International Journal of Veterinary Sciences and Animal Husbandry

ISSN: 2456-2912
NAAS Rating: 4.61
VET 2025; SP-10(7): 04-08

www.veterinarypaper.com
Received: 12-05-2025
Accepted: 13-06-2025

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Artificial intelligence in veterinary sciences: A paradigm shift

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Abstract
Artificial Intelligence (AI) is rapidly transforming veterinary science by offering innovative, data-driven solutions that enhance diagnosis, disease tracking, reproductive management, and research. By using machine learning (ML) and deep learning (DL), AI improves diagnostic accuracy, speeds up vaccine development, and advances research in antimicrobial resistance (AMR) and oncology. These technologies also aid personalized medicine and data-driven animal care. This shows AI's ability to change veterinary practice and public health. AI, a part of computer science, allows machines to imitate human thinking skills such as learning, reasoning, and decision-making. Even though the idea started in the 1950s, real progress has only been made in the past few decades due to powerful computers, large datasets, and improved algorithms. Nowadays, AI plays a vital role in many areas of veterinary and biomedical science, promising more accuracy and efficiency in animal health care. This review offers an overview of key AI techniques and their real-world uses in veterinary medicine, such as diagnostics, epidemiology, reproduction, and research. It also looks at current limitations, ethical issues, and future possibilities for AI within the One Health framework.

Keywords: Artificial intelligence, veterinary medicine, machine learning, disease diagnosis, radiomics, antimicrobial resistance, reproductive health, one health

1. Introduction

Artificial intelligence (AI) is a branch of computer science in which computer systems are designed to perform tasks that mimic human intelligence (Appleby & Basran, 2022). Artificial intelligence (AI) is the creation of intelligent machines, primarily computer programs, by combining the best aspects of science and engineering. Even if the idea originated in the 1950s, the AI spring was actually felt in the early 2020s. We are currently in the midst of the AI revolution thanks to unparalleled developments in infrastructure, parallel excellence in human resources, and computation and machine learning (ML) modules, including deep learning (DL), (Parija & Poddar, 2024) [23]. Today, AI has almost reached every sphere of human life and is floating to transform the health-care sector (Jiang *et al*., 2017) [18].

2. History of Artificial intelligence

Current applications of AI have been developed in the last decade, the concepts and ideas have been around for at least 70 years. In the late 40s and early 50s, the first concepts of AI were introduced to the scientific community. Perhaps most famously, British computer scientist Alan Turing was one of the first to introduce the concept of computers performing intelligent tasks in 1950. The term *artificial intelligence* was coined by John McCarthy in 1955 (Kaul *et al*., 2020) [19]. Some of the current applications of AI have been in the works for the past 10 years, but the application of some of the concepts and ideas has been at least 70 years. The first ideas of AI were proposed to the scientific community in the late 40s and early 50s. Most famously, the British computer scientist introduced the notion of machines that could think in 1950 (Kaul *et al*., 2020) [19]. The name artificial intelligence was proposed by John McCarthy in 1955 (Kaul *et al*., 2020, Currie, 2022) [19, 11]. The field of artificial intelligence was extensively investigated in the second half of the 20th century, but there was little progress with respect to the scope of its application and use because of limitations in computer performance.

Yet with the dramatic increase in computer processing power that occurred since the turn of the millennium and the mass acquisition and digitization of data, AI has taken off (Tran *et al*., 2019, Kaul *et al*., 2020) [30, 19]. In the medical field, data relevant to artificial intelligence applications encompasses, but is not limited to, diagnostic imaging such as radiographs, CT scans, and MRIs; microscopic images from cytology and histopathology; and information extracted from medical records, including unstructured clinical notes and laboratory test results. An important application of AI in medicine is to see what can be learned from these large data sets by computer algorithms in order to make or enhance diagnoses and improve therapy and patient outcomes. As we will soon find out, the manner in which this information can be interpreted and utilized can be different and may depend on the objective of the artificial intelligence.

