Chances of Cancer in Veterinarians Due to Zoonotic Cases

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ABSTRACT

Zoonosis, an infectious disease transmitted from animals to humans, are inherent occupational hazard in veterinary practice. The potential correlation between the incidence of cancer and the occupational exposure of veterinarians to zoonosis has been discussed. While the risks associated with zoonotic infections have been extensively studied, there is a limited understanding of the potential long-term health consequences for veterinarians, particularly concerning cancer development. The research employs a retrospective cohort design, utilizing health records and occupational histories of veterinarians over an extended period. By analyzing data from diverse veterinary settings, including small and large animal practices, research laboratories, and wildlife rehabilitation centers, this study aims to identify patterns and trends in cancer occurrence among this unique occupational group.

Furthermore, the investigation delves into specific zoonotic agents veterinarians may encounter during their professional activities, such as bacteria, viruses, and parasites, and assesses their potential carcinogenic effects. Factors such as duration of exposure, protective measures, and individual susceptibility will be considered in the analysis to provide a comprehensive evaluation of the relationship between occupational exposure to zoonotic agents and the likelihood of developing cancer.

The findings of this study could have significant implications for veterinary occupational health and safety practices. Understanding the potential risks veterinarians face in their daily interactions with animals and zoonotic agents may lead to the development of targeted preventive measures, improved safety protocols, and enhanced awareness within the veterinary community. Ultimately, this research contributes to the broader conversation surrounding occupational health in veterinary medicine and highlights the importance of proactive measures to safeguard the well-being of veterinary professionals.

Keywords: Cancer, tumors, Zoonosis, public health, veterinarians

CITATION

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1. INTRODUCTION

The study of tumor illnesses in populations is central to the field of cancer epidemiology. A valuable source found in pets for epidemiological research on spontaneously developing neoplasms are cancers (Fiumana et al. 2023). Due to the potential for etiological agents to be transferred to humans through animal food items and the closeness of pets to individuals residing in the same residency, attention has been given specifically to cancer in livestock and companion animals. Furthermore, Epidemiology may offer insight into preventing or understanding neoplasms and cancer (Fiumana et al. 2023).
Radiations, herbicides, anesthetics, and zoonotic infections are among the potential carcinogens to which veterinarians may be exposed (Fritschi 2000; Kinnunen et al. 2022). Only a few studies have looked into the cancer risks associated with this career. Our knowledge includes six pertinent cohort studies. Five of them were done in the United States; one of them, which comprised 5016 white male veterinarians, overlapped the four other studies while the sixth involved a total of 3440 veterinary surgeons who lived in Britain (Tomasi et al. 2022).For a number of reasons, including companionship, entertainment, security, pets have grown to be an integral part of homes (Kinnunen et al. 2022). The greatest rate of pet ownership in the world is thought to be in the US, where an estimated 79.7 million houses (65% of households) keep pets. Other nations have reported data along the same lines. As, 63% of families in Australia, or almost 5 million houses, have a pet (Voice 2019). These numbers probably understate the situation. Fig. 1 highlights the route of transmission of cancer to veterinarians.

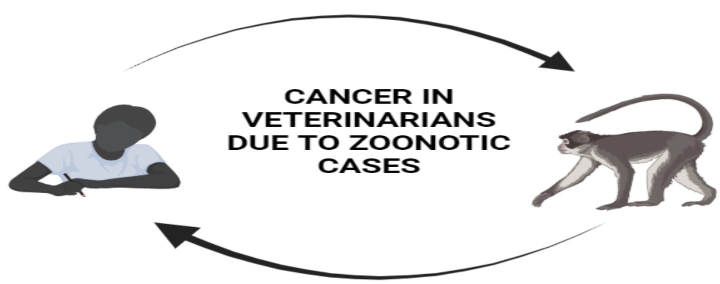

Fig. 1: Cancer transmission to a veterinarian

The benefits to human mental and physical health from interaction with pets and the enhancement of quality of life have been recognized in numerous researches. Because of these factors, using pets as therapy for mental health issues and chronic illnesses is becoming more common (Friedmann and Son 2009). Animal-assisted therapy has been found to have a positive impact on human physiology. Patients with chronic conditions experience a reduction in blood pressure and heart rate. Anxiety levels decrease and social skills improve in mental health inpatients (Moreira et al. 2016). When dealing with the difficulties of a protracted therapy process, which significantly impacts their way of life from a physical and psychological standpoint, oncology patients experience a similar route. Cancer patients receiving aggressive cancer therapy have found AAT (Animal-assisted therapy) to be helpful (Orlandi et al. 2007). AAT mostly employs professionally trained canines (Orlandi et al. 2007). Radiation, anesthetic gases, pesticides (especially insecticides), and zoonotic organisms are just a few of the possibly cancer-causing exposures that veterinarians come into contact while performing their professional duties. The carcinogenic dangers associated with this profession are, however, little understood (Fritschi 2000). Although, there is less data available on the carcinogenicity of exposures in veterinary professionals. In this chapter, the degree of exposure to suspected carcinogens in the veterinary profession will be discussed. This chapter will also analyze the carcinogenicity of these substances in light of the available information.

