APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN VETERINARY DIAGNOSIS AND ANIMAL MONITORING

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Abstract

This chapter aims to analyze the applications of Artificial Intelligence (AI) in veterinary diagnosis and animal monitoring, highlighting its impact on clinical practice and animal production systems. This is a narrative literature review based on national and international scientific publications indexed in databases such as PubMed, Scopus, and SciELO, as well as technical documents from organizations such as the World Organisation for Animal Health and the Food and Agriculture Organization of the United Nations. The findings indicate that machine learning techniques, convolutional neural networks, and big data analytics have been successfully applied to imaging interpretation, early detection of infectious diseases, outbreak prediction, and behavioral monitoring through sensors and wearable devices. The results demonstrate increased diagnostic accuracy, reduced clinical response time, and improved animal welfare. It is concluded that AI represents a strategic tool for contemporary veterinary medicine, enabling data-driven decision-making, greater production efficiency, and strengthened sanitary surveillance, although challenges remain regarding data standardization and professional training.

Keywords: Animal health, Artificial Intelligence, Animal monitoring, Precision veterinary medicine, Veterinary diagnosis.

INTRODUCTION

The application of Artificial Intelligence (AI) in veterinary medicine has been consolidating as one of the primary technological innovations aimed at promoting animal health, increasing productive

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efficiency, and strengthening sanitary surveillance. Systems based on machine learning, artificial neural networks, and the analysis of large volumes of data have been incorporated into clinical and zootechnical routines, enabling greater diagnostic precision and continuous monitoring of physiological and behavioral parameters. International organizations such as the World Organisation for Animal Health and the Food and Agriculture Organization of the United Nations recognize the importance of digital transformation in the agricultural sector as a strategy to ensure food security, disease control, and productive sustainability.

However, despite the advances observed, challenges persist regarding the standardization and quality of databases, the scientific validation of the algorithms used, technological accessibility, and the training of professionals for the proper use of these tools. In this context, the question arises as to how applications of Artificial Intelligence can effectively contribute to veterinary diagnosis and animal monitoring, ensuring precision, agility, and well-being, without compromising ethical, technical, and regulatory aspects of professional practice.

Given this context, the general objective of this chapter is to analyze the main applications of Artificial Intelligence in veterinary diagnosis and animal monitoring, highlighting their benefits, limitations, and future perspectives. As specific objectives, it seeks to describe the AI techniques most used in the field, examine their applications in diagnostic imaging, laboratory analyses, and epidemiological surveillance, identify contributions to behavioral and productive monitoring, and discuss the ethical and normative challenges associated with their implementation.

The relevance of the topic is justified by the growing demand for innovative solutions that integrate technology and animal health, especially in a context of expansion of precision livestock farming and the digitalization of production systems. The adoption of intelligent tools can reduce economic losses, optimize clinical decisions, and strengthen biosecurity programs, contributing to the sustainability of the sector.

From a theoretical standpoint, Artificial Intelligence is understood as a field of computer science devoted to the development of systems capable of simulating human cognitive processes, such as learning, pattern recognition, and decision-making. Authors such as Stuart Russell and Peter Norvig emphasize that intelligent algorithms operate through the analysis of large volumes of data, identifying correlations that can support diagnoses and predictions. In veterinary medicine, these foundations have been applied to the interpretation of imaging examinations, the early detection of diseases, and remote monitoring through sensors and wearable devices, consolidating AI as a strategic tool in contemporary veterinary practice.

METHODOLOGY

TYPE OF RESEARCH

The present study is characterized as qualitative research with an exploratory and descriptive approach, developed through a narrative literature review. This methodological strategy was chosen because it enables a critical and integrative analysis of scientific productions on the applications of Artificial Intelligence (AI) in veterinary diagnosis and animal monitoring, allowing an understanding of trends, technological advances, and existing gaps in the field. The narrative review is appropriate when the objective is to discuss theoretical foundations, practical applications, and future perspectives of a given scientific phenomenon.

