

Malignant Neoplasms in Cats - Epidemiological Surveillance in a Veterinary Teaching Hospital's Oncology Service

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ABSTRACT

Background: Cancer is a leading cause of death in dogs and cats, with its high prevalence linked to factors such as population growth, advances in veterinary medicine, and increased life expectancy. In Brazil, which had the 2nd largest pet population globally in 2017, the feline population is expanding rapidly and is expected to surpass dogs within a decade due to urbanization and lifestyle changes. Cancer epidemiology allows for the analysis of disease distribution, risk factors, and the impact of prevention and treatment on survival and quality of life. This study aims to conduct an epidemiological survey of feline oncology cases at the FCAV/UNESP Veterinary Hospital from 1997 to 2018.

Materials, Methods & Results: This retrospective study analyzed 21 years of feline malignant neoplasms at a veterinary hospital. Data from medical records included patient characteristics, clinical history, diagnostics, treatments, and outcomes. Ethics approval was unnecessary, and owner consent was obtained. Medical records identified 70 cases of feline malignant neoplasms with adequate information. Epithelial tumors were the most prevalent (71.43%), with squamous cell carcinoma being the most common (72%), followed by mesenchymal neoplasms (18.57%) and round cell tumors (8.57%). Most affected patients were female (66%), predominantly aged between 7 and 14 years. Light-skinned bicolor cats were the most affected (34%), and 28% had outdoor access. Single lesions were the most frequent (42%), and 12% of tumors were smaller than 1 cm. Ulcerated tumors were observed in 30% of cases. The most affected regions included the mammary chain (26%), periocular areas (20%), and nasal planum (20%). Among treatment approaches, 78% of cats received therapy, with surgery, chemotherapy, cryosurgery, and electrochemotherapy being the most commonly used modalities. Mesenchymal tumors exclusively affected females, primarily in the subcutaneous tissue of the lateral abdomen (46.15%). Surgery was the primary treatment, followed by chemotherapy. Round cell neoplasms included lymphomas and mast cell tumors, mostly affecting the gastrointestinal tract and skin. Surgery and chemotherapy were the main treatment options, with 1 case surviving beyond 24 months. Squamous cell carcinoma was associated with sun exposure and light skin, characterized by ulcerated and invasive lesions. Injection-site sarcomas were predominantly found in vaccinated cats, confirming their association with injectable substances.

Discussion: Squamous cell carcinoma (SCC) was the most common epithelial tumor, affecting outdoor cats with light skin and sparse fur, mainly in sun-exposed areas. Lesions were often ulcerated, adherent to muscle, and invasive to bone. Surgery, chemotherapy, cryosurgery, and electrochemotherapy were the main treatments, as radiotherapy and photodynamic therapy were unavailable locally. Feline injection-site sarcomas (FISS) predominantly affected vaccinated and neutered cats aged 7-10 years, consistent with literature. Tumors were mostly in subcutaneous tissue, showing infiltrative behavior. Surgical excision was the primary treatment, with histological subtypes including sarcomas and fibrous histiocytomas. Chemotherapy involved doxorubicin alone or combined with other agents. Lymphomas were the most frequent round cell tumors, with gastrointestinal and cutaneous forms observed. A senior cat with cutaneous lymphoma exhibited metastases, resembling cases in literature. Treatment included lomustine and prednisolone. The growing cat population in Brazil as well as around the world, brings a crescent need for further medical knowledge about the incidence of neoplastic processes in felines.

Keywords: cancer, tumors, oncology, neoplasms, neoplastic process, feline.

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INTRODUÇÃO

Currently, cancer represents one of the main causes of death in dogs and cats. Studies suggest that the high prevalence of malignant tumors that affect these species is related to population growth, improvement in diagnostic, therapeutic and preventive medicine, in addition to balanced diets that result in greater life expectancy and, thus a greater occurrence of diseases associated with longer survival [3].

According to Brazilian Institute of Geography and Statistics [1] in June 2017, Brazil had the 2nd largest population of pets in the world, with 22.1 million felines and 52.2 million dogs. The most interesting point is about the cat population, which multiplies at a greater rate and should become predominant in less than 10 years. According to ABINPET (Brazilian Association of the Pet Products Industry), the verticalization of large centers and the change in people's lifestyle are factors that make Brazilians opt for a more independent and easily adaptable pet to smaller environments.

