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Cancer Among Mammalian Species: Similarities, Differences, and Connections in Cancer Progression between Humans and Domestic Animals

Author: Leah Browne
Major: Animal Science Pre-Vet and Microbiology
Department of Microbiology and Molecular Genetics, Oklahoma State University, Stillwater, OK 74078, USA

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Cancer is one of the leading causes of death worldwide in not only humans but companion animals as well. Differences in how cancer develops in various species have been reported. For example, case studies have proven that canines are not as susceptible to lung cancers stemming from second-hand smoke exposure, unlike humans. Similar findings have been found with rats, documenting that they cannot spontaneously develop melanoma like canines or humans. Piecing these differences together has proven to be challenging, but gut microbiomes hold an important role in the future of connecting cancer between different mammalian species. Furthermore, another connection pertaining to age plays a universal role in the prevalence and onset of cancers among these species. Despite the fact that cancer may never be fully eliminated, reports show that companion animals can aid in the health and longevity of their owners and vice versa. The further development of veterinary oncology could not only increase the knowledge base on animals, but help piece together the puzzle of cancer across the board.

Introduction

Cancer has been diagnosed and recognized in various species, but are humans much different than animals in terms of cancer development? Cancer is one of the most common causes of death in dogs, cats, and humans (Sarver et al., 2022). As it turns out, the cells of humans and animals may be more similar than one might think, and microbiomes may be the biggest connection between cancer, humans, and companion animals (specifically dogs) (Pinto et al., 2022). Cancer research in veterinary medicine is still underdeveloped, but new findings have revealed that cancer is not a "one-size-fits-all" between mammalian species. For example, a case study provided insight into a rat's natural resistance to melanoma that is not found in humans or dogs (Pinto et al., 2022). Another example study focused on canines and their common risk factors as well as their probability of developing lung cancer. Unlike humans, canines were proven to have a stronger natural resistance to the carcinogens breathed in from secondhand smoke (Zierenberg-Ripoll et al., 2017). In the past few decades, humankind has transformed the collective idea of having relationships with animals by

putting even more emphasis on their care and well-being. Animals have gone from being kept for work purposes to being considered an integral part of peoples' families. This helps illuminate the importance of developing the branch of veterinary oncology. The better care that can be provided for animals also holds weight to impact the personal life of the pet owners. Eliminating cancer altogether is certainly an unrealistic expectation as of now, but there is evidence starting to suggest that the mutualistic relationship between humans and companion animals may be helping to reduce reported cases of cancer and extending life/prognosis expectancies (Sarver et al., 2022).

Recent Progress

Despite similarities that will be discussed later on, some interesting differences have been found in cancer progression in various species. Lung cancer has been on the rise for decades with 236,740 new cases (almost 13% of all cases) reported in 2022 (Zierenberg-Ripoll et al., 2017). Lung cancer has also been identified as being responsible for more deaths than any other cancer (Zierenberg-Ripoll et al., 2017). Tobacco use is considered the biggest and most important risk factor, but second-hand smoke has also been proven to increase cancer development likelihood. Second-hand smoke has been identified as a carcinogen and exposure to it increases the risk of cancer development in humans by up to 30% (Zierenberg-Ripoll et al., 2017). In fact, 3000 lung cancer deaths per year are attributed to second-hand smoke exposure (Zierenberg-Ripoll et al., 2017). With this in mind, it has also been widely believed that animals were being exposed to the same risks as humans when consuming and exposed to second-hand smoke. However, for comparison, lung cancer in canines is very rare and only accounts for 1% of all reported canine cancers (Zierenberg-Ripoll et al., 2017). A case study performed on dogs hypothesized that exposure to second-hand smoke was associated with the development of primary lung tumors in dogs, like in humans. 1178 dogs with lung cancer of varying breeds, sizes, and household backgrounds were surveyed and tested to see how strong of a connection could be made between the two factors (Zierenberg-Ripoll et al., 2017). Despite the large sample size, there was no discernable association found between primary lung cancer in dogs and exposure to second-hand smoke (Zierenberg-Ripoll et al., 2017). In an attempt to explain this difference, it is important to consider that like humans, some canine breeds may be more predisposed genetically to certain cancers, but no breed has been found to have higher incidences of lung cancer thus far (Zierenberg-Ripoll et al., 2017). Either way, this evidence shows that canines either have a lower susceptibility to such smoke carcinogens or that their cells are able to combat the carcinogen in a more efficient way than humans. In another study, it was discovered that mice, unlike humans or dogs, cannot spontaneously develop melanoma (Pinto et al., 2022). Instead, they must be genetically manipulated. Researchers were able to draw this conclusion by observing that only the rats whom they injected directly with melanoma cells had the ability to develop cancer (Pinto et al., 2022). It was not endogenous and non-environmentally influenced. Rats and dogs are surely different in almost all aspects from humans and from each other, but this creates the question of how this is possible and what drives the differences between the cells of different mammals. Developing research has begun to dive into how microbiomes are becoming the big players in understanding how these differences arise in seemingly similar cells.