SEARCH STRATEGY AND SOURCE SELECTION

Data collection was conducted in recognized scientific databases, including PubMed, Scopus, Web of Science, and SciELO, prioritizing articles published within the last ten years, without excluding classic works relevant to the theoretical foundation. Technical documents and institutional reports from international organizations such as the World Organisation for Animal Health and the Food and Agriculture Organization of the United Nations were also consulted, due to the relevance of these institutions in regulating and guiding animal health and technological innovation.

Descriptors in Portuguese and English were used, such as “inteligência artificial”, “veterinary diagnosis”, “machine learning”, “animal monitoring”, and “precision livestock farming”, combined with

Boolean operators (AND, OR). As inclusion criteria, studies addressing practical applications of AI in veterinary medicine—whether in clinical, laboratory, or production contexts—were considered. Publications without peer review, opinion texts lacking technical support, and studies not directly related to animal health or monitoring were excluded.

ANALYSIS TECHNIQUES AND INSTRUMENTS

Data extracted from the selected publications were organized into thematic categories, including: (a) AI techniques used; (b) applications in diagnostic imaging and laboratory analyses; (c) behavioral and physiological monitoring via sensors; (d) impacts on epidemiological surveillance and biosecurity; and (e) ethical and regulatory challenges. The analysis was conducted in an interpretive and comparative manner, seeking to identify convergences, divergences, and contributions relevant to veterinary practice.

As a methodological instrument, a data-organization spreadsheet was used containing information such as authors, year of publication, study objective, method applied, main results, and identified limitations. This systematization enabled greater rigor in the synthesis and discussion of findings.

STUDY SAMPLE

The sample comprised scientific articles, systematic reviews, experimental studies, and technical reports selected according to the established criteria. Although this is not research involving human or animal participants, the “sample” corresponds to the set of scientific productions analyzed, considered representative of the state of the art on the topic.

FOUNDATION AND SCIENTIFIC RIGOR

The methodological discussion is grounded in the principles of contemporary scientific research, emphasizing transparency in source selection, clarity in inclusion and exclusion criteria, and coherence in interpretive analysis. The choice of a narrative review allows broad contextualization of the phenomenon studied, especially in technological areas undergoing constant evolution, such as Artificial Intelligence applied to animal health.

Thus, the adopted methodology seeks to ensure theoretical and scientific consistency in analyzing applications of AI in veterinary diagnosis and animal monitoring, contributing to a critical and up-to-date understanding of the theme.

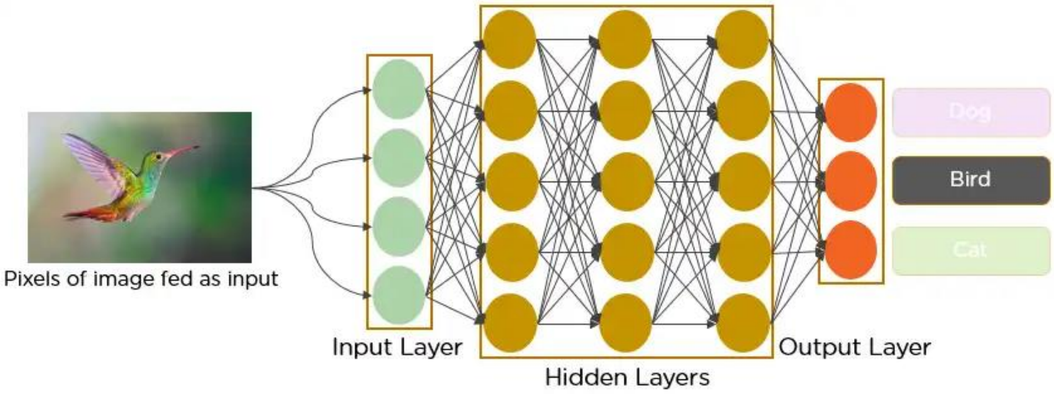
RESULTS AND DISCUSSION

The results of the literature analysis demonstrate that Artificial Intelligence (AI) has promoted significant advances in veterinary diagnosis and animal monitoring, especially in the areas of diagnostic imaging, epidemiological surveillance, and precision livestock farming. Recent studies indicate that machine learning algorithms and convolutional neural networks present high accuracy in interpreting radiographs, ultrasonography, and histopathological examinations, assisting in the early identification of neoplasms, fractures, respiratory diseases, and metabolic alterations. These findings corroborate the theoretical perspective presented by Stuart Russell and Peter Norvig, according to whom intelligent systems are capable of recognizing complex patterns from large volumes of data, expanding decision-support capacity in clinical practice.