3. Techniques of Artificial intelligence

AI is composed of a great number of subfields and techniques, one of them being machine learning (ML) (Chartrand *et al*., 2017) [10]. Despite the long history of use of artificial neural networks, the field of medical image analysis has recently made significant progresses due to advancements in machine learning and image processing, including increased computer power and access to a bigger quantity of labeled pictures (Tsuneki, 2022) [31]. Multiple studies have been conducted in this area, leading to improvements in tasks such as image classification, object detection, and image segmentation. Evaluating medical images is such a subjective and complex process, it would be very beneficial to automate the analysis process using deep learning and artificial intelligence techniques. There have been numerous advancements in the field of human medical image analysis in recent years, but advancements are also beginning to be made in the veterinary field (Hennessey *et al*., 2022) [17].

4. Machine Learning

To understand AI and how it can be used in veterinary practice we will first go over some general words that you will come across when dealing with AI. There are many techniques (too many to discuss in this article), however, there are some broad terms that any person who reads about AI will come across. An often-encountered term is machine learning (ML), a subdivision of AI that trains algorithms to accomplish tasks by learning information from data instead of by explicit programming (Waljee & Higgins, 2010) [32]. While it may seem unusual to describe computers as capable of learning, this ability to adapt and improve with experience is what truly distinguishes artificial intelligence from rule-based computer programs.

Machine learning models can be trained in 3 ways supervised learning, unsupervised learning, and semi supervised learning. In supervised learning, labelled data sets are used to train algorithms to classify data or to forecast a number (Jiang *et al*., 2017) [18]. In supervised learning, the result of medical data (in other words, the diagnosis/class of a patient) is known before the ML model is trained to perform the task (labelled). In this form of ML, the algorithm requires 2 things: lots of data and the corresponding labels. Supervised learning is the predominant type of learning among ML algorithms in medical practice because it yields the most directly clinically relevant information (Jiang *et al*., 2017) [18]. Yet, unsupervised learning, in which the ML algorithm provides its own criteria for classifying data or predicting outcomes, can be useful, particularly in the analysis of big datasets for which the features that differentiate groups are not in hand (Jiang *et al*., 2017) [18]. In this type of ML, the algorithm is provided with data that lacks any labels or predefined categories. The aim in unsupervised learning is to try to make some sense of the data by “sifting” it and seeing whether there are any patterns or relationships between persistence and patient characteristics which could be clinically relevant. Semi supervised learning takes a combination ensemble and would be useful in algorithmic development context when some of the data is lacking a definitive conclusion (Jiang *et al*., 2017) [18].

There are several fancy sounding terms such as ‘support vector machines, decision trees, logistic regression and linear regression, which depend on supervised learning. But essentially, these are algorithms that just make a prediction about an outcome based on some input data. Unsupervised machine learning methods, like clustering and principal component analysis, are used to explore patterns and groupings in data without using labelled outcomes. At the heart of these algorithms is that they reveal patterns in data, which serve as a way to condense information. These approaches are referred to as traditional ML (Jiang *et al*., 2017) [18]. However, contemporary ML revolves around the 2 remaining most widespread terms in AI: Artificial Neural Networks (ANNs) and deep learning.

