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Transposition of human oncology therapies to veterinary medicine: potential, challenges, and perspectives – a systematic review

[*Transposição de terapias oncológicas humanas para a medicina veterinária: potencial, desafios e perspectivas – uma revisão sistemática*]

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ABSTRACT

The growing interest in transferring therapeutic advances from human to veterinary medicine has spurred research into monoclonal antibodies and advanced therapies for treating cancer in small animals. This systematic review evaluates the feasibility and potential of these innovations, previously applied successfully in human oncology, for managing neoplasms in pets. By analyzing selected studies, the efficacy, mechanisms of action, challenges, and future perspectives of monoclonal antibodies, genetic therapies, and cellular therapies in veterinary oncology are assessed. Key findings include the successful use of bevacizumab and cetuximab in extending survival in human patients with metastatic cancers, the importance of Brazilian natural product research for identifying novel antineoplastic agents, and the emerging role of immune checkpoint inhibitors in veterinary oncology. This review highlights the scientific evidence supporting the potential of advanced treatments to improve therapeutic outcomes in small animals, while also addressing implementation challenges, such as species-specific adaptations, safety assessments, and economic considerations. The translation of these therapies opens new avenues for cancer treatment in companion animals, aligning veterinary medicine with contemporary advances in human oncology.

Keywords: oncology, translational medicine, veterinary oncology, immunotherapy, small animals

RESUMO

O crescente interesse na transposição de avanços terapêuticos da medicina humana para a veterinária impulsionou pesquisas sobre o uso de anticorpos monoclonais e terapias avançadas no tratamento do câncer em pequenos animais. Esta revisão sistemática avalia a viabilidade e o potencial dessas inovações, anteriormente aplicadas com sucesso na oncologia humana, para o manejo de neoplasias em pets*. Por meio da análise de estudos selecionados, discutem-se a eficácia, os mecanismos de ação, os desafios e as perspectivas futuras dos anticorpos monoclonais bem como das terapias genéticas e celulares na oncologia veterinária. Os principais achados incluem o sucesso do bevacizumabe e do cetuximabe na ampliação da sobrevida de pacientes humanos com câncer metastático, a relevância da pesquisa de produtos naturais brasileiros na identificação de novos agentes antineoplásicos e o papel emergente dos inibidores de* checkpoint *imunológico na oncologia veterinária. Esta revisão destaca evidências científicas que demonstram o potencial dos tratamentos avançados para melhorar os resultados terapêuticos em pequenos animais, abordando os desafios para sua implementação, como a necessidade de adaptações específicas por espécie, a avaliação de segurança e as considerações econômicas. A translação dessas terapias abre novos caminhos para o tratamento do câncer em animais de companhia, aproximando a medicina veterinária dos avanços contemporâneos da oncologia humana.*

Palavras-chave: oncologia, medicina translacional, oncologia veterinária, imunoterapia, pequenos animais

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INTRODUCTION

Cancer in small animals is one of the principal challenges of modern veterinary medicine, reflecting not only the complexity of neoplasms but also the increasing demand for more effective treatments. Rising longevity in companion animals has led to a higher incidence of cancer, driving interest in therapies with greater specificity and fewer side effects. Contemporary human oncology has contributed significantly to therapeutic innovation, especially with the advent of monoclonal antibodies and advanced therapies targeting specific pathways (Adams and Weiner, 1999).

These advances include agents such as bevacizumab and cetuximab, which have notably extended survival in human patients with metastatic cancers by inhibiting tumor growth and angiogenesis (Adams and Weiner, 1999). The present study investigates the ways in which these therapies, initially developed for human oncology, may be transposed to treat oncological conditions in small animals. It focuses on the adaptations needed to address physiological and immunological differences among species and explores how these therapies can be integrated safely and effectively into veterinary practice (Lopes *et al*., 2022).

The significance of this investigation lies in its potential to enhance outcomes for small animals with cancer, offering more targeted and less toxic alternatives than many conventional options. Evidence from human applications of monoclonal antibodies, genetic therapies, and cellular approaches suggests that such methods could also benefit veterinary oncology if properly adapted (Adams and Weiner, 1999). Nonetheless, meaningful challenges remain, such as immunogenicity and the high costs of developing specialized veterinary formulations (Schwarz *et al*., 1999).

Given these considerations, a systematic review is warranted to map the current state of advanced oncological therapies in veterinary medicine, identify practical hurdles, and highlight areas for future research. By synthesizing existing data, the review aims to clarify feasibility, efficacy, and mechanisms of action, as well as to present key directions for further progress. Addressing these issues through collaborative research will be essential to align veterinary oncology with the scientific and technological strides made in human cancer treatment (Lopes *et al*., 2022).