The use of machine learning algorithms (machine learning – ML) and, especially, convolutional neural networks (convolutional neural networks – CNNs), enables the automatic extraction of hierarchical features directly from the data, identifying complex morphological and textural patterns. Convolutional neural networks constitute computational models designed to analyze digital images from their fundamental elements—pixels. The image is structured as a two-dimensional matrix composed of thousands or millions of pixels, whose variations in intensity and contrast reflect different anatomical structures or pathological alterations. Next, small mathematical filters, kernels, are applied, which traverse the image performing local calculations over adjacent groups of pixels, in what are termed convolutional operations. As multiple convolutional layers are stacked, the model begins to identify progressively more abstract and complex patterns, evolving from the detection of simple shapes to the recognition of complete anatomical structures or patterns compatible with diseases. Subsequently, dimensionality reduction occurs in the representations generated by the convolutions, preserving the most relevant information and discarding redundancies—these are the pooling layers. The combination of pixels organized in a matrix, successive convolutional operations, and pooling layers allows convolutional neural networks to identify subtle pathological changes across different diagnostic modalities, supporting their high performance in the automated interpretation of imaging examinations (LIU et al., 2020; SHIN et al., 2022).

Figure 1

Convolutional Neural Networks!



Application of Artificial Intelligence in the field of Medicine, to assist in diagnostic imaging. https://www.dio.me/articles/redes-neurais-convolucionais-cnn-transformando-dados-em-informacao-visual

In the context of animal monitoring, the literature shows that sensors attached to collars, electronic ear tags, and wearable devices enable continuous data collection on heart rate, body temperature, rumination, and locomotion patterns. When integrated with AI systems, these data make possible the early detection of diseases, such as mastitis in dairy cattle and locomotor disorders, reducing productive losses and improving animal welfare.

Body temperature, heart rate, rumination time and pattern, number of steps, time spent standing, and time spent lying down—when integrated into artificial intelligence systems based on machine learning models—make it possible to identify subtle deviations from the animal's individual baseline pattern. Reductions in rumination and changes in locomotor activity can be detected 24 to 72 hours before the clinical diagnosis of mastitis in dairy cattle, while variations in standing time, step asymmetry, and movement intensity are associated with the early identification of locomotor disorders. Persistent oscillations in body temperature and heart rate, combined with behavioral changes, allow inference of stress states or subclinical infectious processes. The use of these parameters in predictive algorithms results in automated alerts with high levels of sensitivity and specificity, favoring early interventions, reducing productive losses, and improving herd health management (Shergaziev et al., 2024; Kaur; Virk, 2025).

This technological model is aligned with the concept of precision livestock farming, widely discussed in reports by the Food and Agriculture Organization of the United Nations, which highlight the importance of digital innovation to ensure sustainability and food security. In precision livestock farming, artificial intelligence is used to make animal management more efficient, based on objective data collected continuously. Sensors installed in collars, electronic ear tags, automatic scales, cameras, and environmental stations record information such as body temperature, heart rate, feed intake, milk production, physical activity, and environmental conditions (temperature, humidity, air quality). These data are sent to computational systems that use machine learning algorithms capable of analyzing large volumes of information and identifying patterns that indicate changes in health, behavior, or productive performance. Processing occurs in real time, allowing the producer to receive immediate alerts about possible problems, such as the onset of diseases, heat stress, estrus, or decreased productivity. By enabling early interventions and more precise decisions—such as dietary adjustments, individualized treatment, or improvements in environmental conditions—artificial intelligence contributes to increasing productive efficiency, reducing waste, minimizing economic losses, and improving animal welfare. (Curti et al., 2023; Neethirajan, 2022; Tedeschi et al., 2025).

