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To cite this article: S Northover, K Hill, N Cogger & K Isaksen (20 Jul 2025): Surveying cytotoxic chemotherapy use in small animal cancer treatment: insights into use and influencing factors in New Zealand, New Zealand Veterinary Journal, DOI: [10.1080/00480169.2025.2533200](https://doi.org/10.1080/00480169.2025.2533200)

To link to this article: <https://doi.org/10.1080/00480169.2025.2533200>



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Surveying cytotoxic chemotherapy use in small animal cancer treatment: insights into use and influencing factors in New Zealand

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ABSTRACT

Aim: To determine how frequently cytotoxic chemotherapy is administered in small animal practice to treat cancer and the reasons why clinics and clinicians do or do not offer and administer chemotherapy in New Zealand.

Methods: A cross-sectional study involving veterinarians working in small and mixed animal practice was performed using an online questionnaire distributed via social media and email. The survey included closed and open-ended questions on respondent demographics, frequency of chemotherapy administration, medications used, cancers treated, and factors influencing administration. Fisher's exact tests were used to assess associations between variables, and content analysis was applied to open-ended responses.

Results: Completed questionnaires were returned by 164 veterinarians working in New Zealand during the study period. Of the 164 respondents, 131 (80%) stated that they would probably or definitely discuss cytotoxic chemotherapy with clients as a potential treatment option for small animals with cancer. Within the 12-months preceding July 2023, 56 (34%) respondents had personally administered chemotherapy and 96 (58.5%) worked at clinics where it was administered: 5 (3%) administered it weekly, 6 (4%) at least monthly, 21 (12.8%) every 1–6 months, and 22 (13.4%) every 6–12 months.

The most common reason given for administering chemotherapy was to provide comprehensive care to the patient. Improving quality and quantity of life was frequently reported. The most common reason for not administering chemotherapy was referral of cases externally for treatment. Excluding referral, respondents stated they do not administer chemotherapy because of insufficient knowledge regarding chemotherapy and the medications used, or insufficient training in how to handle and administer cytotoxic medications. Of the veterinarians that do not currently perform chemotherapy, 40% and 42% would consider performing it if they had additional education in oncology and chemotherapy, and in the handling and administration of cytotoxic medications, respectively.

Conclusion: Cytotoxic chemotherapy is frequently discussed as a treatment option by veterinarians in New Zealand but is currently administered by a smaller proportion. Decisions to use chemotherapy are guided by quality-of-life considerations and adherence to standards of care, while limited knowledge and training hinders its use by other clinicians.

Clinical relevance: Chemotherapy is administered less frequently in New Zealand than in the UK. Continuing education and the development of resources that further clinicians' knowledge regarding oncology, chemotherapy, and safe drug handling and administration are needed to support wider adoption in clinical practice.

Abbreviations: VCNZ: Veterinary Council of New Zealand

ARTICLE HISTORY

Received 24 February 2025
Accepted 26 June 2025

KEYWORDS

Cytotoxic chemotherapy;
New Zealand; small animal;
cancer; frequency


Introduction

Through advancements in veterinary medicine and improvements in nutrition, companion animals are now living 1.3–1.6 times longer than they did 30–40 years ago (Inoue *et al.* 2018; Urfer *et al.* 2020). Senior pets now constitute 30–40% of the patients seen in practice, and this percentage is only expected to increase as the advancements made become more widely available (Metzger 2005). This increase in longevity means that canines now exceed their

evolutionarily adapted lifespan, which is in part responsible for the observed increased incidence of cancer seen in this species (Sarver *et al.* 2022).

Cancer is reported to be the most common cause of death in dogs older than 1 year of age in North America (Fleming *et al.* 2011). Additionally, recent research by Kent *et al.* (2022) revealed that cancer accounts for at least one-third of all deaths in cats. Due to the commonality of cancer coupled with an aging animal population, it becomes evident that

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 Supplemental data for this article can be accessed online at <https://doi.org/10.1080/00480169.2025.2533200>.

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veterinarians in general practice will likely see oncological cases regularly and possibly with increasing frequency. It is therefore imperative that clinicians have a good understanding of how the different therapeutic options available to treat cancer complement each other, including knowing if or when chemotherapy could be implemented (Biller *et al.* 2016).

In the UK, the frequency of chemotherapy administration has been increasing as more pet owners seek a higher level of care for their animal companions (Mellanby *et al.* 2002). In comparison, the use and frequency of chemotherapy in small animal practice in NZ remains unknown. This study aims to provide insight into the current usage of chemotherapy by veterinarians working in NZ and the factors that impact its adoption in practice. Ultimately, this study aims to shed light on areas within veterinary medicine where additional training of clinicians, the creation of standardised educational materials, or future research may be beneficial.