In cancer epidemiology, it is possible to observe the distribution of various forms of cancer in a population, the observation and analysis of variations in its occurrence in different groups or communities, including the risk factors to which they are submitted. Observational cancer studies aim to assess the social impact of this disease, understand risk or protective factors and understand the effects of prevention actions, early diagnosis or treatment on epidemiological indicators, quality of life and survival of patients [11].

Therefore, the aim of the present study was to collect from medical records an epidemiological survey of the feline population assisted in the routine of the Oncology Service (SOV) at the Veterinary Hospital of FCAV/UNESP Campus Jaboticabal, from 1997 to 2018.

MATERIALS AND METHODS

Ethical considerations

Informed consent (verbal or written) was obtained from the owner or legal custodian of all animal (s) described in this work for all procedure(s) undertaken. As a retrospective study based solely on previous clinical data, ethics committee approval was not necessary.

Study design and evaluated population

This retrospective study performed an epidemiological surveillance of cats affected by malignant

neoplasms. Through analysis of medical records of patients treated by professionals from the Oncology Veterinary Service (SOV) at the Veterinary Hospital, an epidemiological survey was carried out of feline patients affected by neoplastic processes treated during a period of 21 years, from February 1997 to November 2018, in Veterinary Hospital "Governador Laudo Natel" (HV) of the Faculty of Agrarian and Veterinary Sciences (FCAV) - UNESP - Jaboticabal Campus.

Epidemiological and clinical variables

Most medical records were available in physical format, cataloged in folders with written records and only a small part was already computerized. A consent term for the use of Hospital data was obtained from the Department of Veterinary Clinic and Surgery of the same Institution.

Data were forwarded to the date of care, city of origin, registration number, sex, age, breed, coat color, weight, habitat, access to the street, anti-rabies vaccination, deworming, castration, use of contraceptives in females, diet, contacts, main complaint, clinical signs, time of evolution to consultation, IVF status until consultation, FIV/FelV status (feline immunodeficiency virus and feline leukemia virus, respectively), history of previous illnesses, medications instituted, blood count and biochemical tests prior to treatment (creatinine and alanine aminotransferase - ALT), research for hemoparasites, imaging tests (x-ray, radiographed region and abdominal ultrasound), as well as their alterations.

Information was also transmitted regarding the number of lesions, size and characteristics such as consistency, adherence, ulceration, devitalization, inflammation and inflammation. Suspicion, cytological and histopathological diagnosis, histological grade, treatment(s) (surgical, chemotherapy and others), evaluation of physiological margins, metastasis in lymph nodes and distant, concomitant diseases, prescribed drugs, therapeutic protocols used, side effects, blood count and biochemicals post-treatment (creatinine and ALT), relapses, disease-free survival and overall survival.

RESULTS

Medical records for 272 patients were obtained; however, 54 were not located, 3 were not filled, 83 had no histopathological confirmation and 62 were not cancer patients. In total, 70 cases were found in

medical records with adequate information. Considering malignant neoplasms ($n = 70/100\%$), those of epithelial origin ($n = 50/71.43\%$) were most largely represented, followed by those of mesenchymal origin ($n = 13/18.57\%$), round cell tumors ($n = 6/8.57\%$) and 1 (1.43%) tumor of epithelial and mesenchymal origin (malignant myoepithelioma). The histopathological classification of malignant epithelial neoplasms was shown on Table 1.

Females ($n = 33/66\%$) were more afflicted than males ($n = 17/34\%$). According to the feline life stage guidelines [12], mature [7 to 10 years old] ($n = 20/40\%$) and senior cats [11 to 14 years old] ($n = 20/40\%$) were most frequently afflicted, followed by geriatric patients [over 15 years old] ($n = 6/12\%$), while adults [3 to 6 years old] ($n = 4/8\%$) were least afflicted. Kittens [0 to 6 months old] and juniors [7 months to 2 years] were not represented in this selection. Bicolor patients with light skin ($n = 17/34\%$) were more affected, followed by grey ($n = 11/22\%$), tricolors ($n = 8/16\%$), white ($n = 4/8\%$), tabby ($n = 4/8\%$) and colorpoint [similar to Siamese] ($n = 2/4\%$). Tortoiseshell ($n = 1/2\%$) and striped ($n = 1/2\%$) were least frequent and in 2 medical records (4%) there was no color information. Concerning living conditions, 9 (18%) lived in a house, 1 (2%) in an apartment and for 40 patients (80%) there was no recorded information. Fourteen (28%) patients had outdoor access, while 7 (14%) did not.