4.1 Artificial neural networks

Artificial intelligence (AI) is transforming medical diagnostics by replicating the structure and function of biological neural systems through artificial neural networks (ANNs). These systems consist of layers of interconnected nodes that process information in a manner inspired by the human brain (Currie, 2022) [11]. Much like neurons, which transmit signals via complex webs of input and output synapses, ANNs are designed to receive data, process it through multiple layers, and produce an interpretable output. To better grasp the analogy, consider how both a human and an AI system might detect pulmonary nodules in a medical image. When a human expert observes such an image on a screen, light signals are received by the retina, stimulating photoreceptors. These signals are then relayed via interconnected optic nerves to the brain, where a trained veterinary radiologist interprets them. The final recognition of “pulmonary nodules” arises from prior training and repeated exposure, which has created specific neural pathways capable of linking shape and colour patterns to that diagnosis. In ANNs, a comparable process occurs computationally. The medical image serves as the input, which is passed through hidden layers within the network. These layers apply weighted filters during the training phase to improve prediction accuracy (Jiang *et al*., 2017) [18]. While a simple ANN may include only one hidden layer, the power of AI lies in deep learning a form of machine learning using neural networks with multiple (often over ten) layers to analyze complex datasets like high-resolution medical scans (Chartrand *et al*., 2017) [10]. A specialized type of ANN known as a convolutional neural network (CNN) is frequently used for medical image analysis due to its capacity to identify spatial hierarchies and extract features from images. Despite the overlapping terminology, it's important to differentiate these concepts: AI is the broader field, machine learning (ML) is a subset of AI, and deep learning is a more specialized branch within ML that depends heavily on neural networks. A major advantage of AI lies in its ability to uncover subtle patterns in data that may not be apparent to human observers.

For example, radiomics is a growing field where AI is used to extract a multitude of quantitative features from imaging data, offering insights into disease phenotypes such as tumour type (Bibault *et al*., 2020) [5]. This approach holds promise for non-invasive diagnostics and personalized treatment strategies such as characterizing a splenic mass or tailoring therapy based on unique imaging features.

Another critical area in AI relevant to veterinary and human medicine is natural language processing (NLP). NLP allows machines to analyze and derive meaning from text and spoken language, which is vital given that much of clinical documentation exists in unstructured text form. By applying ML techniques rooted in linguistics, NLP enables rapid and accurate information extraction from medical records, supporting better clinical decision-making and workflow efficiency.

5. AI in Veterinary Clinical Practice

AI is revolutionizing veterinary clinical care by improving diagnostics, therapeutic planning, and outcome predictions. A subfield of precision medicine known as radiomics applies mathematical analysis to medical images, revealing disease-specific processes beyond human visual perception as shown in Figure 1. Radiomics involves extracting quantitative features from imaging modalities like MRI, CT, PET, and ultrasound. These data, analyzed using statistical software, contribute to personalized precision medicine.

Machine learning (ML), a core AI component, builds predictive models from historical data. In veterinary contexts, AI helps decipher host-pathogen interactions, develop precision therapies, and improve predictive epidemiology. AI enhances diagnostic accuracy, proposes treatment plans, identifies risk factors, and fosters the development of targeted therapies (Bibault *et al*., 2020, Ezanno *et al*., 2021) [5, 14].

5.1 Disease Diagnosis

Early disease detection is vital for successful treatment. AI aids in analyzing large clinical and imaging datasets, improving diagnostic precision and enabling continuous health monitoring. For example, (Reagan *et al*., 2020) used ML algorithms to diagnose chronic hypoadrenocorticism (CHA) in dogs from routine blood panels. Similarly, Texture Analysis (TA) has distinguished inflammatory meningoencephalitis from glial neoplasia in canines, overcoming limitations of conventional image interpretation (Bouhali *et al*., 2022) [8]. Radiomics and AI are being incorporated into routine diagnostics to improve sensitivity, accuracy and reproducibility (Bohr & Memarzadeh, 2020) [7].

5.2. Zoonotic Disease Monitoring

AI offers significant promise in zoonotic disease surveillance. Integration of machine learning with traditional disease control methods enables risk prediction, early detection, and intervention (Agrebi & Larbi, 2020, Guo *et al*., 2023) [1, 16]. Models like Word2vec and VIDHOP predict viral host range from nucleotide sequences (Bartoszewicz, 2022) [4]. FluSPred uses protein and genomic data to assess the human infection potential of influenza strains (Roy *et al*., 2022) [26].

