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COMPARATIVE ONCOLOGY - REVIEW OF SIMILARITIES BETWEEN ANIMAL AND HUMAN CANCER

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Abstract

This review paper aims to present and compare the similarities between animal cancer and human cancer, with a focus on how these parallels can inform and enhance the understanding of cancer treatment in humans. Cancer is a disease that transcends species boundaries, affecting both humans and animals alike. Animal models play a crucial role in cancer research, providing valuable insights into the biochemical and physiological processes of cancer occurrence and development This paper explores the similarities between animal and human cancers, with a focus on how these parallels can inform and enhance our understanding of cancer treatment in humans.

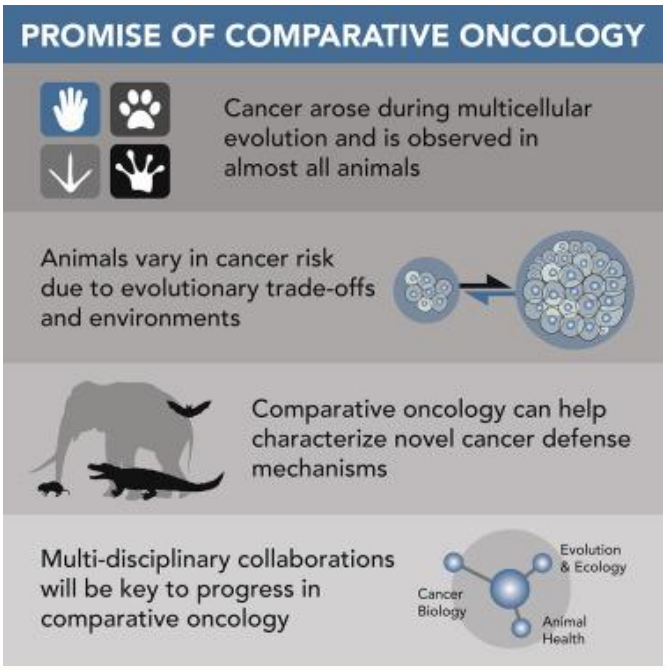
Key words: Comparative oncology, animal cancer, human cancer, one health

Introduction

Comparative Oncology, or a Bridge Between Species, as it is often referred to, investigates the similarities between naturally occurring cancers in animals and humans, with the aim of developing more effective cancer treatments. Cancer is a disease that transcends species boundaries, affecting both humans and animals alike, and the similarities between animal and human cancers, with a focus on how these parallels can inform and enhance our understanding of cancer treatment in humans.

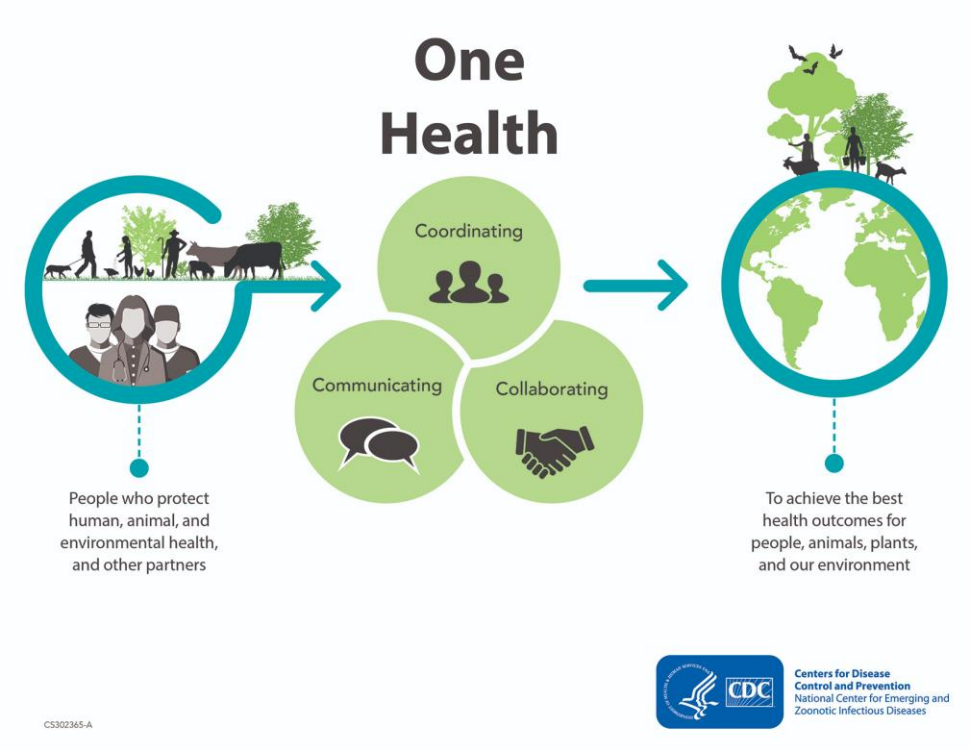
Cancer is a disease that affects both humans and animals, and there are striking similarities between the two. This has led to the development of a field known as comparative oncology, which studies naturally occurring cancers in animals as models for human disease. Specific forms of naturally occurring cancer in pet animals closely mimic those in humans, providing a