Materials and methods

A cross-sectional study of veterinarians working in NZ was performed to understand the frequency at which chemotherapy is administered within small animal practice to treat cancer, and what factors alter the likelihood of it being performed or not. The study was judged to be low risk through peer evaluation and an online assessment by the Research Ethics Office (Massey University, Palmerston North, NZ), and therefore did not require review by a human ethics committee (Ethics Notification Number: 4000027530).

Participants

Participants were recruited anonymously using email and social media (Facebook and LinkedIn). A link to the questionnaire was emailed to veterinary practices using clinic information found online, and was also included in monthly emails sent to registered veterinarians in NZ by the Veterinary Council of New Zealand (VCNZ) and the New Zealand Veterinary Association. Links to the questionnaire were posted on social media with a request for it to be shared between veterinary colleagues to allow further distribution.

The questionnaire was open from 3 to 31 July 2023. Respondents were required to be qualified veterinarians working in either small animal only or mixed animal practice, with a proportion of their job involving the treatment of companion animals. Respondents could work in general or referral practice. Individual respondents were asked to complete the questionnaire only once. However, as thoughts about chemotherapy usage could vary between veterinarians within the same practice, multiple veterinarians from the same practice could answer the questionnaire. Veterinarians

were not required to have any experience using chemotherapy to answer the questionnaire. Only fully completed questionnaires from veterinarians working in NZ were used for data analysis.

Questionnaire design

The questionnaire was designed in Qualtrics (Provo, UT, USA) and contained both open-ended and closed questions (see Supplementary Materials). Open-ended questions were used to allow respondents to voice their own perspectives and thoughts on the use of chemotherapy in small animal practice and explain the factors that impacted whether they chose to perform it or not in greater detail. Participants did not answer all questions as a skip logic algorithm guided participants through the questionnaire based on their response to the previous question. The final question was an open comments section for respondents to add any final thoughts about the use of chemotherapy in practice that could then provide further ideas for discussion.

The questionnaire was pre-tested for question clarity and understanding by a small number of veterinarians ($n = 10$). Changes to question wording were made based on their responses. The skip logic algorithm was not pre-tested due to time constraints on the project.

Statistical analyses

Results were recorded and analysed in Qualtrics. Tables were produced in Microsoft Excel (Redmond, WA, USA). For categorical variables, the number and percentage of all participants' responses were determined. Data analysis was performed using R version 4.3.1 (R Institute for Statistical Computing, Vienna, Austria). Respondents were grouped into categories for analysis, including country of graduation, type of employment (small animal only vs mixed practice), and time since graduation. For analysis of the primary outcome – whether respondents had personally performed chemotherapy in the past 12 months – Fisher's exact tests were used to assess associations between this and categorical variables such as those above, as well as whether respondents reported discussing chemotherapy with clients. Statistical significance was set at $p < 0.05$.

To assess the likelihood of a respondent performing chemotherapy across different categories, risk ratios (RR) with 95% CI were calculated using the epitools package in R. These provided estimates of the relative probability of chemotherapy administration between groups (e.g. those who did vs did not graduate in NZ).

Responses to open-ended questions were analysed using text analytics within Qualtrics, which automatically extracted and classified text data. Content analysis was then applied, with responses reviewed and

grouped according to predominant themes. If a veterinarian mentioned multiple ideas within one response, each idea was categorised individually. For one question, participants selected from a pre-defined list and could also provide additional free-text responses. Multiple selections were permitted, and each option selected or provided was treated as an individual response. These additional data points were then collated and summarised according to thematic content.

Results

Completed questionnaires were received from 193 veterinarians from around the world. A further 23 questionnaires were started but not completed within the allotted time frame and were therefore excluded from all analyses. Of the completed questionnaires, 164 (85%) were from veterinarians currently working in NZ; only these data were used for further analysis.

In 2023, 3,098 veterinarians were registered and working in NZ; of those, 1,738 (56.1%) worked in small animal and mixed practice (provided as full-time equivalents by VCNZ 2024). The response rate to the survey was therefore calculated to be 9.4%.

Of the respondent veterinarians, the majority were educated in NZ, currently work in companion animal practice, and 72% have been in practice for at least 10 years (Table 1).