5.3 Epidemiology and Surveillance

AI supports early disease detection and resource optimization in veterinary epidemiology. Systems like PADI-web integrate ML algorithms to detect emerging diseases. AI can rank samples by likelihood of testing positive, prioritize cases, and improve surveillance efficiency in foodborne and animal diseases (Guitian *et al*., 2023) [15].

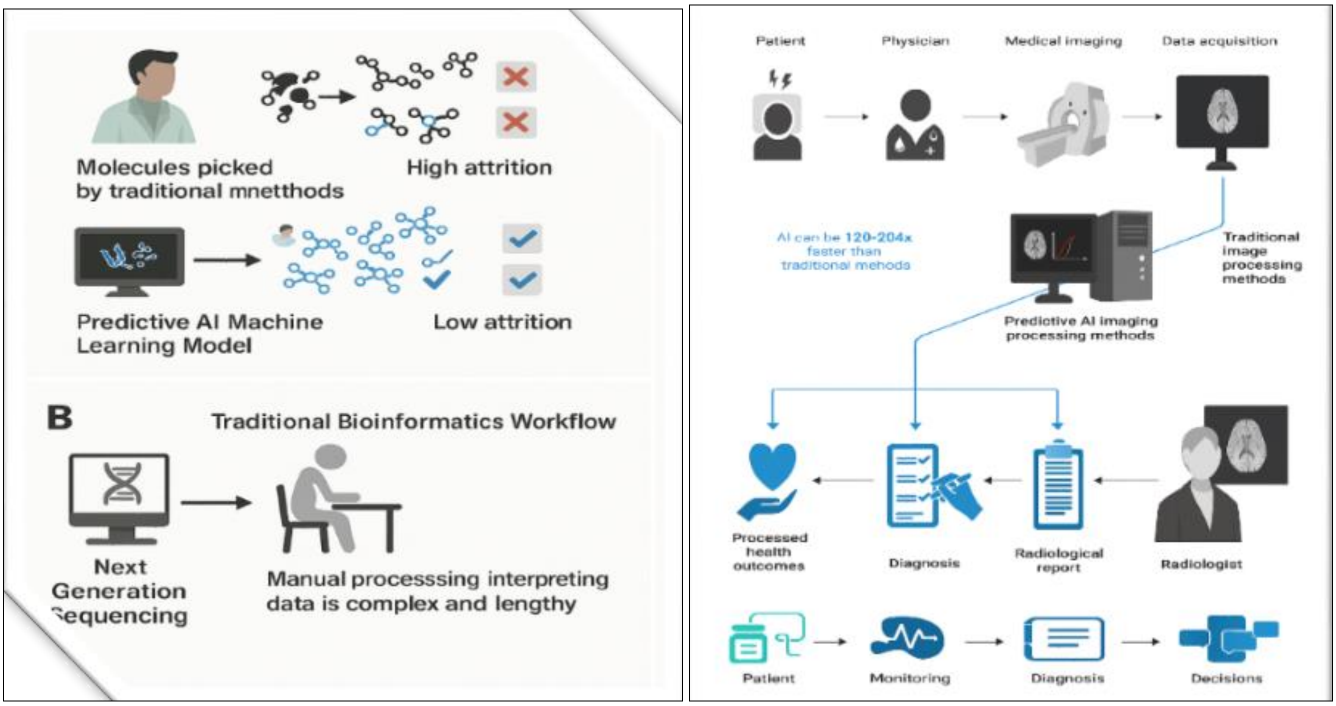

Fig 1: A). Machine learning (ML) models aid in predicting outcomes and identifying promising drug targets. B). In genome sequencing, ML enhances source attribution, pathogenicity assessment, antibiotic resistance prediction, and clinical outcome forecasting. C). Radiomics a key tool in precision medicine extracts quantitative features from medical images, enabling data-driven personalization of veterinary care. Figure taken from https://www.frontiersin.org/journals/veterinaryscience/articles/10.3389/fvets.2024.1347550/

5.4 Development of Disease Models

ML-based disease models predict outbreaks and assess risk factors. For instance, ML predicted porcine epidemic diarrhoea virus spread in Canada. It has also identified bat reservoirs of beta-coronaviruses and improved genome-based source attribution and pathogenicity prediction.