unique opportunity for comparative research, and moreover, animal models are used in clinical trials to evaluate the therapeutic effects of various clinical interventions. They are indispensable in cancer research, helping to simulate the occurrence, development, and malignant transformation mechanisms of tumors.



Picture 1 – The promises of comparative oncology
Source: https://images.app.goo.gl/pwUqLgLKqoVVXTpN6

The **One Health approach**, as a transdisciplinary approach, recognizes the interconnection between people, animals, plants, and their shared environment. It aims to achieve optimal health outcomes by working at the local, regional, national, and global levels. This approach is particularly important in the context of disease prediction and control, as it considers the role of changing environments with regard to infectious and chronic disease risks affecting humans and nonhuman animals**.**



Picture 2 - One Health pillar
Source : https://images.app.goo.gl/cfbAauuLZhUDLcZUA

The **One-health approac**h emphasizes the interconnection of human, animal, and environmental health and the importance of transdisciplinary efforts. It has been recognized as a major element of disease control and prevention strategies by international agencies, including the Food and Agriculture Organization of the United Nations, the World Organisation for Animal Health, and the World Health Organization.
The one-health approach can help prevent outbreaks of zoonotic disease in animals and people, improve food safety and security, reduce antimicrobial-resistant infections, and protect global health security.

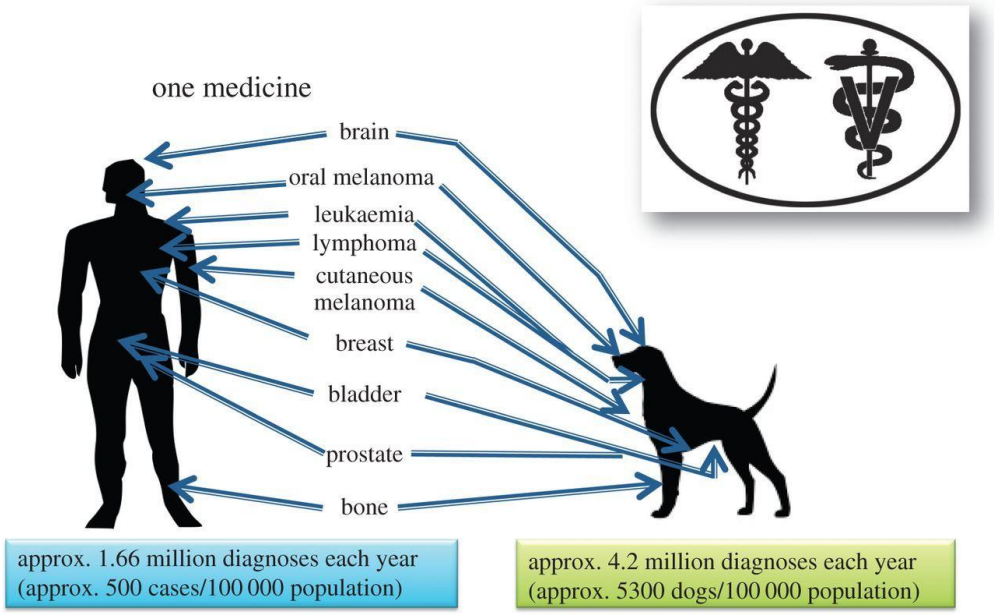
1. The major similarities between animal and human cancer

Certain types of cancer, such as osteosarcoma, are remarkably similar between dogs and humans, both microscopically and molecularly. Spontaneous cancers in dogs also closely recapitulate their human counterparts in terms of clinical presentation, histological features, molecular profiles, and response to therapy. Canine Cancer is often called a Mirror to human cancer. Dogs, in particular, are valuable models for cancer research due to their high genetic similarity to humans - approximately 95%.

