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Revolutionizing veterinary medicine through artificial intelligence: A mini review

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Abstract

Artificial intelligence (AI) is gradually changing veterinary medicine by using data to improve how diseases are diagnosed, treated, and monitored, as well as how animals are managed in production systems. This mini-review summarizes the use of AI in important areas of veterinary science, including disease diagnosis, treatment planning, epidemiology, zoonotic disease tracking, reproduction, surgery, and vaccine development. Technologies such as machine learning, deep learning, computer vision, and natural language processing are now being used together with clinical records, medical images, genetic information, and sensor data to help veterinarians make quicker and more accurate decisions. AI-based imaging tools and prediction models support earlier disease detection and better evaluation of outcomes. In livestock farming, AI helps continuously monitor animal behaviour, health, and productivity. In herd and public health, AI plays a role in predicting disease outbreaks and supporting One Health surveillance by connecting animal, human, and environmental health data. Reproductive management has improved through AI tools that analyze semen quality and detect the optimal breeding time. In surgery, AI assists with planning procedures, guiding advanced tools, and monitoring recovery. AI is also helping speed up vaccine and drug development through computer-based simulations and immune response predictions. Despite these benefits, there are still challenges, such as limited data for many animal species, lack of standard systems, possible bias in algorithms, high costs, and ethical concerns about data use and responsibility. With better collaboration, proper testing, and transparent systems, AI has strong potential to make veterinary care more accurate, efficient, and preventive.

Keywords: Artificial intelligence, veterinary medicine, disease diagnosis, animal health

Introduction

Artificial intelligence (AI) represents a growing domain within computer science, skilful at executing tasks similar to those performed by human intellect. In June 1956 John McCarthy coined the term AI. The classification of artificial intelligence primarily encompasses three categories: general artificial intelligence, super artificial intelligence, and narrow artificial intelligence. AI, often referred to as a digital brain, constitutes a highly intricate computer program that emulates the learning and problem-solving abilities observed in humans (Murtaza *et al.*, 2025) ^[1]. This technology is transformative in today's society, significantly simplifying various aspects of life. AI has the potential to improve our personal and professional lives, but it also raises ethical issues, such as data security, patient privacy, and informed consent issues. These issues must be resolved to guarantee that AI-driven systems respect the rights and welfare of animal patients and their owners. The large discipline of veterinary science includes topics like public or community health with reference to zoonotic illnesses and animal health, particularly for companion animals. Artificial intelligence (AI) has been a powerful tool in the healthcare industry in recent years, and it has demonstrated significant promise in tackling the problems associated with zoonotic illnesses (Guo *et al.*, 2023) ^[2]. Artificial intelligence (AI), which has transformed diagnostic medicine, has had an influence on veterinary research. Veterinary AI applications employ machine learning (ML), deep learning (DL), and computer vision to increase the accuracy of sickness detection, facilitate early diagnosis, and lower diagnostic errors. By integrating many data sources, including clinical records, genomics, and medical imaging, these state-of-the-art systems offer a fresh approach to animal health

monitoring. This comprehensive approach ensures that veterinarians have a thorough understanding of an animal's health, enabling them to make more informed decisions regarding care and treatment.

Genetic analysis, treatment planning, artificial insemination, medication and vaccine discovery, and personalised care are just a few of the many areas in veterinary medicine where artificial intelligence is being used (Akinsulie *et al.*, 2024) [3]. Numerous artificial intelligence (AI) tools, including machine learning (ML) algorithms, deep learning (DL) networks, natural language processing (NLP), and computer vision techniques, are being used to analyse enormous volumes of veterinary data, extract significant patterns, and produce actionable insights (Sharma *et al.*, 2021) [4]. This paper explores the overview of AI in veterinary medicine, highlighting recent applications, some limitations and future directions in the field.