Single lesions were most frequent ($n = 21/42\%$); however, 8 cats (16%) presented with 2 to 3 lesions and 5 patients (10%) had more than 3 lesions. In 16 medical records (32%) this information was not available. Regarding tumor characteristics, in 6 patients (12%) tumors were up to 1 cm in size; in 5 cats (10%) size varied between 1 to 3 cm; in 4 (8%) tumors measured from 3 to 5 cm; 1 cat (2%) presented with lesions 5 to 10 cm in size and 1 (2%) presented with lesions larger than 10 cm. In 33 medical records (66%), this information could not be found. Regarding the speed of tumor progression, 7 (14%) progressed within 1 month, 8 (16%) progressed over 1 to 3 months, 2 (4%) within 3 to 6 months, 1 (2%) within 6 months to 1 year, 4 (8%) progressed over more than 1 year and medical records for 28 patients (56%) did not have this information. Most tumors ($n = 6/12\%$) were adhered to muscles, while 2 (4%) were not adhered; in 2 (4%) patients subcutaneous tissue was involved, and

1 (2%) had both subcutaneous and muscle tissue compromised; records for 37 patients (78%) did not have this information. Regarding ulceration, 15 patients (30%) presented with ulcerated tumors, while in 7 patients (14%) this was not observed and in 28 records (56%) this information was not available.

Concerning the locations of malignant neoplasms of epithelial origin, 13 were located on the mammary chains (26%), 10 in the periocular region (20%), 10 in the auricular region (20%), 10 on the nasal planum (20%), 2 on the jaw (4%), 2 inside the mouth (4%), 1 inside the pharynx (2%), 1 metastatic neoplasm in the omentum (2%) and 1 (2%) had no recorded location.

Among the treatment modalities most used for such neoplasms, there were chemotherapy, cryosurgery, electrochemotherapy and surgery (Table 2). A total number of 39 cats (78%) were treated.

According to information given by owners via telephone calls regarding the cats in this study, 54.55% ($n = 6$) of cats had recurrent neoplasms; 2 patients (33.33%) had a recurrent tumor within 1 month of the primary tumor excision; 2 other patients (33.33%) had recurrent neoplasms 1 to 3 months after the primary tumor excision; 1 cat (16.67%) presented with neoplastic recurrence between 6 months and 1 year after the primary tumor excision and 1 owner was unable to define when neoplastic recurrence occurred. Five owners (45.45%) declared there was no recurrence.

The total number of patients afflicted by malignant neoplasms of mesenchymal origin was 13 (18.57%), as described on Table 3. Only females were afflicted ($n = 13/100\%$) by this tumor subtype. Mature female cats were more frequently affected ($n = 5/38.46\%$), followed by senior ($n = 3/23.08\%$), adult ($n = 2/15.38\%$), and geriatric ($n = 2/15.38\%$). One junior female cat (7.69%) and no kittens were affected. Of all 13 females, 8 (61.54%) were spayed, 2 (15.38%) were not spayed and 3 records (23.08%) did not contain data regarding their reproductive status. Regarding vaccination status, 5 cats (38.46%) were vaccinated, 6 (46.15%) had never been vaccinated and records for 2 patients (15.38%). Regarding anatomical locations, 6 were located subcutaneously [lateral abdomen] (46.15%), 3 on limbs (23.08%), 1 on ear (7.69%), 1 on mammary chain (7.69%), 1 on nose (7.69%) and 1 in the cephalic region (7.69%).

Treatments used for these patients were surgical exeresis and chemotherapy. Eight cats (61.54%) underwent surgical procedures and records for 5 patients (38.46%) there was no available information. Among the 8 cats surgically treated, 3 (37.50%) received chemotherapy, 3 (37.50%) did not and records for 2 patients (25%) there was no mention to chemotherapy. Of the 3 patients who received chemotherapy, 1 (33.33%) was treated with doxorubicin, 1 (33.33%) was treated with doxorubicin and prednisolone and 1 (33.33%) was treated with doxorubicin, methotrexate and cyclophosphamide.