Cancer is a serious hazard to the health of people worldwide. It is predicted that there will be 19.3 million new cases and nearly 10 million deaths in 2020 (Sung et al. 2021). Pathogens and poor lifestyle choices are just two of the many environmental factors that might contribute to carcinogenesis. 15.4% of cancer cases globally are caused by infectious diseases (Plummer et al. 2016) in developing nations, this percentage rises to 20% (De Martel et al. 2012). By 2050, it has been anticipated that infections will cause a number of cases of human cancer (Zur Hausen 2006). IARC has identified group 1 carcinogens include 11 species of pathogenic microorganisms that are "carcinogenic to humans". *Helicobacter pylori*, human papillomavirus (HPV), hepatitis B virus (HBV), hepatitis C virus (HCV), and Epstein-Barr virus (EBV) are all known biological carcinogens (Sung et al. 2021). *Opisthorchis viverrini, Clonorchis sinensis*, and *Schistosoma heamatobium* are examples of helminth species that are a part of group 1 (De Martel et al. 2012). Aside from that, *Schistosoma japonicum* and *Opisthorchis felineus* have been categorized as, Group 3 (not classifiable carcinogens) and Group 2B (potential carcinogens), respectively (Bülow et al. 2021; Pakharukova and Mordvinov 2022). In addition, researchers are now evaluating the long-ignored hypothesis that additional metazoan and protozoan parasites may influence the emergence and progression of cancer (Cheeseman et al. 2016; Sawant et al. 2020).

There are different viral (Truyen and Lochelt 2006), putative bacterial species (Swennes et al. 2016), and transmissible tumor cells (Murchison et al. 2014; Ganguly et al. 2016; Stammnitz et al. 2023) that cause cancer. Over the years, certain parasites have been identified as impacting animal health, though their significance was overlooked (Ewald 2018; Porras-Silesky et al. 2021). While advancements in the feline field have led to a reduction in the burden of cancer in the veterinary field (Sarver et al. 2022), the list of pathogens capable of causing animal cancer continues to grow (Rolph and Cavanaugh 2022; Aluai-Cunha et al. 2023).

2. RISK FACTORS FOR DEVELOPING CANCER DUE TO ZOONOTIC DISEASES

In a progressively interconnected world, where the boundaries between humans and animals blur, the threat of zoonotic diseases has gained unprecedented prominence. Beyond the immediate health concerns, a growing body of research has shed light on a concerning link between zoonotic diseases and cancer development. While the origins of cancer are multifaceted, the emergence of zoonotic pathogens as potential risk factors has sparked considerable interest in understanding the complex interplay between human health and the animal kingdom. This exploration delves into the intricate web of risk factors that connect zoonotic diseases to cancer, unraveling the mechanisms and implications that underscore this evolving field of study.

2.1. THE RELATIONSHIP BETWEEN HAVING PETS AND THE RISK OF CANCER

Examples of known human carcinogens include asbestos, silica dust, diesel engine exhaust, and wood dust. Other environmental influences include UV radiation, radon gas, infectious diseases, and others. Pet exposure may also be harmful, according to some studies. The relationship between birds and lung cancer, dogs and breast cancer, and cats and brain tumors or hematological malignancies are all connected to a higher chance of developing cancer.