ETHICAL ASPECTS

This article is a literature review and therefore does not require submission to a research ethics committee.

MATERIALS AND METHODS

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). A research question was formulated using the PICO strategy: small animals with oncological conditions (Population) treated with advanced oncological therapies and monoclonal antibodies from human oncology (Intervention), compared to conventional therapies or no comparator (Comparison), and evaluated for feasibility, efficacy, safety, and translational applicability (Outcome).

Articles published between January 2020 and December 2023 in English or Portuguese were included if they addressed the use of monoclonal antibodies, immunotherapies, or other advanced oncological strategies translatable from human to veterinary contexts. Publications exclusively focused on large animals or lacking direct relevance to small-animal oncology were excluded.

A comprehensive search was performed in PubMed, Scopus, Web of Science, and Google Scholar using Boolean operators to combine keywords such as “Monoclonal Antibodies,” “Veterinary Oncology,” “Cancer in Small Animals,” and “Immunotherapy.” Relevant articles were selected through a double-blind process by two independent reviewers, and any disagreements were resolved by a third reviewer. Data extraction recorded study design, species, intervention details, outcomes, and limitations, followed by a narrative synthesis due to the heterogeneity of study designs and reported endpoints.

RESULTS

An initial search yielded 437 records, of which 32 met the eligibility criteria after screening and removal of duplicates. These articles encompassed four thematic areas: immune checkpoint inhibitors, cellular and genetic therapy, monoclonal antibody immunotherapy, and pharmacogenomics/translational medicine.

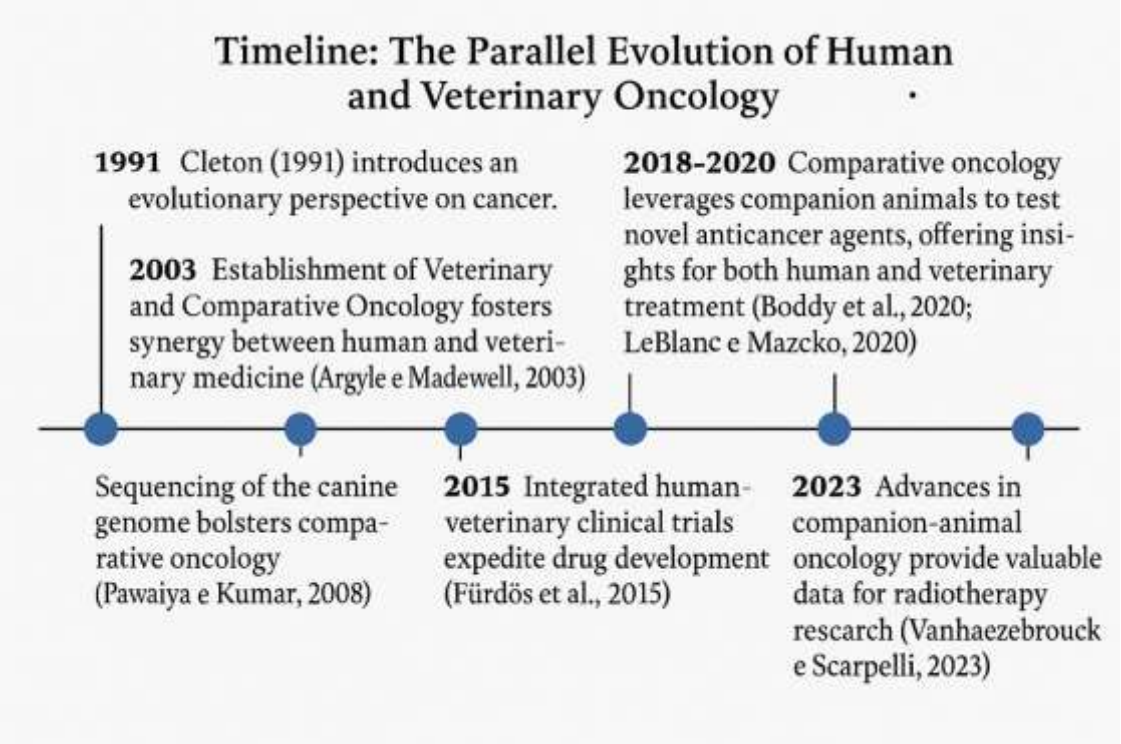

Figure 1. Timeline: the parallel evolution of human and veterinary oncology.

Checkpoint inhibitors have reshaped human oncology and show promises for companion animals. Mangili *et al*. (2022) demonstrated that agents like pembrolizumab and avelumab could enhance antitumor immune responses in gestational trophoblastic neoplasia, suggesting new possibilities for small-animal oncology.

Early-stage work in gene therapy and stem cell approaches reveals personalized treatment strategies. Kitamura *et al*. (2022) highlighted targeted interventions for high-grade pancreatic intraepithelial neoplasia, which may guide future veterinary adaptations.