5.5 Artificial Insemination

AI enhances reproductive efficiency through data analysis and image recognition. Predictive models identify optimal breeding windows, assess fertility, and guide insemination timing. CASA and flow cytometry enable precise semen analysis, improving sire selection (Zuidema *et al*., 2021) [33]. AI tools monitor oestrus signs, behaviour, and reproductive health from video and image data, enabling precision breeding and boosting conception rates.

5.6 Patient assessment, treatment and evaluation

AI enables personalized treatment planning by integrating genetics, medical history, and clinical data. It assists in drug selection, dosing, and treatment adjustment. In dairy, ML identifies mastitis (Dhoble *et al*., 2019) [12], lameness, predicts calving, and forecasts milk yield (Shine & Murphy, 2021). AI also supports antimicrobial resistance (AMR) monitoring, tracking resistant bacteria, antibiotic use patterns, and outbreaks (Rabaan *et al*., 2022) [24].

6. AI in Veterinary and Biomedical Research

6.1. Antimicrobial Resistance (AMR) Research

AI tracks AMR trends, predicts resistance, and supports new antibiotic development. Algorithms like Naïve Bayes, decision trees, and support vector machines assist in resistance prediction and antibiotic design (Elalouf *et al*., 2025) [13]. AI reduces drug development time, optimizes surveillance, and identifies resistance genes in food chains.

6.2 Cancer Research

AI improves cancer diagnostics, treatment planning, and drug discovery. It automates tumour identification, predicts drug efficacy and toxicity, and personalizes treatment by analysing genomic and proteomic data (AlZaabi *et al*., 2024) [2]. Tools like Sybil predict lung cancer risk from a single LDCT scan, enabling efficient screening (Mikhael *et al*., 2023) [21].

6.3 Vaccine Development

AI accelerates vaccine design by identifying immunogenic antigens, predicting epitope binding, and optimizing adjuvants. It enables selection of high-potential candidates before trials, improving vaccine efficacy and safety (Sharma *et al*., 2022) [28]. Artificial intelligence is changing how vaccines are developed by making the process more efficient and precise. By examining large sets of genomic, proteomic, and immunological data, AI helps quickly identify promising vaccine targets and simplifies candidate selection. These tools support the smart design of vaccines with better effectiveness, including personalized and cross-protective formulations. AI also aids in real-time monitoring of vaccine performance, improving safety and responsiveness during use. Additionally, it encourages international teamwork through data sharing and common platforms, speeding up global vaccine innovation. Overall, AI serves as a strong force for developing next-generation vaccines and tackling new public health challenges (Olawade *et al*., 2024) [22].

6.4 Phytomedicinal and Pharmaceutical Research

AI streamlines drug discovery from natural products, evaluates therapeutic efficacy, and predicts adverse effects (Blanco-Gonzalez *et al*., 2023) [6]. It supports personalized medicine, optimizes clinical trial design, and reduces failure rates in pharmaceutical R&D.

7. Future Perspectives and Challenges: As artificial intelligence becomes increasingly entrenched in veterinary science, there are a number of challenges still to be addressed. Firstly, access to large, quality datasets is necessary for training robust algorithms. Most veterinary datasets are not standardized or complete, making effective model development difficult. Secondly, the "black-box" nature of most AI models restricts transparency and potentially diminishes clinician trust (Burti *et al*., 2024) [9]. Ethics and regulatory frameworks need to be established that can direct the application of AI technologies responsibly in animal welfare (Ezanno *et al*., 2021) [14]. These include tackling challenges related to algorithmic bias, data privacy, and liability for AI-assisted decisions. Data literacy and AI tool training of veterinary professionals will also be instrumental in increasing adoption.