Concerns arose about the likelihood of a link between cat ownership and a higher risk of malignancies in their owners in a number of researches conducted in the 1970s with relations to cats. In this research, it was proposed that cats might serve as hosts for *Toxoplasma gondi*, FeLV, or FIV, which could result in brain tumors and hematological malignancies. In individuals who own cats and have various hematological neoplasms, however, more recent research has established that there are no evident titers of feline viruses. *T. gondi* commonly spread through cat contact, eating contaminated undercooked or cured meats, and vertical transmission. Adult brain cancer incidence was observed to be greater in nations with higher *T. gondi* antibody prevalence (Thomas et al. 2012). The nations included in this study had *T. gondi* seroprevalence ranging from 4% to 67% and the risk of brain tumors was positively associated with *T. gondi* prevalence in the countries with the highest incidence. Garcia et al. (2016) undertook a sizeable epidemiological investigation so far to investigate links between pet ownership and oncological risk. (Garcia et al. 2016) looked at whether owning pets (particularly canines, felines, or birds) was linked to a minor risk of all cancers. A total of 123,560 participants out of which 20,981 canine owners, 19,288 feline owners, 1338 bird owners, and 81,953 non-pet owners participated in the Women's Health Initiative (WHI) observational study and clinical trials. The findings indicated that there was no correlation between owning a pet and the overall incidence of cancerous tumors. It is also important to bring up the research conducted by (Tranah et al. 2008), whose researchers not only failed to show a connection between pet ownership and human oncologies but also argued for the reverse, saying that having pet animals and being around farm animals may actually be protective against the growth of non-Hodgkin's lymphoma (NHL).

2.2. PET EXPOSURE RISK IN IMMUNE-COMPROMISED INDIVIDUALS

According to Voice (2019), 13 % of Australian residents are of view point that they plan to get a pet animal in the coming year, and surveys show that 77% of households got a pet after receiving a cancer diagnosis. Pet ownership is widespread; as indicated in the introduction, roughly 62% of Australian homes keep pets. Dogs are the most popular pet (approximately 40%), followed by cats (30%).

The possibility of zoonotic diseases is the main issue regarding having a pet in relation to cancer patients, and this might be particularly correct for immune-compromised patients or those getting immunosuppressive treatment (immune-suppressants/chemotherapeutic medicines). Animal bites, scratches, direct skin or mucous membrane contact, contact with bodily fluids, direct contact with urine or feces, and inhaling infected droplets are ways that humans might contract zoonotic diseases. For bacterial, fungal, parasitic, and viral pathogens, there is compelling evidence to substantiate pet origins. *Bartonella* species, *Campylobacter*, *Salmonella*, *Giardia duodenalis*, Cryptosporidium species, Pasturella, Dermatophytes, *T. gondi*, and Lymphocytic Choriomeningitis Virus are some of the common pathogens to be concerned about (Elad 2013).

Instead of this, patient surveys, case reports, and epidemiological research suggest that there are generally few human diseases that may be linked to dogs. However, it is unknown how many immune-compromised patients actually contract zoonotic infections. Due to the rare nature of these instances and the fact that they are typically not reportable infections, there is not a lot of data available. Immune-compromised individuals are not in any greater risk from pet interaction than the general public (Hemsworth and Pizer 2006). This is in line with the results of a few studies on hospital patients who were exposed to rehabilitation dogs (Snipelisky and Burton 2014).

The danger of an illness varies widely, it is acknowledged. The type of cancer patient, the species of animal, its time of life, and characteristics of pet-animal contact relating to animal management and hygiene are some other factors that affect risk. We have a variety of animals available that are the pet species that pose the highest zoonotic risk because they are known Salmonella carriers and can cause severe bacteremia in high-risk individuals, such as those with hematological malignancies (Gradel et al. 2009). Even if having pets is not controversial for the high-risk public, extra safety measures should be taken to prevent the spread of pathogens. Recommendations are typically broken down into pet selection, contact with animals, husbandry practice, and cleanliness habits. In 2017, a survey was conducted to examine the rates of participation in potentially infectious activities among pet owners with compromised immune systems (Gurry et al. 2017). There were three separate patient populations in total, with hematological malignancies being one of them. Only 17% of diseased individuals with pets recalled receipt of instructions about proper pet handling from their physicians, even though 80% of patients engaged in no less than one potentially transmissible activity with their pets, like touching animal feces or sharing a bed. This shows that doctors should counsel people more frequently about responsible pet ownership and interaction. Veterinarians should recommend de-sexing (spaying or neutering) for pets at a young age to reduce roaming and contact with wild animals (Elad 2013; Stull et al. 2015). Fig. 2 shows the occurrence of zoonotic diseases in some closely related species.

Experts and practitioners have a crucial part in educating oncology patients who own dogs about preventative health practices. During a consultation, doctors should actively seek out information about previous interactions with pets and offer pertinent guidance on lowering the risk of zoonotic diseases. Additionally, reportable zoonotic cases should be informed to public health authorities so that particular exposures and behaviors that raise the risk of pet-linked zoonotic disease can be appropriately recognized (Stull et al. 2015).

