions in respect to putting another pet through radiotherapy.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I support the treatment of radiotherapy in pets					
I feel radiotherapy was the best treatment for my pet					
I am NOT anxious/apprehensive about radiotherapy for my pet					
My partner/other family felt radiotherapy is the best option for our pet but I am unsure					
I do NOT have any concerns about the repeat anaesthetics during radiotherapy treatment					
I do NOT have any concerns about the side effects from the treatment					