Interdisciplinary cooperation will be instrumental in designing the future of AI in animal health. Converging veterinarians, computer scientists, ethicists, and policymakers will ensure AI is effective for both animal and public health.

8. Conclusion

Artificial Intelligence is rapidly emerging as a critical component of contemporary veterinary science. From enhancing disease diagnosis to outbreak prediction and speeding up drug and vaccine development, AI technologies have tools that can significantly improve the health of animals. But careful implementation is imperative. This involves investing in data infrastructure, upskilling professionals, and putting in place ethical guidelines that regulate AI use in veterinary facilities (Shah *et al*., 2024). By linking technological progress with ethical obligation and clinical value, AI can not only revolutionize veterinary practice but also make the wider discipline of One Health, in which human, animal, and environmental health converge, all the stronger.

9. Funding Information

This research received no funding.

10. Ethics Statement

Not applicable: This manuscript does not include human or animal research

Conflict of Interest

Not available

Financial Support

Not available

11. Reference

1. Agrebi S, Larbi A. Use of artificial intelligence in infectious diseases. In: Artificial intelligence in precision health. Elsevier, 2020, p. 415-438.
2. AlZaabi AA, Bouchareb Y, Hussain ML. The potential of artificial intelligence and machine learning in precision oncology. In: Artificial Intelligence, Big Data, Blockchain and 5G for the Digital Transformation of the Healthcare Industry. Elsevier, 2024, p. 173-188.
3. Appleby RB, Basran PS. Artificial intelligence in veterinary medicine. J Am Vet Med Assoc. 2022;260(8):819-824.
4. Bartoszewicz JM. Deep learning approaches for predicting pathogenic potentials of novel DNA and RNA sequences.