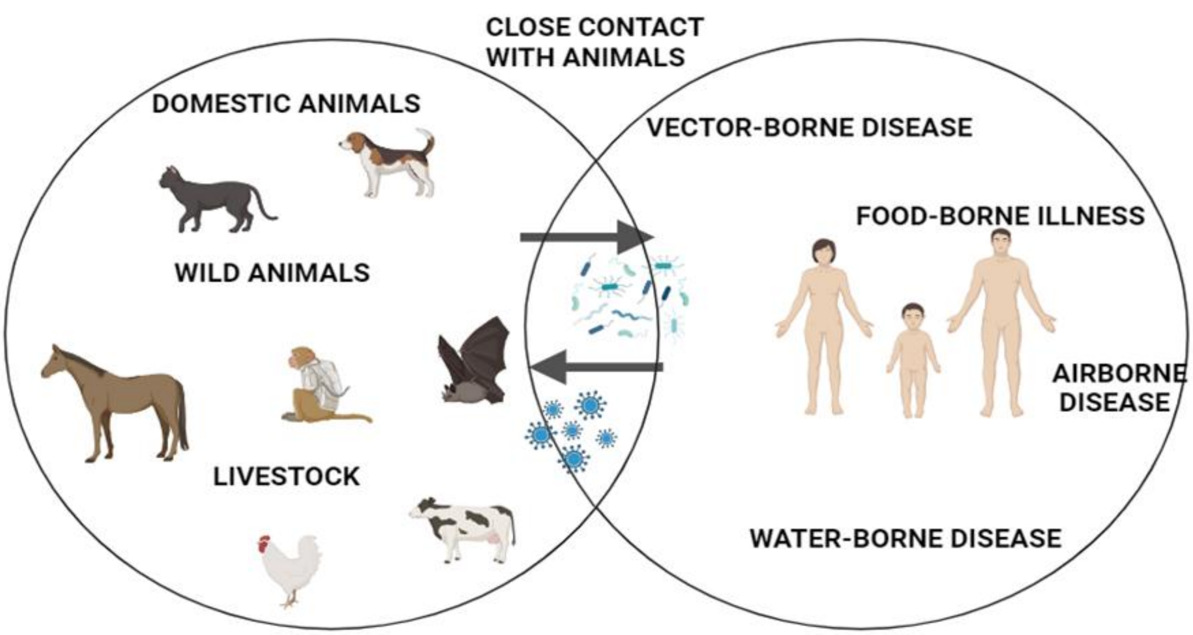

Fig. 2: Zoonotic disease occurs among the closely interacting species

2.3. AREAS FOR INVESTIGATION

There is a positive link between particular viral or bacterial zoonotic infections as a probable cause of malignancy. The methodology was said to have caused some bias in the findings. By using improved procedures, later studies have questioned these conclusions. The majority of the discrepancies could be attributed to undiscovered residual confounding risk factors. Questionnaires were frequently used in the studies to obtain data, which will exacerbate recall bias. Therefore, to remove confounding factors, more rigorous study designs are needed. Uncertainty exists over the precise pathophysiology of the environmental risk factor for cancer. To support or refute the hypothesis, additional research should be done on cancers with potential zoonotic risk links. The pathophysiology of the causal agent's pathogenesis would be useful in better understanding the risk of cancer associated with specific environmental exposures, particularly animal exposure (Elad 2013).

More research is needed to determine the risk factors and advantages of allowing pets in healthcare facilities, even though the majority of studies have found that immune-compromised patients are not more at risk from pet encounters than the general population. This is because zoonotic infections are a persistent concern in this population (Kamioka et al. 2014). A comprehensive investigation is needed to accurately measure the proportion of infectious diseases in humans stemming from interactions with animals, pinpoint particular pathogens, risk factors, and modes of disease transmission, and assess the effectiveness of diverse preventive measures. This thorough data can empower individuals to evaluate the pros and cons of engaging with pets.

3. RISK FACTORS FOR DEVELOPING CANCER IN VETERINARIANS OTHER THAN ZOONOTIC FACTORS

According to reports, the majority of veterinarians in practice use radiographic technology. 64% of respondents in a postal poll of all women receiving veterinary medicine degrees from American institutions in the 1970s admitted to having been exposed to radiation while pregnant with a sample size of total 2427 individuals, this survey had an amazing response rate of 90%.

In another postal survey conducted by Wiggins et al. (1989), it was discovered that approximately 82% of female graduates with veterinary medical degrees from the University of California had potentially encountered ionizing radiation. Once again, the survey boasted a commendable response rate of 86%, and the study encompassed a substantial sample size of 457 individuals. Unlike previous surveys, this one encompassed exposure beyond those related to pregnancy, making it a more representative reflection of typical exposure scenarios.