Neoantigens identified in human tumors can inform new therapeutic targets in veterinary oncology. Jiang *et al*. (2022) demonstrated the impact of such antigens in multiple myeloma, laying a foundation for customized antibody treatments in small animals.

Applying pharmacogenomics to veterinary contexts can optimize dosing, safety, and efficacy (Santiago *et al*., 2023). Personalizing regimens for an animal's genetic makeup would enhance treatment outcomes and reduce adverse effects, echoing the precision medicine trend in human oncology.

DISCUSSION

The findings underscore the translational promise of human-derived therapies—monoclonal antibodies, immune checkpoint inhibitors, and genetic or cellular interventions—for veterinary oncology (Ribeiro *et al*., 2023). Historical data reveal that natural products, antibody development, and molecularly targeted therapies in human medicine have paved the way for these innovations (Monks *et al*., 2002; Adams and Weiner, 1999; Schwarz *et al*., 1999).

Table 1. Main results from selected studies

Study	Authors	Main Findings
Pharmacogenomics and Translational Medicine	Santiago Miranda *et al*., 2023	Clinical and molecular characteristics in Brazilian families with multiple endocrine neoplasia type 1.
Glycolysis & Fatty Acid Synthesis	Cao *et al*., 2023	Investigated therapeutic targets regulating glycolysis and de novo fatty acid synthesis for neointimal hyperplasia.
Immune Checkpoint Inhibitors	Mangili *et al*., 2022	Showed the potential of checkpoint inhibitors in managing gestational trophoblastic neoplasia in humans.
Cellular and Genetic Therapy	Kitamura *et al*., 2022	Assessed the efficacy of genetic/cellular therapy in diagnosing high-grade pancreatic intraepithelial neoplasia.
Monoclonal Antibody Immunotherapy	Jiang *et al*., 2022	Identified neoantigens in multiple myeloma, guiding personalized immunotherapies.

Despite this potential, immunogenicity across species, cost barriers, and limited veterinary-specific formulations pose challenges to implementing such treatments in small-animal practice (Schwarz *et al*., 1999). Nonetheless, growing interest in comparative oncology and translational medicine, combined with advancements in veterinary-specific research, may help overcome these hurdles (Cao *et al*., 2023).

Continued investment in well-designed trials for veterinary patients, along with interdisciplinary partnerships, is essential to refine these innovative methods and validate their safety and efficacy. By merging insights from human oncology with veterinary expertise, the field can move toward more precise and personalized treatments, ultimately improving care for companion animals with cancer.

CONCLUSION

This systematic review highlights the feasibility and promise of advanced oncological therapies developed in human medicine, particularly monoclonal antibodies and genetic or cellular interventions—for small-animal oncology. Although differences in physiology, immunogenicity, and production costs present obstacles, the evidence suggests that these approaches can significantly improve survival and quality of life in pets. Going forward, robust clinical trials, collaborative research, and ongoing technological advances will be essential for translating these therapies into routine veterinary practice. By aligning veterinary oncology with human medical progress, a pathway emerges for more precise, effective, and individualized cancer care in companion animals.

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CONTRIBUTORS

A.R. Fukushima: study conception, definition of the objective, coordination of the systematic review, critical analysis of the included articles, drafting and final revision of the manuscript, approval of the version to be published.
L.A.B. Leoni: literature search, study selection, data extraction, preparation of tables and figures, revision of the discussion, and approval of the final version.
M.L.É. Silvestre: methodological support in the construction of the PICO and PRISMA framework, data analysis, collaboration in drafting the methods and results sections, critical revision of the text, and approval of the final version.
L.P. Pantaleon: analysis of mechanisms of action of advanced therapies, contribution to the discussion section, technical revision of the immunotherapy portion, and approval of the version for publication.

E.L. Ricci: scientific interpretation of studies on cellular and genetic therapies, revision of consistency between results and conclusions, collaboration in the final drafting, and approval of the manuscript.
J.C.M.O.B. Delorenzi: technical evaluation of monoclonal therapies, reference verification, standardization of citations according to ABNT guidelines, textual revision, and approval of the final version.
D.G. Silva: support in searching indexed databases, initial screening of articles, preparation of images and formatting of the manuscript, critical revision, and final approval.
M.A. Nicoletti: specialized contribution on natural products with antineoplastic potential, pharmacological interpretation of the included articles, final revision, and approval of the version to be published.
H.S. Spinoza: technical review in veterinary oncology, assessment of translational applicability to small animals, conceptual adjustments to the discussion, and approval of the final version.

DATA AVAILABILITY STATEMENT

Data-in-article – All data supporting the findings of this study are included in the body of the article.

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