When contacted via telephone, 3 owners reported recurrent tumors (75%). In 1 of the cats (33.33%), a new mass appeared within 3 to 6 months; another patient (33.33%) had tumoral recurrence take place between 1 to 2 years and came to pass due to chronic kidney disease and another patient (33.33%) had a recurrent tumor after 2 years, passing due to tumor recurrence.

Last but not least, a total of 6 patients presented were diagnosed with malignant round cell tumor (8.57%), being mast cell tumor and cutaneous lymphoma the most frequent (N = 2 each), followed by plasm cell tumor (n = 1), gastric lymphoma (n = 1). One junior patient was afflicted (16.67%), as well as 2 adults (33.33%), 1 mature (16.67%) and 2 seniors (33.33%). Kittens and geriatric cats were not affected. Regarding the placement of malignant round cell neoplasms, the most frequently afflicted sites were the stomach (n = 2/33.33%) and cutaneous tissue (n = 2/33.33%), of which anterior right limb (n = 1/16.67%) and lateral thorax (n = 1/16.67%) had the highest incidence, followed by spleen (n = 1/16.67%) and oral cavity (n = 1/16.67%).

Surgery and chemotherapy were the treatment modalities of choice. Three cats (50%) received chemotherapy; 1 of these also underwent surgery. Records for 3 patients (50%) had no information. Of the 3 treated cats, one (33.33%) received lomustine, 1 (33.33%) had vincristine and prednisolone 1 (33.33%) received lomustine and vinblastine. The latter underwent partial gastrectomy. Through telephone calls, owners reported that 3 patients did not have recurrent tumors. One patient (33.33%) passed 1 month after treatment, another (33.33%) passed 4 months after treatment and 1 cat (33.33%) is currently still alive, with a survival span of over 24 months.

Table 1. Histological subtypes of malignant neoplasms of epithelial origin diagnosed in cats by the Oncology Veterinary Service at the Veterinary Hospital - FCAV/ UNESP - Jaboticabal, SP, Brazil from 1997 to 2018.

Neoplasms	N	%
Squamous cell carcinoma	50	71.43
Mammary carcinoma	36	72
Metastatic carcinoma	11	22
Acinic cell carcinoma in salivary glands	2	4

Table 2. Treatment modalities for patients afflicted with malignant neoplasms of epithelial origin diagnosed by the Oncology Veterinary Service at the Veterinary Hospital - FCAV/ UNESP - Jaboticabal, SP, Brazil, from 1997 to 2018.

Treatment modalities	N	%
Exeresis	16	41.03
Chemotherapy	3	7.69
Cryosurgery	3	7.69
Electrochemotherapy	1	2.56
Exeresis and Chemotherapy	9	23.08
Exeresis and Cryosurgery	1	2.56
Cryosurgery and Chemotherapy	1	2.56
Exeresis and Electrochemotherapy	1	2.56
Electrochemotherapy and Chemotherapy	3	7.69
Exeresis. Chemotherapy and Cryosurgery	1	2.56

Table 3. Histological subtypes of malignant neoplasms of mesenchymal origin (N = 13) diagnosed in cats by the Oncology Veterinary Service at the Veterinary Hospital - FCAV/ UNESP - Jaboticabal, SP, Brazil, from 1997 to 2018.

Neoplasms	N	%
Sarcoma	6	46.15
Fibrous histiocytoma	3	23.08
Chondrosarcoma	1	7.69
Hemangiosarcoma	2	15.38
Osteosarcoma	1	7.69
Sarcoma	6	46.15

DISCUSSION

In this study, out of all tumors of epithelial origin, the ones most largely represented was squamous cell carcinomas. These were located in regions with sparse fur, light skin and ulcerated lesions. Most lesions were less than 1 cm in size and most patients were between 7 and 14 years old with outdoor access, which predisposes to more exposure to ultraviolet radiation due to natural sunlight. Previous studies [6], mention that SCC are

one of the most common malignant epithelial tumors in cats. In literature, the SCC development is related to sun exposure, light skin, depigmented skin and areas with sparse or no fur, such as ears, eyelids, nasal plana and temples [6,7]. Such a correlation is consistent with the Jaboticabal region, which has a warm, sunny climate. Murphy [7], explains that this disease affects animals of both sexes between the ages of 10 and 12 years. In contrast to Lino *et al.* [6], observed in a 58 population cats, a higher prevalence of affected cats between males and those over 11 years of age. In the same research, single lesions were more frequent, most of which were ulcerated and over 2 cm long.