4. EVIDENCE INDICATES EXPOSURE LEVELS COMPARABLE TO THOSE EXPERIENCED BY VETERINARIANS ARE CARCINOGENIC

It has been known that ionizing radiations are carcinogenic, especially in relation to leukemia, thyroid cancer, and skin cancer (Benson et al. 2012). A case-control study found female dentists and dental hygienists 13 times more likely to develop thyroid cancer than non-dental workers (Bordicchia et al. 2014). These malignancies are associated with higher socioeconomic status and not necessarily with X-rays eviction or work-related chemicals. Record linkage studies showed that people working in medicine had an increased risk of melanoma and an increased risk of colorectal cancer (Bordicchia et al. 2014).

The bovine papillomavirus and the feline leukemia virus are two examples of well-known viruses that cause cancer in a variety of animals and may pose a danger to humans (Bordicchia et al. 2014). Other viruses can also cause cancer in humans, such as Epstein-Barr virus, which causes Burkitt's lymphoma and nasopharyngeal cancer, and herpes papillomavirus, which causes cervical cancer (Benson et al. 2012). In addition, it is said that some viruses, such as cowpox, foot-and-mouth virus, and many arboreal viruses, can be transmitted from animals to humans. These findings led to speculation about the possibility that carcinogenesis in animals could transfer to humans and cause cancer. There is evidence that some of tumors may be caused by a virus; speculation has focused on lymph hematopoietic malignancies. Inadequate exposure assessment limited this investigation of the hazards of zoonotic disease exposure. The absence of animals in the home does not guarantee non-exposure. In addition, it is likely to affect how people respond to questionnaires about exposure to sick animals (Bordicchia et al. 2014).

5. UNVEILING THE CONNECTION: PARASITES AND NEOPLASIA IN DOMESTIC AND WILD ANIMALS, IMPLICATIONS FOR HUMAN ONCOLOGY

The Table 1 provided below enumerates the original research studies discovered during the literature search, concentrating on the correlation between parasites and spontaneous neoplasia within the field of veterinary medicine (Shahvazi et al. 2021). Evidence of a presumed and substantiated association between parasites and carcinogenesis has been established across diverse animal species, encompassing both domestic animals (such as dogs, cats, ruminants, rats, mice, and chickens) and wildlife or exotic species (including prosimians, New and Old-World monkeys, snakes, and muskrats). A total of 15 distinct parasite genera have been identified, with the majority (14) belonging to metazoans, particularly (though not exclusively) helminths. Among the cataloged parasite species are trematodes (*C.sinensis, Fasciola* spp*., O.viverrini*, *Platynosomum illiciens, S.mansoni*), cestodes (*T.taeniformis*), nematodes (*G.pulchrum, S.lupi, Heterakis* spp., *Nochtia nochti, Ollulanus trichuspis, Ophidascaris* spp., *Trichinella* spp.), and arthropods such as pentastomids (*Linguatula serrate*). Furthermore, a protozoan parasite, *T. annulata*, was also identified (Sawant et al. 2020), but recent advancements in diagnostic technologies have shifted attention to other potential parasites, including protozoa (Sawant et al. 2020; Mahdavi et al. 2022; Salim et al. 2022).

There was just one hematological lesion (lymphoma), and there were reports of both mesenchymal and epithelial neoplasms.

6. SOME PRELIMINARY REFLECTIONS OF DIFFERENT DISEASES

6.1. *GONGYLONEMA NEOPLASTICUM*

For millennia, it has been hypothesized (Bignold et al. 2007) that there is a relationship between parasite-related diseases and tumor incidence. However, scientific evidence no longer supports some of these hypotheses, such as the theory of Justammond (1737-1786) that cancer was majorly caused by insects

Table 1: Parasite related neoplasia cases in wild and domestic animals

Phylum	Parasite species	Neoplasms	Cases on record
Nematoda	*Ganglyonema pulchrum*	Esophageal SCC	1
	Heterakis gallinarum	Leiomyoma	8
	Heterakis isolonche	Leiomyoma	2
	Ollulanus trichuspis	Gastric adenocarcinoma	2
	Nochtia nochti	Invasive gastric papilloma	6
	Clonorchis sinensus	Cholangiocarcinoma	2
Platyhelminthes	*Fasciola gigantica*	Leiomyoma	44
	Fasciola hepatica	HCC	11
	Platynosomum illiciens	Cholangiocarcinoma	4
	Taenia taeniformis	Hepatic sarcoma	11
	Taenia taeniformis	Hepatic Fibrosarcoma	55
Arthropoda	*Linguatula serrate*	Nasal basosquamous carcinoma	1
Apicomplexa	*Theileria annuluta*	Lymphoma	1