Classification of AI

Artificial intelligence is majorly classified into three categories general artificial intelligence, super artificial intelligence and narrow artificial intelligence. 'Strong artificial intelligence' or 'artificial generalised intelligence' are other terms for general artificial intelligence (Bose *et al.*, 2024) [5]. Any intelligence that is higher than the human brain is referred to as Super artificial intelligence. Because of how they are portrayed in science fiction, this kind of AI causes a great deal of anxiety. Indeed, certain researchers contend that

this kind of AI might never emerge. AI tools are often designed to do certain tasks like speaking, walking, reasoning, and responding to commands. They could have answers to several scientific problems in the field of medicine (Gill *et al.*, 2024) [6]. Artificial narrow intelligence is the type of artificial intelligence used in veterinary medicine. Artificial narrow intelligence, often referred to as restricted or weak artificial intelligence, is specifically employed for a single, distinct purpose, such as identifying abnormalities in an X-ray image. Even though these tasks are still difficult and require a lot of data (thousands of radiographic pictures, for example) to train the AI system, they are still regarded as weak or limited in terms of intelligence (Akinsulie *et al.*, 2024) [3].

Applications of AI

In several disciplines, including veterinary and animal science, artificial intelligence has emerged as a disruptive force. Research, veterinary procedures, herd management, and animal care might all be enhanced by the use of AI approaches in this field (Akinsulie *et al.*, 2024) [3]. The use of AI methods in veterinary medicine is essential for solving challenging issues in the fields of host-pathogen interaction, precision medicine for humans and animals, and numerical and predictive epidemiology. The applications of artificial intelligence are discussed in the following subsections. Fig.1 gives an illustration about the application of AI in veterinary settings.

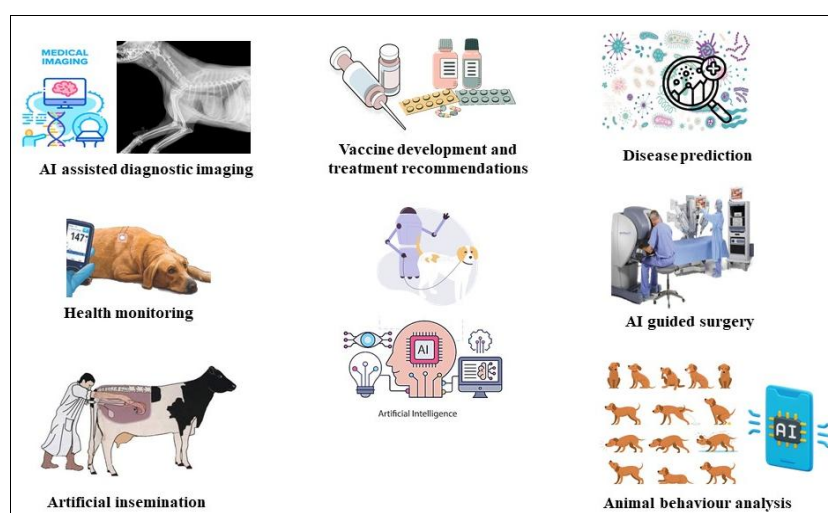


Fig 1: Applications of AI in veterinary medicine

Disease diagnosis and treatment planning

Artificial intelligence (AI) has transformed diagnostic medicine, extending its influence into the realm of veterinary science. Applications of veterinary AI utilize machine learning (ML), deep learning (DL), and computer vision to enhance the accuracy of disease detection, facilitate early diagnosis, and minimize diagnostic errors. These advanced technologies amalgamate various data sources, including medical imaging, genomics, and clinical records, thereby providing a revolutionary approach to managing animal health. This comprehensive strategy ensures that veterinarians possess a thorough understanding of an animal's health, enabling them to make more informed decisions regarding treatment and care. AI algorithms are particularly adept at rapidly analyzing complex datasets, equipping veterinarians with near-instantaneous insights into the health status of animals. This capability is especially crucial in urgent

situations that necessitate swift decision-making (Akinsulie *et al.*, 2024) [3]. Artificial intelligence is significantly transforming the domain of veterinary disease detection by utilizing advanced imaging techniques and data analytics. AI algorithms evaluate medical images, including radiographs and ultrasounds, with greater precision, leading to faster and more reliable diagnoses, which are crucial for effective treatment that can enhance patient outcomes and prognoses. Furthermore, machine learning algorithms have the capability to forecast disease outbreaks by recognizing trends in animal health data, facilitating preventive measures and reducing economic losses for farmers (Aijaz *et al.*, 2025) [7]. Machine learning algorithms, notably random forests, support vector machines (SVM), and decision trees, have been effectively employed in disease classification and outbreak prediction. For example, Giger *et al.*, (2020) [8] illustrated the application of ML-based hematological profiling for differentiating

