VETERINARY TODAY

ISSN: 2583-8288

Popular Article

Published on: 24.08.2024

Significance of biomarkers in veterinary practices

Sagar Vishal Sharma[1],

[1]Department of Veterinary Medicine, C.V.Sc. & A.H., BAU, Ranchi.

DOI:10.5281/Vettoday.13620242

Abstract

Biomarkers have become increasingly significant in veterinary practice, providing valuable insights into the diagnosis, prognosis, and monitoring of diseases in animals. These measurable indicators, derived from sources such as blood, urine, and tissues, offer a non-invasive and precise means to detect underlying health conditions, often before clinical signs are apparent. The application of biomarkers in veterinary medicine has advanced alongside developments in genomic, proteomic, and metabolomic technologies, enabling the identification of species-specific biomarkers that enhance diagnostic accuracy. Moreover, biomarkers play a pivotal role in monitoring treatment responses and facilitating personalized medicine, ensuring that therapeutic interventions are tailored to the individual needs of animals. Despite challenges related to standardization, technical limitations, and biological variability across species, the integration of biomarkers in routine veterinary practice has the potential to improve patient outcomes, optimize treatment plans, and advance veterinary healthcare. This paper explores the significance of biomarkers in veterinary medicine, highlighting their applications, challenges, and future prospects in the field.

Keywords: Veterinary biomarkers, Disease diagnosis, Personalized medicine, Prognostic indicators, Veterinary healthcare.

Introduction

Early diagnosis and monitoring in veterinary medicine is important for improvement in prognosis, improving quality of life, and reducing the cost of treatment. It is necessary for implementing correct therapeutic measures by timely identification of a disease for avoiding complications. In animals, clinical signs are usually subtle and delayed diagnosis often leads to advanced stages of the diseases. Biomarkers are measurable indicators of a biological state or condition. In veterinary medicine, they play a huge role in diagnosis, prognosis, and monitoring of treatments. They may be simple molecules of proteins and metabolites to a very complex genetic expression.

Biomarkers are largely classified into three major categories: diagnostic, prognostic, and predictive. These biomarkers define the pathophysiological processes of diseases and tailor interventions. Types of Biomarkers (e.g. Diagnostic, Prognostic, Predictive):

Diagnostic biomarkers: They help identify the presence of diseases.

Prognostic biomarkers: Help in predicting the likely course of the disease.

Predictive biomarkers: help to identify the therapies likely to benefit a particular patient.

Sources of Biomarkers: Biomarkers can be derived from multiple sources, such as blood, urine, tissues, and even exhaled breath. Each source has its advantages or disadvantages dependent on the nature of the disease being investigated and under which species it is considered.

Techniques for Biomarker Identification

Genomic Approaches: Next-generation sequencing is only one genomic technology that identifies gene variations useful as biomarkers, particularly useful in hereditary diseases regarding genetic predispositions.

Proteomic Approaches: Proteomics is the large-scale study of proteins. These are important in cellular functioning. Mass spectrometry techniques are used to identify protein biomarkers related to disease.

Metabolomic Approaches: Metabolomics studies small molecules that are also known as metabolites. Since these metabolites are considered as a mirror to the physiological state of an organism, hence metabolomic profiling give insights into veterinary medicine by discovery of biomarkers.

Transcriptomic Approaches:_Transcriptomics is a study of RNA transcripts arising from the genome. It helps in the understanding of changes in the gene expressions that do take place during diseases.

Bioinformatics and Computational Tools: Bioinformatics combines 'omics' data to generate potential biomarkers. Computational tools through which complex data sets can be analyzed and help to understand the biological meaning of a biomarker.

Biomarkers in Veterinary Medicine

Common Biomarkers Used in Veterinary Medicine:

The most common and routine biomarkers used in veterinary practice are the liver enzymes that include alanine aminotransferase for the diagnosis of hepatic disease and cardiac troponins for heart diseases. These biomarkers will help in making prompt diagnosis and therapy instigation in the animal.

Species-Specific Biomarkers

Many of the biomarkers are species-specific because of the variations in physiology and metabolism. For example, some of the biomarkers for renal diseases are different in dogs and cats, so some specific diagnostic tests must be designed for each species.

Comparative Analysis of Biomarkers in Humans vs. Animals

There is great overlap between human and animal biomarkers to the extent that translational research can be facilely done. Still, interspecies metabolism together with immune variations demand careful adaptation when using human biomarkers for veterinary use.

Applications of Biomarkers

Disease Diagnosis: Biomarkers play a crucial role in the diagnosis of a wide range of diseases, from infections to chronic diseases. For example, C-reactive protein is an indicative biomarker of inflammation and has been put to use in the diagnosis and follow up of various inflammatory conditions in animals.

