

Popular Article



One Health Approaches in Veterinary Science

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Abstract

One Health is an integrated approach that recognizes the interconnectedness of human, animal, and environmental health. Veterinary science plays a central role in implementing this approach through disease surveillance, zoonotic disease prevention, food safety, antimicrobial stewardship, wildlife health, and sustainable livestock management. Increasing interactions among humans, domestic animals, wildlife, and changing environments have intensified the risk of emerging infectious diseases and antimicrobial resistance. Collaborative surveillance and information sharing among veterinarians, physicians, environmental scientists, farmers, and public health professionals are therefore essential for effective prevention and control. Digital technologies, vaccination, biosecurity, responsible antimicrobial use, and community participation further strengthen One Health strategies. Integrating these measures can improve disease preparedness, protect animal and human populations, support environmental sustainability, and promote resilient health systems globally.

Keywords: One Health, Veterinary Science, Zoonoses, Antimicrobial Resistance, Food Safety, Wildlife Health, Sustainability

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Introduction

The health of humans, animals, and the environment is closely interconnected. Diseases that affect animals can directly or indirectly affect human populations, while environmental changes can influence the emergence, transmission, and persistence of diseases in both animals and people. This interconnectedness forms the foundation of the **One Health approach**, which promotes coordinated action among veterinary, medical, environmental, agricultural, and public health

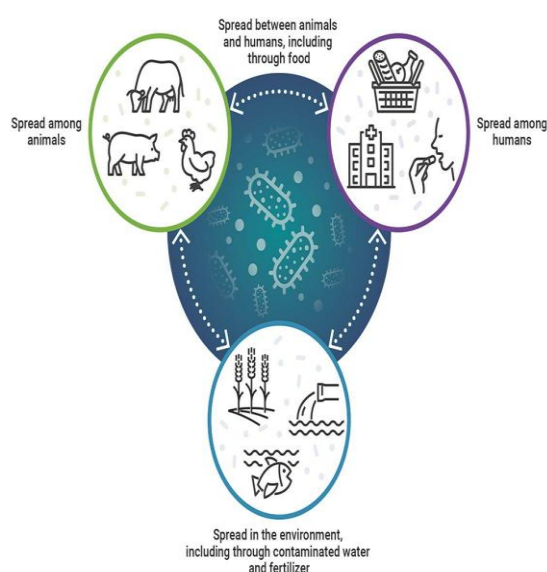
professionals. Veterinary science occupies a central position within this framework because veterinarians work at the interface of animal health, food production, zoonotic disease prevention, ecosystem health, and human well-being.

The growing movement of people and animals, intensification of livestock production, climate change, biodiversity loss, urbanization, and increased interaction between wildlife, domestic animals, and humans have created new opportunities for infectious diseases to

emerge and spread. Diseases such as rabies, avian influenza, brucellosis, leptospirosis, tuberculosis, anthrax, and several food-borne infections demonstrate the importance of integrating animal and human health surveillance. At the same time, antimicrobial resistance has become a major global concern in which antibiotic use in humans, livestock, aquaculture, and companion animals is interconnected.

One Health therefore extends beyond disease control. It includes responsible antimicrobial use, food safety, animal welfare, environmental protection, wildlife conservation, occupational health, and sustainable agricultural practices. Veterinary professionals can contribute through disease surveillance, vaccination, epidemiological investigations, laboratory diagnosis, biosecurity, farmer education, food inspection, wildlife health monitoring, and policy development.

A successful One Health system requires continuous communication and data sharing among different disciplines. Rather than treating human, animal, and environmental health as separate sectors, it recognizes them as components of a single interconnected system. The approach is particularly important for developing effective strategies against emerging diseases and for promoting sustainable health and agricultural systems.



Concept and Principles of the One Health Approach

One Health is an integrated approach that recognizes the interdependence of people, animals, plants, and their shared environment. Its central principle is that complex health problems cannot always be solved effectively by one profession or sector working independently. Veterinary medicine, human medicine, environmental sciences, epidemiology, microbiology, ecology, agriculture, food science, and social sciences may all contribute to understanding and managing a health problem.

The One Health approach is based on several important principles. The first is **collaboration**. Veterinarians, physicians, laboratory scientists, environmental specialists, farmers, wildlife experts, policymakers, and community organizations should work together. The second is **communication**, particularly the timely exchange of information about disease occurrence, antimicrobial resistance, environmental hazards, and emerging threats.

The third principle is **coordination of surveillance and response**. Information collected from livestock, wildlife, humans, food systems, and environmental sources can be combined to identify disease patterns at an early stage. The fourth principle is **prevention rather than dependence on treatment alone**. Vaccination, biosecurity, hygiene, environmental management, vector control, and responsible antimicrobial use can reduce disease risks before they become widespread.

Another important principle is **sustainability**. Health interventions should consider their long-term effects on ecosystems, agricultural productivity, animal welfare, and human livelihoods. One Health also recognizes that health risks are influenced by social and economic conditions. Smallholder farmers, livestock workers, veterinarians, slaughterhouse employees, and rural communities may face particular occupational and environmental exposures.

Role of Veterinary Science in One Health

Veterinary science is one of the major pillars of One Health because animals serve as reservoirs, hosts, sentinels, and sources of food and livelihood. Veterinarians can identify diseases in animals before they become apparent in human populations and can contribute to controlling pathogens at their source.