canine anemia. In a similar vein, Huang *et al.*, (2021) ^[9] applied SVM to diagnose bovine mastitis using milk spectral data, achieving an accuracy exceeding 90%. Furthermore, deep learning models, particularly convolutional neural networks (CNNs), have demonstrated remarkable potential in the analysis of radiographic and ultrasonographic images. Huang *et al.*, (2019) ^[10] developed a CNN system for evaluating canine thoracic radiographs, which achieved diagnostic accuracy comparable to that of experts in detecting cardiomegaly. Li *et al.*, (2022) expanded the use of these applications to the detection of equine lameness through gait video analysis, demonstrating the capabilities of automated motion recognition. Another study by Li *et al.*, (2020) ^[12] employed thoracic radiographs and a deep learning methodology to detect enlargement of the left atrium in canines, subsequently comparing their findings with those of veterinary radiologists. The research effectively identified diseases in animals, although the accuracy achieved was similar to that of the veterinary radiologists. Currently, bioinformatics methods powered by artificial intelligence enable the identification of genomic biomarkers for various diseases, including canine lymphoma and feline infectious peritonitis. Raj *et al.*, (2023) ^[13] utilized neural network classifiers to differentiate between cancer subtypes in dogs using RNA-Seq data, thereby enhancing diagnostic accuracy. To identify ear and tail lesions in pigs during slaughter and assess indicators of pig welfare, Blömke *et al.*, (2020) ^[14] developed an automated approach. The method was tested on a sample of 5,952 pigs, with evaluations conducted by qualified veterinarians for comparison. The results indicated that the system effectively identified lesions in both ears and tails, achieving high sensitivity (over 77%), specificity (exceeding 96%), and accuracy (greater than 95%). This finding is significant for the diagnosis of ear and tail diseases in pigs and for enhancing animal welfare.

Research conducted by Reagen *et al.*, (2020) indicates that a machine-learning system has been utilized to diagnose dogs suffering from chronic hypoadrenocorticism. The diagnosis of chronic hypoadrenocorticism is notably challenging due to limited knowledge and a low index of suspicion. In the study by Reagen, routinely collected screening tests, which included a serum chemistry panel and a complete blood count, were employed alongside machine learning techniques to facilitate the diagnosis of chronic hypoadrenocorticism. From 2010 to 2017, these researchers compiled medical records of dogs, focusing on those with initial cortisol level measurements. After a week, they reassessed cortisol levels and conducted serum chemistry and blood count tests, excluding dogs and cases diagnosed with hyperadrenocorticism. The developed algorithm model outperformed traditional screening methods, such as logistic regression analysis, achieving a sensitivity of 96.3%, specificity of 97.2%, and an ROC of 0.994. Drawing from these studies as foundational frameworks for enhancing data sharing and promoting algorithmic transparency, AI-assisted diagnostics are poised to emerge as a crucial component of veterinary clinical practice.

Artificial Intelligence (AI) is transforming the planning of veterinary treatments by amalgamating information from diagnostics, genetics, imaging, and clinical records to enhance personalized care. Utilizing machine learning (ML), deep learning, and knowledge-based systems, veterinarians are able to forecast treatment results, modify dosages, and customize interventions according to species, breed, or even the unique physiology of individual animals. Predictive modelling for therapeutic outcomes, AI-enhanced surgery and radiation

planning, customised medication, decision assistance for complex multispecies situations, and treatment protocol simulation and optimisation are the main applications (Zhou *et al.*, 2026) ^[16].