Table 2 outlines details regarding the chemotherapy practices of the respondents, from both an individual and clinic perspective. Of the 164 respondents, 56 (34%) reported that they had personally administered chemotherapy in the past 12 months. Of these 56 respondents, five (3%) administered chemotherapy on a weekly basis, six (4%) at least monthly, 21 (12.8%) every 1–6 months and 22 (13.4%) every 6–12 months. Two respondents (1%) selected that they had “personally performed chemotherapy within the

Table 1. Demographics of veterinarians (n = 164) working in New Zealand who responded to a survey of cytotoxic chemotherapy practices in small animal cancer treatment.

Variable	Frequency	Percentage (n = 164)
Country of graduation		
New Zealand	117	71%
United Kingdom	22	13%
Australia	6	4%
South Africa	5	3%
Ireland	5	3%
USA	2	1%
Germany	2	1%
Other ^a	5	3%
Type of employment		
Companion animal practice	134	82%
Mixed animal practice	30	18%
Time since graduation		
< 3 years	14	9%
3–5 years	10	6%
5–10 years	22	13%
10–20 years	49	30%
> 20 years	69	42%

^aOther: a single respondent graduated from each of Argentina, Canada, China, India and the Netherlands.

past 12 months,” but went on to select “previously performed” (i.e. not in the past 12 months) as the frequency for administration. When chemotherapy had been performed within the past 12 months, the median frequency of administration was every 1–6 months. Results were left-skewed, with intervals of administration of 1–6 months or greater being more common than intervals less than this.

One respondent (1/164; 0.6%) mentioned that they would definitely not discuss chemotherapy if a patient was diagnosed with cancer, calling the treatment option “poison.” A further four respondents (2.4%) indicated that they would probably not discuss it. Whether clinics offered in-house treatment, referral or neither option was also assessed, and results indicated that 93% of respondents either offer in-house treatment or referral.

Table 3 outlines how demographics may impact whether a respondent administers or discusses the option of chemotherapy. Individuals who administered chemotherapy, when compared to those who did not, were more likely to have graduated from countries other than NZ (not including the UK; Table 3). Additionally, our study found that the number of years since graduation significantly impacted whether a respondent veterinarian had personally performed chemotherapy in the past 12 months. Of respondents who have administered chemotherapy,

Table 2. Chemotherapy practices of veterinarians (n = 164) working in New Zealand who responded to a survey of cytotoxic chemotherapy practises in small animal cancer treatment.

Variable	Frequency	Percentage (n = 164)
Is chemotherapy discussed as a potential treatment?		
Definitely yes	64	39%
Probably yes	67	41%
Maybe	28	17%
Probably not	4	2.4%
Definitely not	1	0.6%
Was chemotherapy administered within the practice in the past 12 months?		
Yes	96	58.5%
No	68	41.5%
Did the respondent personally administer chemotherapy in the past 12 months?		
Yes	56	34%
No	108	66%
Chemotherapy services offered		
In-house chemotherapy only	25	15%
In-house chemotherapy and referral	71	43%
Referral only	57	35%
Neither in-house chemotherapy or referral	11	7%
Frequency at which chemotherapy has been administered in the practice in the past 12 months		
Weekly	8	5%
At least once a month	9	6%
Every 1–6 months	33	20%
Every 6–12 months	39	24%
Previously performed ^a	26	16%
Chemotherapy is not performed	49	30%

^aRespondents have performed chemotherapy previously but not in the past 12 months due to circumstances such as moving practices or a lack of cases.

Table 3. Demographic impact on whether a respondent veterinarian personally performs chemotherapy or not (n = 164), based on responses to a survey of cytotoxic chemotherapy practices in small animal cancer treatment in New Zealand.

Variable	Total number	Personally performed chemotherapy		Risk ratio (95% CI)	P-value ^a
		Yes (%)	No (%)		
Country of graduation					
New Zealand	117	35 (30)	82 (70)	Reference	
United Kingdom	22	7 (32)	15 (68)	1.06 (0.54–2.08)	1.00
Other	25	14 (56)	11 (44)	1.87 (1.2–2.92)	0.02
Type of employment					
Companion animal practice	134	50 (37)	84 (63)	Reference	
Mixed animal practice	30	6 (20)	24 (80)	0.54 (0.25–1.13)	0.09
Time since graduation					
< 10 years	46	7 (15)	39 (85)	Reference	
10–20 years	49	17 (35)	32 (65)	2.28 (1.04–4.99)	0.04
> 20 years	69	32 (46)	37 (54)	3.05 (1.47–6.31)	< 0.001
Chemotherapy discussed as a treatment option					
Definitely yes	64	33 (52)	31 (48)	Reference	
Probably yes	67	18 (27)	49 (73)	0.52 (0.33–0.83)	0.004
Maybe	28	5 (18)	23 (82)	0.35 (0.15–0.79)	0.003
Probably/definitely not	5	0 (0)	5 (100)	–	0.05

^aDetermined using Fisher's exact test.

those who have been in practice for > 20 years were three times more likely to have administered chemotherapy than those who graduated < 10 years ago. Veterinarians who either probably or maybe discuss chemotherapy were less likely to have personally administered it to a patient within the past 12 months compared to those who definitely discuss chemotherapy.