consumed through the lymphatic vessels, and the research of Sennert (1572-1637) on the causes of leprosy and carcinoma (Bignold et al. 2007). The scientific basis for the relationship between cancer and infectious agents was established in the early 20th century (Hajdu and Darvishian 2013). The new data showed that the genus *Gongylonem* appeared to be in decline. Zhou et al. (2021) just published the first human case of esophageal squamous cell carcinoma growth associated with esophageal *G. pulchrum* infection. Interestingly, a teenager female lemur (*Lemur macaca variegate*) in a German zoo also showed an association between *G. pulchrum* infection and the same neoplasia (Bleier et al. 2005). The fact that *G. pulchrum* is phylogenetically connected to another spirurid worm, *S. lupi*, whose carcinogenic potential is recognized, calls Fibiger's research into question. Despite the few cases, *G. pulchrum* cancer-causing potential remains unknown. These insights highlight the complexities of this issue while also rekindling interest in Fibiger's work (he himself underlined the importance of multiple components in the genesis of cancer) (Fibiger 1919).

6.2. *SPIROCERCA LUPI*

Dogs who contract spirocercosis are affected by the worm *Spirocerca lupi*, a member of the Spirocercidae family (van der Merwe et al. 2008) *S. lupi* is the only nematode worm known to cause cancer in dogs (Porras-Silesky et al. 2021). This particular parasite has been suggested as an ideal model for investigating the mechanisms through which nematodes function as cancer-causing agents. However, due to its limited zoonotic potential, this parasite is often neglected in the literature. In addition, there are problems with experimental in vivo cancer production of *S. lupi* in laboratory animals (because they act as paratenic hosts) and dogs (for ethical reasons) (Stettner et al. 2005). In recent research, there have been efforts to maintain the vitality of adult *S. lupi* worms within mouse fibroblast cells in an ex vivo environment, although this was achieved only for a limited duration (Sako et al. 2017). Nonetheless, given the rising prevalence of this parasite and its potential implications for combating cancer in the field of human medicine, it is evident that additional research is imperative.

6.3. *CLONORCHIS SINENSIS*

A common zoonotic flatworm called hepatic fluke can damage the liver and bile duct. *C. sinensis* was classified as possibly carcinogenic to human being in 1994. However, more recent and convincing evidence (Choi et al. 2006; Sripa et al. 2012) led to the classification of this substance as highly carcinogenic to humans. Adenocarcinomas account for approximately 70% of cancers caused by *C. sinensis*, while biliary anaplastic and squamous tumors account for the remaining 30% (Choi et al. 2006; Qian et al. 2016). Among these complications, cholangiocarcinoma stands out as the most significant. Surprisingly, recent research indicates that individuals who have both hepatocellular carcinoma and a *C. sinensis* infection experience a poorer prognosis, even in the presence of HBV co-infection (Li et al. 2023). Although there is little information in the domestic literature, experimental animal models have been useful for understanding carcinogenic pathways (Wang et al. 2017).

7. INCREASED SENSITIVITY OF PARASITES TO ENVIRONMENTAL CARCINOGENS

By inducing controlled trematode infections in animal models, researchers recently investigated a process that may indirectly cause cancer. This process can result in a diminished clearance of food or environmental carcinogens (such as nitrosamines, aromatic amines, and aflatoxins) due to mechanical damage, a chronic inflammatory milieu, and the release of parasite ESP, which can impair critical metabolic liver enzymes.

Experimental infections with blood (Schistosoma spp.), liver (Opisthorchis spp.) and/or *C. sinensis* fungi have been found to induce inflammatory changes in the absence of carcinogens. However, the appearance of neoplasia required low doses of nitrosamines, which are not per se carcinogenic (Sripa et al. 2012). Sub carcinogenic oral doses of nitrosamines have been shown to induce biliary tumors in hamsters whose bile ducts were surgically ligated to induce mite infection. It is important to note that an older hypothesis suggested that nitrosamines were the cause of cancer development, with parasite infection acting as a proliferative stimulus to initiate cell proliferation. However, mycological infection of the liver can also promote nitrosation of amine precursors. Aflatoxin B1 (AFB1) and N-dimethylnitrosamine (NDMA) are two carcinogens metabolically activated by the CYP2A5 enzyme that have been implicated in the induction of Opisthorchis and Fasciola infection (Yongvanit et al. 2012). Human and hamster bile ducts have been discovered to contain high quantities of NDMA. *Schistosoma mansoni* has also been experimentally linked to pro-carcinogen metabolic activation via a 300% rise in aflatoxin metabolites (Habib et al. 2006). Undoubtedly, these findings suggest that parasites increase exposure to environmental carcinogens and indirectly increase cancer risk.