In terms of treatment, many of the same medications, including chemotherapy and radiation, are used to treat both animals and humans. The primary differences lie in the dosage and frequency of treatment, with animals typically receiving more conservative doses to reduce toxicity and side effects.

Clinical trials play a crucial role in advancing our understanding of cancer and developing new treatments. The Comparative Oncology Trials Consortium (COTC), part of the Comparative Oncology Program at the National Institutes of Health, consists of veterinary oncologists across the United States. They are working together to perform clinical trials in dogs and cats with cancer.

By studying the genetic and environmental contributions to cancer in dogs, researchers can gain a greater understanding of similar contributions to human disease. This approach not only benefits human health but also advances veterinary medicine by improving cancer treatment for animals.



Picture 3 – Comparison with the approach One Health
Source : https://images.app.goo.gl/5f58sZ3HYLGVSDy97

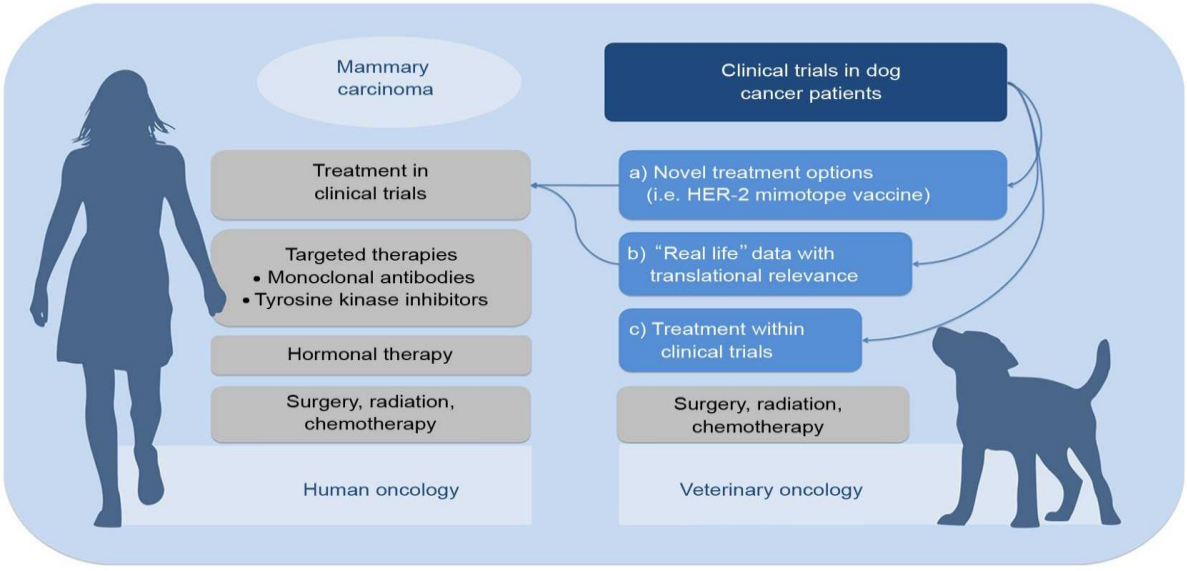
Cancer is the leading cause of mortality in dogs, just as it is a major cause of death in humans. Certain types of cancer, such as osteosarcoma, are remarkably similar between dogs and humans, both microscopically and molecularly. Spontaneous cancers in dogs also closely recapitulate their human counterparts in terms of clinical presentation, histological features, molecular profiles, and response to therapy.

In treatment approaches, there are **shared medications and techniques**, and many of the same medications, including chemotherapy and radiation, are used to treat both animals and humans. The primary differences lie in the dosage and frequency of treatment, with animals typically receiving more conservative doses to reduce toxicity and side effects. Veterinary researchers are also working to develop targeted therapies for animals, similar to those available to humans.