Zoonotic diseases

Zoonotic diseases present considerable risks to public health (Elsohaby and Villa 2023) ^[17]. AI predictive models are capable of monitoring the transmission of these diseases, pinpointing potential hotspots and at-risk populations (Ganasgeran and Abdulrahman 2019) ^[18]. Tools powered by AI can evaluate health risks in animals by considering a range of factors, such as genetic vulnerabilities, environmental influences, and lifestyle choices (Ezanno *et al.*, 2021; Kamel Boulos *et al.*, 2019) ^[19, 20]. Artificial intelligence tools play a crucial role in genomic epidemiology by facilitating the identification of pathogen mutations and the tracking of transmission pathways. AI-driven phylogenetic clustering has been employed to observe the evolution of SARS-CoV-2 and the occurrences of zoonotic spillback events. Furthermore, Rahman *et al.*, (2023) ^[21] illustrated how AI-enhanced metagenomic sequencing expedites the identification of pathogens in newly emerging zoonotic diseases. This customized strategy allows veterinarians to foresee possible health complications in individual animals, thereby promoting early interventions and personalized preventive care strategies (Ezanno *et al.*, 2021) ^[19]. Artificial intelligence serves as a promising instrument for the surveillance and monitoring of zoonotic diseases, including monkeypox, influenza, anthrax, Rift Valley fever, COVID-19, leptospirosis, Ebola virus infection, and various other viral zoonotic diseases. Specifically, the potential use of AI in veterinary research and medicine holds significant promise for addressing challenges associated with newly emerging zoonotic diseases (Akinsulie *et al.*, 2024) ^[3]. The amalgamation of artificial intelligence methodologies with traditional disease management approaches presents novel opportunities for comprehending, anticipating, and mitigating the impacts of zoonotic diseases through the application of machine learning and sophisticated algorithmic models (Guo *et al.*, 2023) ^[2]. Several AI risk assessment models can be employed to predict critical symptoms and ascertain the probability that a patient's illness will be diagnosed in a timely manner. Certain AI algorithms have been utilized to predict viral hosts and the susceptibility of host ranges. A natural language processing model, such as Word2vec, is implemented to vectorize features extracted from viral nucleotide and protein sequences to predict the host ranges of the influenza virus. This model was developed to assist in identifying high-risk viral strains for further investigation and to evaluate the potential emergence or threat posed by a new influenza virus should it acquire the capability for human-to-human transmission (Kaur *et al.*, 2022) ^[22].

Artificial Intelligence (AI) bolsters the "One Health" paradigm by amalgamating data pertaining to human, animal, and environmental health. According to Miller *et al.*, (2024) ^[23], an AI-based One Health data framework has been suggested, which connects veterinary and human surveillance systems to facilitate coordinated management of zoonotic diseases. This interdisciplinary integration improves situational awareness and enhances coordination of responses during outbreaks.

Epidemiology and surveillance

Veterinary epidemiology and surveillance play a crucial role in the management of animal health, the control of zoonotic

diseases, and the protection of global food security. The advent of artificial intelligence (AI) has become a key factor in revolutionizing the systems for monitoring, predicting, and responding to diseases. By utilizing extensive data from farms, sensors, genomic databases, and digital reports, AI facilitates the early detection of outbreaks, real-time mapping of diseases, and informed decision-making in the realm of veterinary public health. To predict the long-term spread of diseases within a population, artificial intelligence (AI) is vital for epidemiological modelling. These models integrate characteristics of illnesses, human behavior, and environmental factors through advanced machine learning algorithms to yield highly accurate predictions. Recently developed platforms aimed at the early detection and diagnosis of new animal diseases include biosurveillance systems and machine learning algorithms linked to online/web-based systems such as PADI-web (Wang *et al.*, 2021) ^[34]. Furthermore, the simultaneous application of genomic and epidemiological data for the prompt diagnosis and reporting of food or waterborne illnesses has been evaluated through machine learning techniques. In the field of veterinary medicine, AI has demonstrated its importance in disease monitoring and epidemiology. In Canada, machine learning algorithms have been employed to predict future developments in the porcine epidemic diarrhea virus (PEDV). Additionally, it is utilized to assess the susceptibility of hosts to diseases. Throughout the clinical investigation, it has also been applied to the processing and interpretation of genomic sequencing data. Machine learning may be advantageous as managing large, intricate structures and relationships can be challenging with conventional methods (Barragán-Montero *et al.*, 2021) ^[25]. The application of machine learning (ML) in whole genome sequencing (WGS) research enhances source attribution, pathogenicity assessment, antibiotic resistance phenotype prediction, and clinical outcome forecasting.