8. UNUSUAL ONCOLOGICAL PHENOMENA: EXPLORING HOST-PARASITE INTERACTIONS IN HUMAN AND VETERINARY MEDICINE

An unusual relationship between the host and the parasite is described during carcinogenesis in a 2015 study by Muehlenbachs and colleagues (Muehlenbachs et al. 2015). A dwarf tapeworm (*Hymenolepsis nana*)-infected HIV-positive patient presented with a metastatic tumor of unclear origin. Neoplastic cell morphology suggested a non-human origin. Additional immunohistochemical and genetic testing proved that malignant cells originated from the worm *H.nana* and infiltrated the host's organs (Muehlenbachs et al. 2015), suggesting that the parasite may also possess a carcinogenic mechanism. In this regard, it has been suggested that the absence of conventional host-defense signals (caused by immunodeficiency) can also cause neoplasia in the parasite and abnormal tapeworm growth, tissue dissemination, and neoplasia in the host (Ito 2015). Fig.3 highlights the route of parasites transmission to human through their primary hosts.

This occurrence is prevalent in both the realms of human medicine and veterinary medicine (Conn 2016), *Versteria spp.* (Goldberg et al. 2014; Niedringhaus et al. 2022), Spirometra spp. (Woldemeskel 2014; Arrabal et al. 2020), Mesocestodes (Conn et al. 2010), and other cestodes that infect people and other animals have all been the subject of numerous accounts of abnormal transformation. *Sparganum proliferum*, a lethal zoonotic tapeworm, is a perplexing illustration of how a real neoplastic phenomenon can be separated from parasite life cycle stages based on larval growth (Conn 2016; Kikuchi et al. 2021). More broadly, this hypothetical situation has given rise to the theory of new and unusual host-parasite interactions (de Souza et al. 2016).

Non-human ductal carcinoma has a broad molecular profile, and Veterinary Oncology identifies atypical routes of tumor transmission, such as contagious infectious malignancies in dogs, Tasmanian devils, golden hamsters, and sea urchins (Kattner et al. 2021). However, by analyzing this phenomenon, research in the field of veterinary medicine can become decisive.

9. CROSSING THE SPECIES BARRIER: ZOONOTIC IMPLICATIONS OF CONCURRENT TUMOR OCCURRENCES IN HUMANS AND HOUSEHOLD PETS

Incidences of tumors vary between species, particularly between dog breeds, according to epidemiological studies (Fiumana et al. 2023). Parodi 1977 claim that the boxer dog has a high chance of developing a number of tumors, including thyroid carcinoma, testicular tumors, malignant lymphoma,