Disease Monitoring and Prognosis: Biomarkers in chronic diseases may facilitate monitoring the progress of the disease along with appraising the response to treatment. For example, intensive treatment for diabetic animals can be achieved through regular monitoring of their blood glucose levels.

Response to Treatment and Personalized Medicine: Biomarkers are key parts of personalized veterinary medicine, in which treatments are tailored for each individual animal based on the biomarker profile. Through this, the treatment is very effective and focused, thereby reducing the side effects.

Disease-Specific Biomarkers

Infectious Diseases: These are used in the detection of infectious agents and immune responses to those infections. For example, serum amyloid A is a biomarker indicating bacterial infection in horses.

Cancer: Oncological biomarkers give a basis for information on diagnosis and staging in the monitoring of cancer in pets. Certain biomarker analyses, like thymidine kinase 1, are also used in monitoring disease progression in dogs.

Metabolic Disorders: Some biomarkers, such as insulin and glucose, are used in the diagnosis of metabolic disorders, for example, diabetes mellitus. By so doing, the monitoring of diseases provides an outline for treatment.

Cardiovascular Diseases: Cardiac biomarkers, like natriuretic peptides, are helpful in the diagnosis and monitoring of heart disease in animals. Increased levels of such biomarkers indicate heart failure in animals.

Neurological Disorders: Biomarkers, such as CSF proteins, can be used for the diagnosis and monitoring of neurodegenerative diseases in animals. Such biomarkers can appreciate the extent of the neurological damage.

Emerging Biomarkers: Potential and Challenges: MicroRNAs represent an emerging class of potential biomarkers for early disease diagnosis but have associated challenges for their validation and standardization across different species.

Challenges and Limitations

Technical and Analytical Challenges: Technically related problems in biomarker research are the necessity of highly sophisticated technologies and skills. The analytical variability prevailing between various laboratories may also contribute to affecting the findings on reproducibility concerning biomarker findings.

Biological Variability and Issues of Standardization: Biological variability across species and even within a species could create confusion in the interpretation of biomarkers. In that respect, standardization of the assays for biomarkers is extremely important for arriving at accurate results and comparability.

Regulatory and Ethical Considerations: The regulatory considerations broadly relate to the approval of the biomarkers for use in the clinical context by relevant authorities and their validation in the laboratory. The ethical considerations revolve mainly around animal welfare issues where the biomarker studies are invasive in nature.

Advances in Biomarker Discovery and Validation

The coupling of 'omics technologies with machine learning is pushing boundaries in the discovery of new biomarkers. Validation of such biomarkers for application in the clinical setting of veterinary medicine will be the focus of future research.

Multi-omics data integration: Integration of genomic, proteomic, and metabolomic data can be foreseen, which would give a more detailed understanding of the disease processes, hence leading to the discovery of multi-faceted biomarkers.

Potential of Individualized Veterinary Medicine: The future of veterinary medicine lies in personalized care because biomarker profiles will lead to individual treatment plans that improve outcomes while reducing side effects.

Collaborative Efforts and Interdisciplinary Research: If biomarker research is going to move forward, it will have to be by veterinarians, researchers, and computational biologists working collaboratively. Much of the existing barriers to the finding and applying of biomarkers will be surmounted through interdisciplinary ways.

Implications for Veterinary Practice: Inclusion of biomarkers into daily practice will allow for enhancing the accuracy of diagnoses, making sure that more specific treatment schedules are adopted, and assuring better health for animals.

Prospects and Research Needs: The key to future research would need to resolve technical hurdles in the standardization of biomarker assays and validation of emerging biomarkers. This will require collaboration to move beyond the current boundaries of what can be achieved by biomarkers in veterinary medicine.

References

Skerrett-Byrne, D. A., Gibb, Z., Nixon, B., & Swegen, A. (2022). The future of biomarkers in veterinary medicine: Emerging approaches and associated challenges. Animals, 12(17), 2194. https://doi.org/10.3390/ani12172194

Brambilla, P. G., & Bagardi, M. (2023). Biomarkers in veterinary medicine as essential supporting aid in the diagnostic workup. Animals. https://doi.org/10.3390/ani13211238

Bagardi, M., et al. (2023). Biomarkers in oncology: From discovery to clinical application in veterinary medicine. Veterinary Journal, 286, 105945. https://doi.org/10.1016/j.tvjl.2023.105945

McCann, T. M., & Taylor, S. D. (2022). Advances in metabolomics for veterinary diagnostics. Journal of Veterinary Science & Technology, 14(4), 12-26. https://doi.org/10.4172/2157-7579.1000648