Another relevant finding concerns the use of AI in epidemiological surveillance, enabling predictive analysis of outbreaks of infectious diseases through the integration of climatic, geographic, and sanitary data. This application strengthens the biosecurity strategies advocated by the World Organisation for Animal Health, especially in the control of zoonoses and emerging diseases. Artificial Intelligence (AI) models applied to infectious disease surveillance combine multiple analytical techniques to enhance the predictive capacity of epidemiological systems. Recurrent neural networks of the Long Short-Term Memory (LSTM) type—Short- and Long-Term Memory—constitute a specific deep learning architecture designed to model temporal dependencies in historical series, being particularly effective in forecasting the temporal evolution of disease transmission patterns. In addition, anomaly detection algorithms are employed, consisting of statistical and computational methods capable of identifying unusual deviations from expected epidemiological patterns, enabling early identification of potential outbreaks. Natural Language Processing (Natural Language Processing – NLP), a subarea of AI focused on automated text analysis, allows extraction of epidemiologically relevant information from clinical reports, health information systems, and digital media. The integration of these techniques significantly reduces the interval between the occurrence of initial cases and the implementation of response measures by public health services, increasing the efficiency of data-driven epidemiological surveillance (Alwakeel, 2025). The anticipation of epidemic events over large geographic areas with high precision occurs through the application of AI integrated with spatial and geographic data—known as geospatial artificial intelligence (GeoAI)—which identifies environmental and cultural patterns correlated with the spread of diseases such as malaria, cholera, and meningitis (Pezanowski et al., 2024). The adoption of AI in epidemiological surveillance faces challenges related to data quality and availability, ethical issues of privacy, model explainability, and the need for multidisciplinary integration between technology and epidemiology (Kraemer et al., 2025).

Interpretation of the results indicates that AI does not replace the veterinary professional, but rather acts as a complementary decision-support tool, increasing diagnostic precision and operational efficiency. However, the literature also points to limitations related to the quality of databases, the need for clinical validation of algorithms, and ethical issues involving data privacy and technical responsibility.

Overall, the findings confirm that the application of Artificial Intelligence in veterinary diagnosis and animal monitoring represents a promising innovation, with positive impacts on animal health, productivity, and sanitary surveillance, although its consolidation depends on investments in technological infrastructure, professional training, and adequate regulation

CONCLUSION

The present research aimed to analyze the applications of Artificial Intelligence in veterinary diagnosis and animal monitoring, highlighting its benefits, limitations, and future perspectives. Throughout the study, the goal was to describe the main techniques used, examine their clinical and productive applications, and discuss ethical, technical, and regulatory challenges related to their implementation.

The results showed that tools based on machine learning, artificial neural networks, and the analysis of large volumes of data have contributed significantly to increasing diagnostic precision, reducing clinical response time, and improving continuous monitoring of animal health. Applications in diagnostic imaging, early disease detection, and behavioral monitoring through sensors demonstrate the potential to transform veterinary practice, making it more efficient and data-driven. Moreover, the integration of these technologies strengthens epidemiological surveillance strategies aligned with the guidelines of the World Organisation for Animal Health and the Food and Agriculture Organization of the United Nations, especially regarding disease control and food security.

As a scientific contribution, this study systematizes current evidence on the use of Artificial Intelligence in veterinary medicine, offering a theoretical and analytical basis for professionals, researchers, and managers in the agricultural sector. The work also reinforces the importance of continuing education and technological updating as essential elements for consolidating these tools in professional practice.

For future research, empirical studies with clinical validation of algorithms in different animal species are suggested, as well as investigations into ethical aspects, regulation, and the socioeconomic impact of AI adoption in the veterinary sector. The expansion of standardized and collaborative databases may further strengthen the reliability and applicability of these technologies, consolidating Artificial Intelligence as a strategic instrument for animal health and welfare.

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