NEOPLASTIC DISEASE

Swiss Feline Cancer Registry 1965–2008: the Influence of Sex, Breed and Age on Tumour Types and Tumour Locations

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Summary

Cancer registries are valuable sources for epidemiological research investigating risk factors underlying different types of cancer incidence. The present study is based on the Swiss Feline Cancer Registry that comprises 51,322 feline patient records, compiled between 1965 and 2008. In these records, 18,375 tumours were reported. The study analyses the influence of sex, neutering status, breed, time and age on the development of the most common tumour types and on their locations, using a multiple logistic regression model. The largest differences between breeds were found in the development of fibrosarcomas and squamous cell carcinomas, as well as in the development of tumours in the skin/subcutis and mammary gland. Differences, although often small, in sex and neutering status were observed in most analyses. Tumours were more frequent in middle-aged and older cats. The sample size allowed detailed analyses of the influence of sex, neutering status, breed and age. Results of the study are mainly consistent with previous analyses; however, some results cannot be compared with the existing literature. Further investigations are necessary, since feline tumours have not been investigated in depth to date. More accurate comparisons would require the definition of international standards for animal cancer registries.

Introduction

Cancer registries are important tools for establishing cancer control and prevention strategies. They are used in epidemiological research to examine risk factors underlying the incidence of different types of cancer. Tumour initiation and progression are influenced by several factors whose precise interactions are still unknown.

Demographic variables such as sex, age (Parkin, 2006) and breed (Dorn et al., 1968b; Thrusfield, 2007) are typically used to analyse the development of specific cancers.

Companion animals with spontaneously developing tumours are, moreover, valuable resources for investigating the complexity of human cancer pathogenesis, progression and therapy. Pets and people share the same environment and are therefore exposed to similar risk factors. Furthermore, their tumours undergo analogous genetic and molecular alterations and they display similar levels of tumour

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heterogeneity, which results in similar mechanisms of cancer development, resistance to therapy, recurrence and metastasis (Dorn *et al.*, 1968a; Thrusfield, 1988; MacEwen, 1990; Paoloni and Khanna, 2008). Finally, in-depth examination of animal tumours could lead to the identification of new genes associated with cancer, relevant environmental risk factors and the development of new prognostic, diagnostic and therapeutic applications (Vail and MacEwen, 2000).

The present study is based on analysis of the Swiss Feline Cancer Registry, which consists of 51,322 feline patient records compiled between 1965 and 2008 (Graf *et al.*, 2015). In this extended examination of data from the registry, we analyse the influence of sex, neutering status, breed and age on the development of the most common feline tumour types (i.e. adenoma/adenocarcinoma, fibrosarcoma, lymphoma and squamous cell carcinoma) and tumour locations (i.e. skin and subcutis, mammary gland, gastrointestinal tract, cardiorespiratory system and oral cavity/pharynx), their distribution and relative frequency over the period of study.

Materials and Methods

Data from the Swiss Feline Cancer Registry (Graf *et al.*, 2015) were used for extended analysis. Three veterinary diagnostic laboratories in Switzerland provided the case records.

Feline breeds with at least 90 individual records were investigated further; the remaining breeds were classified as 'other breeds'. The sex of the animals was grouped as following: male, neutered male, female, neutered female and unknown.

To unify the classification of some of the anatomical locations, we changed two specifications: leucosis with the location 'bone marrow' was changed to the location 'unknown' and fibrosarcomas with the location 'skin' were changed to the location 'soft tissue' (subcutis).

Since there is no obligatory registration of cats in Switzerland, there are only approximate estimates of the size of the feline population. Therefore, proportional calculations from the available patient datasets are given.

Data, wherever applicable, were analysed in two groups. In the first group all tumours (i.e. benign and malignant together) were analysed and in the second group only malignant tumours were included.

Using ICD-0-3 for human patients (WHO, 2013), tumour names were sometimes slightly different from those used in veterinary pathology (i.e. malignant lymphoma, mast cell sarcoma and fibromatous neoplasia). 'Basal cell tumour' is also an old term,

which is now usually replaced with the terms 'trichoblastoma' or 'sweat gland ductular adenoma'.

Data editing and statistical analyses were performed using Stata Software (StataCorp, 2011; Stata Statistical Software: Release 12; StataCorp, College Station, Texas, USA). Statistical analyses were carried out using Chi-square/Fisher's exact test. Significant variables were further integrated and analysed in a multiple logistic regression model (using binary logistic models and stepwise backward procedure). The following variables were included in the final model as fixed terms: canton of origin, age, sex/neutering status, breed, year and method of examination. $P \leq 0.05$ was considered to be significant and odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. The power was set at >0.8.

Results

The Swiss Feline Cancer Registry consists of the records of 51,322 cats that underwent pathological examination. The number of patients with confirmed tumours was 17,856 (34.79%). Some cats were diagnosed with multiple primary tumours, adding up to a total of 18,375 diagnosed tumours. Of these diagnoses, 14,759 (80.32%) tumours were malignant.

Most cats were of the European shorthair breed. In the statistical evaluation, this breed was used as the standard for comparisons with the remaining breeds.

Breed, sex and age distribution of the entire dataset are presented in Graf *et al.* (2015).

The following results introduce the most common tumour types and anatomical locations in cats, the influence of age, breed and sex, as well as occurrence over the years.

Adenoma/Adenocarcinoma

Adenoma/adenocarcinoma was the most common tumour diagnosed between 1965 and 2008. Among the 18,375 diagnosed tumours, 3,515 (19.1%) were either an adenoma or an adenocarcinoma. Of the total number, 2,613 (74.3%) were malignant (adenocarcinomas). In the 1960s, approximately half of the diagnosed tumours were adenomas/adenocarcinomas. Their relative frequency decreased over the period covered by this study (Fig. 1).

The most common anatomical locations of adenoma/adenocarcinoma and adenocarcinoma were the mammary gland, gastrointestinal tract and cardiorespiratory tract (Fig. 2).

Using multiple logistic regression analysis, the odds of cat breeds developing an adenoma/adenocarcinoma were compared with those of the European shorthair cat (OR = 1). Two analyses were carried