Artificial insemination

Recent developments suggest that artificial intelligence (AI) is progressively revolutionizing artificial insemination (AI) methods in animal reproduction by improving precision, efficiency, and reproductive results across livestock systems. The literature collectively emphasizes that AI-driven technologies—especially machine learning and deep learning algorithms—are being incorporated into essential phases of the artificial insemination process, such as estrus detection, semen quality evaluation, and the optimal timing for insemination. For example, sensor-based monitoring systems paired with predictive analytics facilitate precise identification of estrus behavior, which is a crucial factor for the success of insemination, thus minimizing human error and enhancing conception rates (Sharifuzzaman *et al.*, 2024; Cho & Kim, 2023) ^[26, 27]. Simultaneously, computer-assisted semen analysis systems that utilize artificial intelligence offer an objective and high-throughput assessment of sperm motility, morphology, and viability, thereby enhancing the selection process for high-quality semen intended for insemination (Baldán *et al.*, 2025) ^[28]. Moreover, predictive models are being increasingly utilized to assess fertility outcomes and inform decision-making related to breeding strategies and genetic selection (Mansour, 2025; Marques *et al.*, 2024) ^[29, 30]. Despite these advancements, there are still challenges concerning data quality, model generalizability, and on-farm implementation; however, current evidence indicates that the incorporation of AI into artificial insemination protocols signifies a promising shift towards precision livestock

reproduction, with considerable implications for productivity and sustainability.

AI and surgery

Artificial intelligence (AI) is transforming veterinary surgery by enhancing surgical planning, intraoperative support, postoperative care, and diagnostic precision. The integration of AI with robotics, machine learning, and imaging has expanded the choices for precision-based veterinary medicines. By evaluating diagnostic images (CT, MRI, and radiography) to detect anatomical abnormalities and precisely plan procedures, AI algorithms—particularly those that employ deep learning—assist in preoperative planning and diagnosis (Burti *et al.*, 2024; Pereira *et al.*, 2023) ^[31, 32]. Machine learning algorithms can evaluate patient-specific results, optimize anaesthesia regimens, and forecast surgical risks. For robotics and intraoperative guidance, AI-powered robotic devices are being investigated more and more in minimally invasive surgery and veterinary orthopedics. AI-powered real-time image analysis facilitates robot-assisted suturing and augmented reality navigation, increasing accuracy and cutting down on operating time (Kuzminsky *et al.*, 2023) ^[33]. Additionally, intraoperative abnormalities, such as excessive bleeding or organ displacement, can be reported to surgeons by automated monitoring systems. AI models are also employed for postoperative monitoring and prognosis to assess the healing process using biomarker data and digital wound images. Personalized recovery plans are made possible by machine learning algorithms that forecast pain levels, rehabilitation schedules, and surgery complications (Akinsulie *et al.*, 2024) ^[3]. These days, artificial intelligence (AI) is used in surgical simulation and veterinary training to evaluate laparoscopic, knot-tying, and suturing abilities using computer vision (Kuzminsky *et al.*, 2023) ^[33]. This promotes competency-based learning and objective assessment. Applications of AI in veterinary surgery are developing quickly, ranging from postoperative analytics and teaching to surgical robots and diagnostic imaging. Surgical standards in animal healthcare will probably be redefined as wearable sensors, telemedicine, and precision imaging continue to be integrated. This demonstrates that even without advanced imaging, data-driven algorithms can provide actionable predictions for veterinary clinicians — potentially improving triage and treatment decisions

Vaccine development

Artificial Intelligence (AI) is progressively revolutionizing the research and development of vaccines in veterinary medicine by hastening discovery, enhancing precision, and lowering expenses. AI-based methodologies amalgamate genomics, immunology, and bioinformatics to create safer and more effective vaccines for livestock, companion animals, and wildlife. The intersection of artificial intelligence (AI) and veterinary vaccine research is reshaping the rapidity, accuracy, and cost-effectiveness of vaccine development. Artificial Intelligence (AI) and machine learning (ML) provide predictive modelling capabilities that can identify new antigens, simulate immune responses, and enhance vaccine delivery systems (Elfatimi *et al.*, 2025) ^[34]. Deep learning networks are capable of predicting B-cell and T-cell epitopes from genomic sequences, which accelerates the identification of potential vaccine targets. For example, Elfatimi *et al.* (2025) ^[34] illustrated that AI models can shorten preclinical trial durations by virtually simulating host-pathogen interactions. In a similar vein, Khan & Muneeb