5. Bibault JE, Xing L, Giraud P, El Ayachy R, Giraud N, Decazes P, Burgun A. Radiomics: A primer for the radiation oncologist. Cancer Radiother. 2020;24(5):403-410.
6. Gonzalez BA, Cabezon A, Gonzalez SA, Torres CD, Riveiro AP, Pineiro A, Fandino GR. The role of AI in drug discovery: challenges, opportunities, and strategies. Pharmaceuticals. 2023;16(6):891.
7. Bohr A, Memarzadeh K. The rise of artificial intelligence in healthcare applications. In: Artificial Intelligence in healthcare. Elsevier, 2020, p. 25-60.
8. Bouhali O, Bensmail H, Sheharyar A, David F, Johnson JP. A review of radiomics and artificial intelligence and their application in veterinary diagnostic imaging. Vet Sci. 2022;9(11):620.
9. Burti S, Banzato T, Coghlan S, Wodzinski M, Bendazzoli M, Zotti A. Artificial intelligence in veterinary diagnostic imaging: perspectives and limitations. Res Vet Sci. 2024;175:105317.
10. Chartrand G, Cheng PM, Vorontsov E, Drozdzal M, Turcotte S, Pal CJ, *et al*. Deep learning: A primer for radiologists. Radiographics. 2017;37(7):2113-2131.
11. Currie G. A muggles guide to deep learning wizardry. Radiography. 2022;28(1):240-248.
12. Dhoble AS, Ryan KT, Lahiri P, Chen M, Pang X, Cardoso FC, *et al*. Cytometric fingerprinting and machine learning (CFML): A novel label-free, objective method for routine mastitis screening. Comput Electron Agric. 2019;162:505-513.
13. Elalouf A, Elalouf H, Rosenfeld A, Maoz H. Artificial intelligence in drug resistance management. 3 Biotech. 2025;15(5):1-21.
14. Ezanno P, Picault S, Beaunée G, Bailly X, Muñoz F, Duboz R, *et al*. Research perspectives on animal health in the era of artificial intelligence. Vet Res. 2021;52:1-15.
15. Guitian J, Arnold M, Chang Y, Snary EL. Applications of machine learning in animal and veterinary public health surveillance. Rev Sci Tech. 2023;42:230-241.
16. Guo T, Nan B, Liang Z, Guo Z, Chawla N, Wiest O, Zhang X. What can large language models do in chemistry? a comprehensive benchmark on eight tasks. Adv Neural Inf Process Syst. 2023;36:59662-59688.
17. Hennessey E, DiFazio M, Hennessey R, Cassel N. Artificial intelligence in veterinary diagnostic imaging: A literature review. Vet Radiol Ultrasound. 2022;63:851-870.
18. Jiang F, Jiang Y, Zhi H, Dong Y, Li H, Ma S, *et al*. Artificial intelligence in healthcare: past, present and future. Stroke Vasc Neurol. 2017;2(4).
19. Kaul V, Enslin S, Gross SA. History of artificial intelligence in medicine. Gastrointest Endosc. 2020;92(4):807-812.
20. Li Y, Cui X, Yang X, Liu G, Zhang J. Artificial intelligence in predicting pathogenic microorganisms' antimicrobial resistance: challenges, progress, and prospects. Front Microbiol. 2024;14:1482186.
21. Mikhael PG, Wohlwend J, Yala A, Karstens L, Xiang J, Takigami AK, *et al*. Sybil: A validated deep learning model to predict future lung cancer risk from a single low-dose chest computed tomography. J Clin Oncol. 2023;41(12):2191-2200.
22. Olawade DB, Teke J, Fapohunda O, Weerasinghe K, Usman SO, Ige AO, *et al*. Leveraging artificial intelligence in vaccine development: A narrative review. J Microbiol Methods. 2024;106998.
23. Parija SC, Poddar A. Artificial intelligence in parasitic disease control: A paradigm shift in health care. Trop Parasitol. 2024;14(1):2-7.
24. Rabaan AA, Alhumaid S, Mutair A, Garout M, Abulhamayel Y, Halwani MA, *et al*. Application of artificial intelligence in combating high antimicrobial resistance rates. Antibiotics. 2022;11(6):784.
25. Reagan KL, Reagan BA, Gilor C. Machine learning algorithm as a diagnostic tool for hypoadrenocorticism in dogs. Dom Anim Endocrinol. 2020;72:106396.
26. Roy T, Sharma K, Dhall A, Patiyal S, Raghava GPS. *In silico* method for predicting infectious strains of influenza A virus from its genome and protein sequences. J Gen Virol. 2022;103(11):1802.
27. Shah SM A, Shamim A, Tariq F. Applications of AI in veterinary medicine. In: Digital Evolution: Advances in Computer Science and Information Technology, 2024, p. 88.
28. Sharma A, Virmani T, Pathak V, Sharma A, Pathak K, Kumar G, *et al*. Artificial intelligence-based data-driven strategy to accelerate research, development, and clinical trials of COVID vaccine. Biomed Res Int. 2022;2022:7205241.
29. Shine P, Murphy MD. Over 20 years of machine learning applications on dairy farms: A comprehensive mapping study. Sensors. 2021;22(1):52.
30. Tran BX, Vu GT, Ha GH, Vuong QH, Ho MT, Vuong TT, *et al*. Global evolution of research in artificial intelligence in health and medicine: a bibliometric study. J Clin Med. 2019;8(3):360.
31. Tsuneki M. Deep learning models in medical image analysis. J Oral Biosci. 2022;64(3):312-320.
32. Waljee AK, Higgins PDR. Machine learning in medicine: A primer for physicians. Off J Am Coll Gastroenterol. 2010;105(6):1224-1226.
33. Zuidema D, Kerns K, Sutovsky P. An exploration of current and perspective semen analysis and sperm selection for livestock artificial insemination. Animals. 2021;11(12):3563.

How to Cite This Article
Khan AH, Muneeb JM. Artificial intelligence in veterinary sciences: A paradigm shift. International Journal of Veterinary Sciences and Animal Husbandry. 2025;SP-10(7):04-08.