Study participants who had personally administered chemotherapy in the past 12 months reported that they use it to treat a wide variety of cancers (Table 4). Lymphoma was reported as being treated most often, with 89% of respondents mentioning that they have used chemotherapy to treat this particular cancer in the past 12 months. Mast cell tumours have been treated by 48% of respondents, while other types of cancer are treated less frequently.

In treating those cancers, respondents reported using a variety of cytotoxic agents (Table 5). Doxorubicin and chlorambucil were reported as being used most frequently by the participants of this survey.

Table 4. Number and percent of veterinarians (n = 56) who have personally administered chemotherapy for different types of cancer in the past 12 months, from a survey of cytotoxic chemotherapy practices in small animal cancer treatment in New Zealand.

Cancer type	Number ^a	Percentage
Lymphoma	50	89%
Mast cell tumours	27	48%
Osteosarcoma	11	20%
Haemangiosarcoma	6	11%
Anal sac adenocarcinoma	4	7%
Sarcoma (unspecified)	4	7%
Other ^b	13	23%

^aRespondents could provide more than one response.

^bOther cancers mentioned include plasma cell tumours, multiple myeloma, histiocytic sarcoma, leukaemia, transitional cell carcinomas of the bladder, nasal carcinoma and thyroid tumours. Additionally, one veterinarian commented that they will try chemotherapy with any cancer if there is evidence that suggests it is indicated and the owners are willing to proceed.

Veterinarians who work in practices that administer chemotherapy were asked to provide insight as to the factors that influenced the clinic's decision to offer this particular service (Table 6). While there were several different reasons given by the participating veterinarians, providing comprehensive care to the patient was the most commonly cited reason for the provision of this service (30/96; 31%).

Reasons why respondent veterinarians do not perform chemotherapy are summarised in Table 7. Referring patients externally was the most common reason for non-performance (34/49; 69%). Many other respondents currently do not administer chemotherapy due to a lack of knowledge and practical skills needed to perform it safely (30/49; 61%).

The influence continuing education may have on veterinarians that do not currently perform chemotherapy is summarised in Table 8. With further education focused on oncology and the use and safe handling of chemotherapy, approximately 40% of

Table 5. Number and percent of veterinarians (n = 56) who reported using specific chemotherapy drugs in the past 12 months, from a survey of cytotoxic chemotherapy practices in small animal cancer treatment in New Zealand.

Cytotoxic agents administered	Number ^a	Percentage (n = 56)
Doxorubicin	41	73%
Chlorambucil	41	73%
Vincristine	38	68%
Cyclophosphamide	37	66%
Lomustine/CCNU	33	59%
Toceranib phosphate ^b	29	52%
Vinblastine	24	43%
Carboplatin	22	39%
Mitoxantrone	11	20%
Cisplatin	7	13%
Procarbazine	3	5%
Cytarabine	3	5%
Other ^c	8	14%

^aRespondents could select more than one option.

^bToceranib phosphate (Palladia; Zoetis Services LLC, Parsippany, NJ, USA).

^cOther agents cited as being used include melphalan, L-asparaginase, vinorelbine and gemcitabine.

Table 6. Number and percent of veterinarians (n = 96) reporting the reasons why their clinic provides chemotherapy services for pets with patients from a survey of cytotoxic chemotherapy practices in small animal cancer treatment in New Zealand.

Reasons why chemotherapy services are offered ^a	Number	Percentage (n = 96)
To provide comprehensive care to the patient	30	31%
To improve the quality and quantity of life of the pet	21	22%
Referral centres are too far away but clients wish to proceed with treatment	18	19%
Clients' request for this service	17	18%
Treatment of cancer that has been diagnosed	15	16%
An interest in oncology	9	9%
Convenience for the client	6	6%
Affordability of care	4	4%
Referral centre that provides this service	4	4%
Income for the veterinary practice	2	2%

^aReasons shown are themes developed from the respondent's answers to an open-ended question. Respondents could provide more than one reason.

respondents who currently do not perform chemotherapy would consider doing so.

Respondents were asked for any additional comments they had regarding the use of chemotherapy in small animal practice that might not have been covered by the questionnaire. A frequent additional point made by 5% of the respondents (n = 9) was that they currently use an online oncologist to assist with case management. Additionally, 10% of respondents (n = 17) made further comments about non-performance due to health and safety concerns they had regarding the provision of chemotherapy.