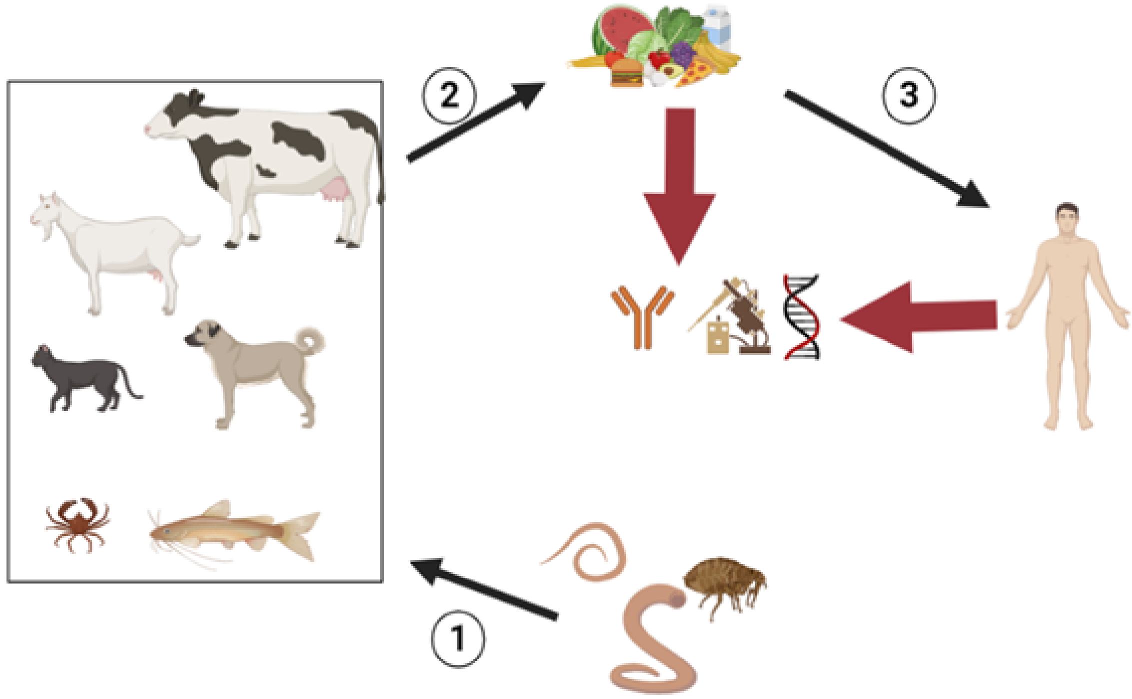

Fig. 3: Parasites through their primary hosts come in the food and thus affect the human causing cancer

and sarcomas of the bone and soft tissues. Large dogs are the primary hosts of skeletal osteosarcomas. Cattle, cats, dogs, and goats with white, non-pigmented skin have an elevated hazard of developing skin squamous cell carcinoma. The absence of melanin's shielding effect against cancer-causing solar radiation has been characterized as a pre-cancerous condition, offering an explanation for this scenario. Depigmentation of hair is linked to equine melatonin illness in grey horses and cutaneous melanomas in miniature swine (Menezes et al. 2003). Ovariectomy in dogs and cats has been shown to be protective against the development of breast cancer, according to case-control studies conducted in the Netherlands. Additionally, it was discovered that the administration of progestogens dramatically raised the risk of the formation of mammary tumors in canine and felines most likely in a dose-related manner (Menezes et al. 2003). These outcomes suggest that early ovariectomy is more effective for preventing oestrus than ongoing progestin therapy. There is a casual link between cat sarcoma tumorigenesis and vaccination against viral illnesses according to recent American studies (Kass et al. 1993).

10. SENTINELS FOR ENVIRONMENTAL HAZARDS

Since pets closely interact with humans in their environment and may act as “sentinel” species for human disease, spontaneous neoplasms in animals may serve as outstanding models for researching the health impacts of environmental risks. Lung cancer in humans is linked to tobacco use. The risk (RR 1.3) of passive smoking in dogs was found to be comparable to that of humans.

11. ZOONOTIC IMPORTANCE

There have been some instances of tumors occurring simultaneously in people and household pets. In one study, cats in leukemia families had greater rates of illness and mortality than cats in families that were chosen at random. The fact that the feline leukemia virus (FeLV) can thrive in human cells in vitro and can theoretically be transmitted to other species made this observation potentially significant (Bordicchia et al. 2014). Nevertheless, epidemiological investigations exploring the potential for cat-to-human transmission have not demonstrated any significant risk associated with FeLV for humans. Despite a comprehensive study that compared cancer incidence between male veterinarians and the broader American population, it was observed that there was an increased occurrence of unexplained cases of leukemia and Hodgkin's disease among veterinarians working in clinical practice.

After adjusting for confounding factors including smoking and occupational exposure, it was discovered that bird keepers in the Netherlands had a 6.7x higher chance of developing lung cancer. For all categories of bird caretakers, there was a similar rise in lung cancer. In addition, exposure to pet birds was linked to an elevated risk of lung cancer in Germany. After he had been exposed for more than ten years, his risk increased. Pigeon raising in Scotland was associated with an increased risk of lung cancer in humans, but not with exposure to domestic ornamental birds. An epidemiological study conducted in the USA on individuals exposed to poultry on the job found no increased incidence of lymphoma, Hodgkin’s disease, and leukemia (Beetz et al. 2012).

12. CONCLUSION

In conclusion, the cancer risk relationship between veterinarians and zoonotic cases is a complex and multifaceted topic that deserves continued research and attention. Working tirelessly to care for both animals and people, these dedicated professionals face unique challenges in their work. Despite the fact, that epidemiological studies have offered major information regarding zoonotic concerns. More research is needed to identify the risk factors for cancer in veterinarians. Preventing and mitigating zoonosis, promoting preventive measures in veterinary practice, and monitoring long-term health outcomes in this key workforce are all critical steps to ensure the well-being of these health heroes. Going forward, collaboration between the veterinary and medical communities is key to shedding light on this important issue and developing strategies to protect the health of those who dedicate their lives to caring for animals, and by extension, the health of all of us.

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