Most SCC described in this study presented with muscle tissue adhesion and bone invasion. Treatment modalities of choice were surgery, chemotherapy, cryosurgery and electrochemotherapy. In agreement with this data, other studies also state that SCC is an aggressive, invasive neoplasm, and depending on its site of origin, there may be tissue and bone invasion [7-9]. Although others treatments options are indicated to SCC such as radiotherapy and photodynamic therapy [6], these treatments are not available in our region being cryosurgery and electrochemotherapy the therapies most used.

Regarding feline injection-site sarcomas, most afflicted cats were 7 to 10 years old, vaccinated for rabies and spayed and neutered patients were more frequent, which would be connected to more frequent use of preanesthetic medication, painkillers, anti-inflammatory drugs and antibiotics. The literature describes the incidence of this particular neoplasm between 6 to 7 years and 10 to 11 years of age [2], which is consistent with this study's findings.

Feline injection-site sarcomas appear more frequently around the site of vaccinations, especially for the feline leukemia virus (FeLV) or rabies [2,14], but may also develop after inoculation of other medications and medical substances [14].

In this survey, facts were again consistent with literature, since the most prevalent location of this tumoral group was in subcutaneous tissue, with tumors showing infiltrative behavior, since many cases had tumors adhered to muscle tissue. Injection-site sarcomas are most commonly located in subcutaneous tissue, but may also be found within muscle tissue, often exhibiting infiltration in deep fascial planes [4].

The treatment of choice for feline injection-site sarcomas is aggressive and radical surgery [2,14],

a conduct that reflects in this study, since the most numerous treatment modality was surgical exeresis.

The most frequent histological subtypes in injection sites in this study were sarcomas and fibrous histiocytomas, though Davidson and Lawrence [2], and Hartmann *et al.* [4] had pointed the most common histological subtype in injection sites in cats to be the fibrosarcoma. Patients in this study were given isolated doxorubicin, doxorubicin with prednisolone or doxorubicin, methotrexate and cyclophosphamide. Chemotherapy protocol consisting of doxorubicin, either isolated or in combination with cyclophosphamide and lomustine is suggested in literature [2].

The most commonly diagnosed round cell neoplasms within this study were lymphomas, 2 of which were cutaneous and 1 gastric. One of the patients with cutaneous lymphoma was a senior cat and presented with a nodule on the right thoracic limb. Ultrasonography pointed abnormalities in the spleen and gastric lymph nodes and ascites, suggestive of metastasis, a behavior similar to that described in other study [5].

Since the feline leukemia virus decline, the gastrointestinal tract has emerged as the most commonly affected anatomical location in senior cats [13]. Kagawa *et al.* [5] reported a senior cat with cutaneous lymphoma on the left pelvic limb. The patient was surgically treated and, after numerous recurrences, passed due to gastric rupture. At the time of necropsy, there was metastatic activity in the stomach, liver, kidneys, heart, abdominal wall, diaphragm and mediastinal and gastric lymph nodes, similar to the patient in this study, which also had abnormalities in abdominal cavity organs. Cutaneous lymphoma is rare in cats and 1 report describes a 13-year-old feline patient with progression within 30 days, with this kind of tumor [10]. The treatment of choice was lomustine and prednisolone, similar to the protocol used for the patient in this study.

CONCLUSION

The growing cat population in Brazil as well as around the world, brings a crescent need for further medical knowledge about the incidence of neoplastic processes in felines. Considering our region, SCC was the most prevalent malignant neoplasm of epithelial origin including surgery, chemotherapy, cryosurgery and electrochemotherapy as therapy modalities. While, feline injection-site sarcomas were the most prevalent neoplasms with radical surgery and chemotherapy the treatments of choice for these patients.

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