Clinical trials play a crucial role in advancing our understanding of cancer and developing new treatments. The **Comparative Oncology Trials Consortium** (COTC), part of the Comparative Oncology Program at the National Institutes of Health, consists of veterinary oncologists across the country working together to perform clinical trials in dogs and cats with cancer. These trials may involve novel diagnostic methods or therapies, including chemotherapy, radiation therapy, and surgical procedures.

2. How do animal models help in cancer research

Animal models play a crucial role in cancer research, providing valuable insights into the biochemical and physiological processes of cancer occurrence and development. They are used to study the genetic basis of cancer, the role of specific genes and gene mutations in cancer development, and to test the effectiveness of antineoplastic drugs.



Picture 4 - Contribution to the development of precision medicine for mammary carcinomas in human and veterinary oncology, with clinical trials in canine cancer patients, Source : https://images.app.goo.gl/F1CRejHesN9eMEwG8

Animal models also facilitate the discovery and development of cancer drugs and interventions. They provide evidence of how healthy cells are targeted by cancer cells, enabling the development of specific treatments to counteract or block this action.

Moreover, animal models are used in clinical trials to evaluate the therapeutic effects of various clinical interventions. They are indispensable in cancer research, helping to simulate the occurrence, development, and malignant transformation mechanisms of tumors.

Mice are the most commonly used animal models in cancer research due to their high adaptation to different environments, genetic variability, and physiological similarities with humans. They can be genetically engineered to develop tumors that mimic those in humans, providing a platform to study the growth and spread of tumors.

For example, Patient-derived xenotransplantation (PDX) models, where cancer cells from a patient's tumor are implanted into a mouse, have become a research hotspot because they retain the microenvironment of the primary tumor and the basic characteristics of cells.

Animal models are instrumental in cancer research, providing a platform for understanding the complex mechanisms of cancer and for the development and testing of new treatments.

Animal models in cancer research offer several benefits:

Understanding the Genetic Basis of Cancer: Animal models help researchers understand the genetic basis of cancer and the role of specific genes and gene mutations in the occurrence and development of cancer.

Drug Development and Testing: Animal models facilitate the development and testing of antineoplastic drugs. They provide a platform for testing the efficacy and safety of new treatments before they are used in humans.

Modeling Human Tumors: Animals, particularly mice, can be genetically engineered to develop tumors that mimic those in humans. This allows researchers to study the growth and spread of tumors in a living organism.

Patient-Derived Xenotransplantation (PDX) Models: In PDX models, cancer cells from a patient's tumor are implanted into a mouse. These models retain the microenvironment of the primary tumor and the basic characteristics of cells, providing a more accurate representation of human cancer.

Clinical Trials: Animal models are used in clinical trials to evaluate the therapeutic effects of various interventions. They simulate the occurrence, development, and malignant transformation mechanisms of tumors, providing crucial data for the advancement of cancer treatments.

Cost-Effective: Animal models, especially mice, are cost-effective, have short life cycles, and help avoid human experiments, making them extremely valuable for cancer research.

Animal models are invaluable tools in cancer research, providing a platform for understanding the complex mechanisms of cancer and for the development and testing of new treatments.
The One Health approach emphasizes the critical interconnectedness of animals, humans, and the environment. Environmental factors can have a significant impact on the development and progression of cancer in both humans and animals.

For instance, human activities can be oncogenic to other animals, exacerbating the dynamics of oncogenesis, causing immunosuppressive disorders in wildlife with effects on host-pathogen interactions, and eventually facilitating pathogen spillovers. Understanding these environmental influences can help in the development of prevention strategies and treatments for both human and animal cancers.

Conclusion

The field of comparative oncology holds great promise for the future of cancer research. By studying the genetic and environmental contributions to cancer in dogs, researchers can gain a greater understanding of similar contributions to human disease. This approach not only benefits our canine companions by providing them with access to cutting-edge cancer treatments but also helps ensure that humans are given treatments more likely to succeed.

The similarities between animal and human cancers provide a unique opportunity for cross-species learning and collaboration. By leveraging these similarities, researchers can enhance our understanding of cancer and accelerate the development of effective treatments for both humans and animals.



Integrating human and animal oncology through the One Health approach provides a comprehensive perspective on cancer research. By studying the similarities and differences between human and animal cancers, we can gain valuable insights that can lead to the development of novel prevention strategies and treatments. This approach not only benefits human health but also contributes to the well-being of our animal companions.

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