Discussion

Our study has shown that one-third of respondent veterinarians working in small and mixed animal

practice in NZ personally administered cytotoxic chemotherapy during the past 12 months. Despite this, the overall regularity with which chemotherapy is administered within respondents' clinics is low, with only 3% of clinics providing the service on a weekly basis, and 4% on a monthly basis. Based on the responses to this survey, the majority of clinics appear to administer chemotherapy sporadically, ranging from once every month to once a year. This indicates that there may only be a small number of veterinarians in NZ administering chemotherapy on a regular basis. Although administration rates were low, our study has revealed that 80% of respondent veterinarians are likely to, or would definitely, engage in discussions about chemotherapy as a treatment option, thereby enabling clients to consider the service.

Understanding factors that influence the provision of chemotherapy was a central aim of this study. Our data focused exclusively on veterinarians practising in NZ, aiming to capture a localised perspective. Additionally, the decision to exclude the 29 responses from veterinarians practising outside NZ from analysis was driven by concerns that they might not accurately represent international practices, given the low sample size. Our findings suggest a potential correlation between a veterinarian's country of graduation and their likelihood of performing chemotherapy. Veterinarians who graduated from countries other than NZ (not including the UK) were more likely to have administered chemotherapy in the past 12 months. On the other hand, the type of employment held by the veterinarian had no impact on whether they personally performed chemotherapy. It is important to note that the small sample size of veterinarians educated in other countries and those in mixed practice may have compromised the statistical power of the analysis thereby increasing the likelihood of type II errors (failing to

Table 7. Number and percentage of veterinarians (n = 49) providing reasons why they do not perform chemotherapy, from a survey of cytotoxic chemotherapy practices in small animal cancer treatment in New Zealand.

Reasons why veterinarians do not perform chemotherapy	Number ^a	Percentage (n = 49)
Cases are referred externally for treatment instead of being treated in clinic	34	69%
Insufficient knowledge or education regarding chemotherapy and the medications used, e.g. how the medications work and which drugs to use for specific cancers	30	61%
Insufficient training in how to handle and administer cytotoxic medications to animals	26	53%
Cost of stocking the medication and necessary equipment is too great	24	49%
Lack of clients that would take up the service even if it were offered	23	47%
Personal concerns about handling and potentially being exposed to cytotoxic medications	21	43%
Concern that the medication could be given incorrectly and there would be secondary problems, e.g. if a vesicant medication was given outside of the vein	17	35%
Concerns about the side effects the patient being treated may experience	13	27%
Ethical concerns regarding the use of chemotherapy in companion animals	10	20%
Concerns for the health and welfare of the animal if they receive chemotherapy	9	18%
There are company policies in place that prevent the use of these types of medications in clinic due to concerns about staff health and welfare when handling them	6	12%
Treatment is cost-prohibitive for clients	5	10%
Cancer sensitive to chemotherapy is not diagnosed at the practice at which the respondent works, therefore there is no opportunity to offer chemotherapy as a service	4	8%
Working for a charity organisation or shelter	3	6%
Government legislation that restricts the ability to order and stock specific cytotoxic medications	1	2%
Working as a specialist (ophthalmologist)	1	2%

^aRespondents could select more than one option.

Table 8. Number and percent of veterinarians (n = 60) who reported their clinic doesn't offer chemotherapy and their likelihood of administering chemotherapy following further education based on a survey of cytotoxic chemotherapy practices in small animal cancer treatment in New Zealand.

	Number	Percentage (n = 60)
Following further education on the safe handling and administration of cytotoxic medications, would you consider administering chemotherapy?		
Definitely not	7	12%
Probably not	14	23%
Might or might not	14	23%
Probably yes	17	28%
Definitely yes	8	13%
Following further education about oncology and chemotherapy, would you consider administering chemotherapy?		
Definitely not	7	12%
Probably not	13	22%
Might or might not	16	27%
Probably yes	15	25%
Definitely yes	9	15%

detect a real effect). A larger study would be needed to understand if these factors truly impact the likelihood of chemotherapy being performed or not.

In the 12 months prior to July 2023, around one-third of our study participants reported administering chemotherapy. This rate of administration of chemotherapy was similar to that seen in private practice in Canada, where 30% of practitioners administer cytotoxic agents (Epp and Waldner 2012) but was much lower than that reported in the UK where chemotherapeutics are administered by 52–70% of practitioners (Mellanby *et al.* 2002; Edery 2017). The median frequency of administration of chemotherapeutics by the respondents' clinics in this study was low, at every 1–6 months. Edery (2017) found that 86% of respondents from their UK study performed < 20 sessions of chemotherapy per year, with a median of < 10 sessions per year. Our study's frequency aligns with the findings of Edery (2017) but is below the median frequency of once every 3 months reported in another UK study (Cave *et al.* 2007). The less frequent median seen in our study may be expected due to the lower overall rate of administration of chemotherapy in practice in NZ when compared to the UK.