The microbiome of an organism is an important natural defense against disease.

Microbiomes may be indicative of predispositions to cancers and other diseases. It has been proven that the microbiome is a direct determinant of a host's immune system status and their natural ability to prevent disease (Pinto et al., 2022). In human medicine, there is evidence that changes in the microbiome can be detrimental in terms of cancer development, possibly making one more susceptible (Pinto et al., 2022). This can be seen in patients prescribed broad-spectrum antibiotics, as the natural microflora of the body helps maintain healthy bacterial levels necessary for normal function. These same findings have held the same truth in relation to canines, felines, and other companion animals (Pinto et al., 2022). Immunocompromised companion animals have a higher chance of contracting illnesses and experience the same higher difficulties in fighting off said illnesses, as is the same for humans. Another similarity that can be drawn between domestic animals, such as dogs and cats, is that the incidence and chance of cancer development and diagnosis increases with age (Sarver et al., 2022). In comparative studies conducted between canines and humans, the increasing size of the dog also increased their risk of developing cancer, which is a principle present in human oncology as well (Sarver et al., 2022). A common problem in human oncology present also with animals is that cancer may be late-stage in companion animals at the time of detection, like in humans. This is largely in part because symptoms are often not noticeable until the cancer is later-stage and more developed (Sarver et al., 2022).

The domestication of animals has been beneficial to humankind in countless ways. The shift from using animals for work to having them as companions have thrown unforeseen variables into cancer and longevity between humans and those who spend company with animals. Considering the semi-similar microbiomes of canines and humans, research has started to begin on how human cancer therapies can be applied to dogs and vice versa (McGhee et al., 2022). Chemotherapy, medications, and diagnostics are now becoming more available for animals (mostly dogs) because of advancements in human medicine. These advancements have been able to increase the life expectancies of a considerable amount of companion animals throughout the past several decades (McGhee et al., 2022). This is truly a mutualistic relationship because it has also been shown that people who have companion animals, or pets, are at less risk for certain diseases (LeBlanc et al., 2020). The development of veterinary oncology can be directly linked to human oncology and vice versa, as more connections can continue to be made.

Discussion

Though ground has been broken in the veterinary oncology field, a lot more research is needed as not much is fully understood yet. Human oncology illuminates a path for possible treatments for other mammalian species and new cancer studies of these species can help round and advance the information gathered previously on humans and cancer, historically. Gut microbiomes have provided a link between humans, animals, and some forms of cancer, but further research is required to investigate how the differences in these microbiomes produce varying results in terms of cancer progression and development. Differences in susceptibilities can help to drive research on how mammalian cells function in terms of the efficiency of processing and combatting carcinogens in the body. The rat and melanoma case study and new gene-splicing technologies leave a door open for researchers to experiment if eliminating or mutating certain genes may affect cancer expression in humans and other animals. Can altering a genome inherently protect one

from certain cancer types? Further research may be able to answer this question. Furthermore, the difference in the impact of second-hand smoke exposure in dogs and humans lends the question as to why they are not as susceptible to the carcinogen, as mentioned earlier. Expanding on these differences may help develop human medicine and how different exposure rates and anatomy play a role in the development of lung cancer specifically in different mammalian species. This is important as lung cancer is currently the cancer boasting the highest number of cancer deaths among humans in the United States. Overall, furthering any knowledge of cancer in any mammal can only shed more light and bring awareness to a disease that can affect any living being.

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