(2025) ^[35] highlighted how antigen mapping through neural networks has advanced vaccine formulation for avian and bovine viral diseases. AI-driven algorithms support in silico vaccine design by amalgamating multi-omics data, which includes proteomics, transcriptomics, and structural informatics. Qu *et al.* (2025) ^[36] emphasized that hybrid machine learning pipelines, which integrate convolutional neural networks with evolutionary algorithms, significantly improved the accuracy of predictions regarding viral mutation rates in animal hosts. This advancement facilitates timely updates to vaccines, particularly for swiftly evolving pathogens like the foot-and-mouth disease virus (FMDV). Furthermore, the combination of artificial intelligence with 3D-printed microneedle systems (Teodoro *et al.*, 2025) ^[37] and the optimization of nanocarriers enables meticulous regulation of vaccine dosages and release kinetics. These innovative systems are currently undergoing testing for both livestock and companion animals, with algorithms fine-tuning material composition to elicit targeted immune responses. Additionally, AI models contribute to the enhancement of adverse event predictions and immune response profiling, thereby decreasing reliance on animal testing. The ability to simulate immune toxicities prior to conducting live trials marks a notable ethical and financial advancement within the veterinary pharmaceutical industry. Nevertheless, obstacles persist, such as the scarcity of high-quality veterinary immunological datasets and the necessity for standardized protocols for AI validation. Establishing collaborative data-sharing frameworks between veterinary institutions and AI developers will be essential for the development of the next generation of 'precision vaccines' for animals.

Limitations of AI

Current literature indicates that, although artificial intelligence (AI) holds transformative potential, its implementation in veterinary medicine is hindered by several notable limitations that require critical examination. A primary issue emphasized in various reviews is the reliance of AI systems on extensive, high-quality datasets, which are frequently limited, incomplete, or biased within veterinary settings due to the diversity of species and irregularities in data collection methods (Bouchemla *et al.*, 2023; Akbarein *et al.*, 2025) ^[38, 39]. The heterogeneity of this data can result in algorithmic bias and diminished generalizability, especially when models that are trained on particular populations or species are utilized in more extensive clinical environments (Owens *et al.*, 2023) ^[40]. Furthermore, the "black-box" characteristic of numerous machine learning models restricts interpretability, creating obstacles for clinical trust, ethical accountability, and decision-making transparency among veterinarians (Burti *et al.*, 2024) ^[31]. Ethical concerns—including data privacy, considerations for animal welfare, and the potential for excessive dependence on automated systems—add further complexity to implementation (Pérez-García *et al.*, 2026) ^[41]. In addition, infrastructural and economic challenges, such as restricted access to advanced technologies and a deficiency of technical expertise within veterinary practice, impede widespread adoption. Together, these challenges highlight the necessity for thorough validation, interdisciplinary collaboration, and the creation of transparent, species-inclusive AI systems to guarantee safe and effective integration into veterinary medicine.

Highlights

- AI improves early disease diagnosis and treatment

decisions in animals.

- AI strengthens zoonotic surveillance and One Health disease monitoring.
- Smart sensors and AI tools enhance livestock health and breeding efficiency.
- AI advances surgical planning and accelerates veterinary vaccine design

Conclusion

Artificial Intelligence (AI) represents a growing domain within computer science, demonstrating capabilities akin to human intelligence. It functions as a digital brain or an intricate computer program that emulates the learning and problem-solving abilities observed in humans and primates. The field of veterinary medicine is experiencing significant and unpredictable technological changes that, if effectively harnessed, could transform the livestock industry and veterinary medicine.

Authors contribution

AUH: Conceptualized, designed the review and drafted the manuscript; SC: reviewed and finalized the manuscript. All the authors read and approved the manuscript.

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