Our study found that respondent veterinarians who graduated > 20 years ago were statistically more likely to have personally administered chemotherapy in the past 12 months when compared to their more recently graduated colleagues. This finding contrasts with a UK study conducted by Mellanby *et al.* (2002), where the results suggested that recent graduates are more likely to use aggressive chemotherapy protocols when compared to their older colleagues. While the reason for this difference remains unclear, some recent graduates in our study expressed willingness to perform chemotherapy if given the opportunity, suggesting limited case exposure rather than

reluctance. Further research is needed to determine whether this trend is due to years in practice or other factors such as referral availability within a specific country, continuing education, clinical confidence, curriculum differences, the veterinarians surveyed, or case access.

There are many motivations for veterinary clinics to offer and administer chemotherapy and our study found that the primary reason for its performance was commitment to delivering comprehensive care to patients, with the end goal being an improvement in their quality and quantity of life. Cancer management should be viewed as similar to that of renal and cardiovascular disease: chronic illnesses that cannot be cured, but with appropriate management and the use of specific medications can be well-controlled, resulting in the maintenance of a good quality of life (Moore 2011). Effective chemotherapy for cancers such as lymphoma, multiple myeloma, and mast cell tumours can reduce cancer-related symptoms, improve quality of life, and extend survival time (Mellanby *et al.* 2003; Vail 2009). Upholding the ethical principle of alleviating suffering (Anonymous 2020a), respondent veterinarians strive to manage cancer patients with care that reflects both clinical best practice and client values. By offering personalised treatment options, including chemotherapy when appropriate, clinicians support informed decision-making and promote the well-being of companion animals facing chronic conditions in line with modern veterinary standards.

Clientele requesting chemotherapy for their pets, coupled with their reluctance to travel long distances to referral centres, was a reason identified in our study as to why some clinics offer in-house chemotherapy. Mellanby *et al.* (2002) documented that there was similar reluctance from UK owners to travel for their pet's treatment due to the increased cost, time and inconvenience involved. With the social status of animals within the family changing, many people now expect a level of care for their pet that is akin to what they would expect for themselves (Brønden *et al.* 2003; Knesl *et al.* 2016; Stephens 2019), and according to our study, this includes accessibility to cancer treatment. Humans diagnosed with terminal cancer request chemotherapy to extend their lives (Matsuyama *et al.* 2006) and some owners may request the same for their animal companions, as any additional time treatment can provide may be priceless to them (Biller *et al.* 2016). For patients to receive this level of care, access to chemotherapy is important. With appropriate protocols and trained staff, most respondents in this study believe it can be feasibly offered in general practice. As pets increasingly occupy central roles in families, veterinary services must adapt to meet evolving client expectations and standards of care.

Although it may seem simplistic, our study found that treating cancer that has been diagnosed was cited as a reason for administering chemotherapy. The types of cancer most commonly treated by veterinarians in NZ are lymphoma and mast cell tumours, although a variety of conditions had been treated in the preceding year. The commonality of these specific neoplastic conditions likely accounted for their high treatment rate. Mast cell tumours are the most common canine cutaneous tumour (Blackwood *et al.* 2012), while lymphoma is the most common haemopoietic tumour of both dogs and cats (Barrs and Beatty 2012; Zandvliet 2016) and accounts for approximately 7–14% of all neoplasms diagnosed in dogs and up to 30% of those diagnosed in cats (Dobson 1998). Given these results, it is not surprising that the cytotoxic agents used most frequently by respondents to this survey are those considered efficacious in the treatment of lymphoma and mast cell tumours. The findings regarding chemotherapeutics used most often align with the results of Ederly (2017) and further reflect the commonality of these cancers and their treatment by veterinarians, irrespective of the country in which they are working.

There were several barriers to performing chemotherapy identified in our study. The most common reason why clinicians refrained from performing chemotherapy was their preference to refer patients to specialised clinics, a sentiment also observed in a UK study (Ederly 2017). Clinicians cited various reasons for such referrals, including a lack of dedicated space or equipment, concerns about staff safety, and insufficient knowledge, interest, and experience in administering IV cytotoxic medications. While Biller *et al.* (2016) suggest that primary care veterinarians consider treating specific cases to build connections with clients, current referral practices ensure clients and their pets access their desired level of care.

For 43% of the study respondents that don't administer chemotherapy, safety was cited as a concern and a reason for non-performance. Consistent with this, a common theme in the comments made by veterinarians was that they had particular concern for the health and safety of the young female nurses who may be exposed to these agents. When handling cytotoxic agents, safety is of the utmost importance as there is no known safe level of exposure to these medications (Smith *et al.* 2018). Dranitsaris *et al.* (2005) found an increased risk of infertility and spontaneous abortion in female staff working in the human medical field who handle chemotherapeutics regularly, which may be why veterinarians are concerned about their nursing staff handling these medications. While the findings of Dranitsaris *et al.* (2005) are important to consider, they may have less relevance within

the veterinary industry where chemotherapy, even in the referral setting, is handled and administered much less frequently. Further studies would be needed to better understand the risk that handling chemotherapeutics poses to veterinary professionals. Additionally, there is worry that some staff members may feel unable to decline being involved in administering chemotherapy and thereby potentially put their own health at risk. This belief has led some clinics to make the conscious decision not to offer chemotherapy as a service. It is reasonable to not want to handle cytotoxic medications, provided appropriate alternatives are offered to the client if they wish to pursue treatment (Moore 2011). Likewise, if a clinic provides chemotherapy services and certain staff members do not wish to be involved, alternative duties should be set for them instead (Smith *et al.* 2018).

Our study found that insufficient knowledge and a lack of training regarding the safe handling and administration of cytotoxic medications emerged as common barriers to chemotherapy administration, echoing findings made by Ederly (2017). Understanding and safely managing these medications is essential to protect both staff and clients (Smith *et al.* 2018). The results of the present study highlight the need for further education on oncology, chemotherapy, and the safe handling of cytotoxic drugs. As chemotherapy is a continually evolving field, ongoing professional development is necessary to keep clinicians informed of current treatment options and their impact on patients' quality of life (Moore 2011; Biller *et al.* 2016). With additional training in oncology and chemotherapy, > 40% of respondents who do not currently perform chemotherapy would consider administering it in practice. If realised, this could increase the number of chemotherapy providers in NZ to a level similar to that seen in the UK, giving our clients and patients access to care in line with what is currently available overseas.

Educational materials on the safe use of chemotherapeutic agents, easily accessible to clinicians, would be a valuable resource. A respondent to our study went further and suggested standardised chemotherapy guidelines, similar to current radiation safety measures, be created to ensure the safety of all involved. Currently, the New Zealand Code of Professional Conduct for Veterinarians and VCNZ do not provide specific guidance on chemotherapy or the use of cytotoxic products in practice. Clinicians treating patients with cancer in NZ are encouraged to ensure they are well educated on the subject and have created clinic-specific safety documents using resources such as those produced by Worksafe NZ/Health and Safety Act (Anonymous 2020b), the Royal College of Veterinary Surgeons, and the guidelines set out by the American Animal Hospital Association in Biller *et al.* (2016)

(S. Butler,¹ pers. comm.). These measures help to minimise staff exposure to cytotoxic agents while supporting the safe delivery of comprehensive cancer care (Hayes 2005).

Clinicians from our study called particular attention to the importance of using closed system transfer devices to safely administer cytotoxic agents. Practical training in the use of personal protective equipment, closed system transfer devices, and safe disposal methods would be especially valuable for those unfamiliar with these protocols so as to ensure the safe handling of chemotherapeutics (Hayes 2005).

Lack of client uptake was identified in our study as a barrier to providing chemotherapy, often due to concerns about animal suffering during treatment. Clinicians noted that some owners decline chemotherapy out of fear that it will reduce their pet's quality of life. Addressing this concern through client education is crucial, as chemotherapy can help to maintain patient comfort and wellbeing (Moore 2011). Despite potential side effects, studies have shown positive owner experiences with treatment involving chemotherapy, reinforcing its relevance and benefit (Brønden *et al.* 2003; Mellanby *et al.* 2003). As veterinarians have significant influence over client decisions (Brown *et al.* 2021), it is essential that all treatment options are presented clearly and without bias to support the making of a fully informed decision by the client (Moore 2011; Brown *et al.* 2021). A follow-up study exploring NZ pet owners' views on chemotherapy could provide further insight into current client perceptions.

Almost 50% of clinicians in our study do not perform chemotherapy due to the cost of stocking medications and the personal protective equipment needed to perform chemotherapy safely. Additionally, respondents to our study reported in the past finding it challenging to source medications, which hinders the ease of administration and further deters their use. Profitability of veterinary clinics can be maximised by optimising inventory levels and minimising waste, therefore concern about holding stock and consumables that may not be used frequently is valid, especially if profit margins are already small (Ackerman 2020). There are ways to mitigate these barriers. Clinics can order pre-filled syringes of particular chemotherapeutics for specific patients (Smith *et al.* 2018), and costs can be directly attributed to that patient, ensuring there is no waste and no requirement for long-term storage of medications or equipment.

Sixty-one percent of respondents cited lack of experience or knowledge as a reason they do not perform chemotherapy. Conversely, at least 5% of respondents manage cancer cases with support from online or referral oncology specialists, who provide

detailed case reports and guidance. Promoting awareness of these services may help more veterinarians – especially in rural or referral-limited areas – to feel confident offering chemotherapy. Building networks between neighbouring clinics and specialists, especially those that refer cases to each other, could enhance collaboration and expand access to a greater spectrum of care for clients and their pets.

Although most of the respondents to our questionnaire would discuss chemotherapy as a treatment option, 3% of respondents mentioned that they would probably or definitely not discuss or administer chemotherapy if cancer was diagnosed in a patient they were caring for. These responses help to show that this study has captured the wide range of opinions held by working veterinarians. Openness when discussing this topic is therefore imperative, as others in the profession may hold differing opinions.

There were limitations to our study. There was potential for professional selection bias, as veterinarians that have a greater interest in oncology may have been more likely to respond. However, a large percentage of respondents (65%; $n = 108$) reported that they do not personally administer chemotherapy, showing that this group of respondents were well represented. The survey had a response rate of 9.4%. This was considered acceptable given the total population that could have responded to the survey and the length of time the survey was open.

Although questions were pre-tested, observational errors were identified during data analysis. There appeared to be confusion in the respondents' understanding of "performed" chemotherapy, which may have led to variability in the answers given. In retrospect a better choice of wording for the questionnaire may have been "prescribed or administered" cytotoxic medications, therefore removing ambiguity for those that do not perform parenteral chemotherapy but do dispense oral chemotherapeutic agents such as chlorambucil, toceranib and lomustine to treat cancer. Based on the frequency of use of adjuvant chemotherapy, Barker *et al.* (2016) suggest that general practice veterinarians may be more comfortable dispensing oral chemotherapeutics compared with administering parenteral medications. Further research could explore how veterinarians' comfort with particular drug formulations (i.e. oral vs parenteral) impacts the likelihood of them recommending treatment and therefore the frequency at which they administer chemotherapy (Barker *et al.* 2016).

The skip logic algorithm applied to the questionnaire led to answering bias, particularly for those veterinarians who do not administer chemotherapy personally but work in practices that do. Those clinicians may have provided further insight into why

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chemotherapy is not performed at the individual level, and therefore should have been sent through a set of questions specific to their situation. To limit the impact of this bias, exclusions were applied, and only the responses from veterinarians who had personally administered chemotherapy in the past 12 months were used when analysing certain results. Pre-testing the skip algorithm could have helped to identify and amend these issues in the questionnaire design.

Conclusions

Eighty percent of respondents reported that they definitely or probably would discuss cytotoxic chemotherapy as a treatment option for client-owned pets diagnosed with cancer; however, chemotherapy was only administered by approximately one-third of respondents in the past 12 months. Frequency of administration was low and sporadic, with most respondents' clinics only administering chemotherapy every 1–12 months. Our study found that clinicians educated in countries other than NZ or the UK and those that graduated > 20 years ago were more likely to have administered chemotherapy in the last 12 months compared to their colleagues. Maintaining high standards of care, improving the quantity and quality of life of their patients, and client demand were the main factors that drive veterinarians to provide chemotherapy as a service. A lack of confidence in knowledge and skill, the cost of medication and equipment, and the belief that there would be a lack of uptake were frequently cited reasons that currently prevent its wider use.

There is a clear need for continuing education that addresses both the theoretical and practical aspects of chemotherapy, including safe handling and administration of cytotoxic medications. Encouraging collaboration between general practices and oncology specialists could help broaden access to chemotherapy for clients who wish to pursue it. While chemotherapy is currently administered less frequently in NZ than in the UK, increased training and support for veterinarians may help shift this trend. As more clinicians gain confidence in recommending and delivering chemotherapy, a wider range of treatment options could become available for companion animals across the country.

Acknowledgements

Thank you to the Veterinary Council of New Zealand and the New Zealand Veterinary Association for helping to distribute the questionnaire to veterinarians around New Zealand. We would also like to acknowledge all the veterinarians who took the time to complete the questionnaire, as without your responses, this study would not have been possible.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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