Veterinary practitioners are involved in routine disease diagnosis, vaccination, treatment, herd health management, and biosecurity. These activities have direct implications for public health. For example, preventing infection in dairy cattle can reduce the risk of contaminated milk entering the food chain, while controlling zoonotic diseases in dogs can reduce human exposure.

Veterinary epidemiologists study patterns of disease occurrence and transmission within and between animal populations. Their work can help identify risk factors and develop targeted interventions. Veterinary laboratories also contribute through pathogen identification, antimicrobial susceptibility testing, molecular surveillance, and monitoring of emerging infections.

Veterinarians working in food safety inspect animals and animal products at different points in the production chain. They contribute to the prevention of food-borne diseases by monitoring slaughterhouses, meat-processing facilities, dairy systems, poultry production, fisheries, and other food-producing sectors.

Veterinary professionals also have an important role in wildlife health. Wildlife species can serve as reservoirs or hosts for pathogens, and changes in land use, habitat fragmentation, and human encroachment can increase contact between wildlife, domestic animals, and humans. Wildlife disease surveillance can therefore provide valuable information for preventing spillover events.

Zoonotic Disease Prevention and Control

Zoonotic diseases are among the most important areas in which One Health principles

are applied. These diseases can naturally move between animals and humans and may be caused by bacteria, viruses, parasites, fungi, or other infectious agents.

Veterinarians contribute to zoonotic disease prevention through surveillance, diagnosis, vaccination, treatment, quarantine, animal movement control, and public education. Diseases such as rabies illustrate the value of coordinated interventions. Mass vaccination of dogs, responsible pet ownership, rapid diagnosis, and appropriate human post-exposure management require cooperation between veterinary and medical sectors.

Brucellosis provides another example. Control in livestock through testing, vaccination where appropriate, movement management, and hygienic handling of animal products can reduce human exposure. Similarly, surveillance of tuberculosis in cattle can contribute to both livestock health and public health protection.

Emerging zoonoses require particularly strong collaboration. Wildlife surveillance, ecological monitoring, animal disease reporting, laboratory diagnostics, and human clinical surveillance can be combined to identify unusual disease patterns. Early detection can permit rapid response before a local outbreak develops into a wider public health problem.

One Health and Antimicrobial Resistance

Antimicrobial resistance is a major challenge that clearly demonstrates the need for One Health cooperation. Resistant microorganisms can circulate between humans, animals, food systems, and the environment. Antibiotic use in one sector can contribute to selection pressure that has implications beyond that particular sector.

Veterinary science can help address antimicrobial resistance through **antimicrobial stewardship**. Veterinarians should prescribe antimicrobial drugs based on appropriate clinical assessment and, where feasible, laboratory evidence. Unnecessary use, inappropriate dosing, prolonged treatment, and indiscriminate use of critically important antimicrobials should be avoided.

Preventive animal health management can reduce the need for antibiotics. Vaccination, improved nutrition, clean housing, adequate ventilation, biosecurity, parasite control, and good husbandry practices can decrease disease incidence. Maintaining accurate treatment records can also help monitor antimicrobial consumption.

Surveillance of antimicrobial resistance in livestock, companion animals, food products, and environmental samples can provide information about resistance trends. Sharing such data with medical and environmental laboratories improves understanding of resistance pathways.

Education is another important component. Farmers and animal owners should understand that antibiotics are not substitutes for proper hygiene, vaccination, nutrition, or disease prevention. Responsible use protects both animal health and the effectiveness of antimicrobial medicines for future generations.

Food Safety and Veterinary Public Health

Food safety represents another major area of One Health practice. Livestock, poultry, fish, dairy products, eggs, and other animal-derived foods can become vehicles for pathogens or chemical hazards if production, processing, storage, or handling practices are inadequate.

Veterinarians contribute to food safety throughout the food production chain. On farms, they support disease prevention and responsible medication use. At slaughter facilities, veterinary inspection helps identify diseased animals and unsuitable tissues. In processing environments, veterinary public health professionals contribute to hygiene monitoring and hazard control.

Food-borne pathogens such as *Salmonella*, *Campylobacter*, pathogenic *Escherichia coli*, and *Listeria monocytogenes* can have significant human health consequences. Controlling these organisms requires interventions at multiple stages, including farm management, transportation, slaughter, processing, distribution, retail, and household handling.

Residues of veterinary medicines and pesticides also require attention. Appropriate withdrawal periods and regulatory monitoring help prevent unacceptable residues in food. Veterinary professionals therefore contribute not only to animal health but also to consumer safety and confidence in food systems.

Wildlife Health and Biodiversity

Wildlife health has become increasingly important within One Health because ecological disturbances can modify disease transmission patterns. Habitat destruction, agricultural expansion, climate change, wildlife trade, and urban development can increase contact between humans, livestock, and wildlife.

Veterinarians working with wildlife can assist in disease surveillance, clinical care, population health assessment, rehabilitation, and outbreak investigation. Wildlife disease monitoring can act as an early-warning mechanism for pathogens capable of crossing species barriers.

Biodiversity also has complex relationships with disease ecology. Changes in species composition may influence host and vector populations, potentially modifying transmission dynamics. Therefore, conservation planning should consider disease ecology alongside habitat and population management.

Veterinary involvement in wildlife conservation is particularly valuable when endangered species are affected by infectious diseases, environmental contamination, or human-associated pressures. Integrated wildlife-livestock management can reduce unnecessary contact and improve disease prevention.

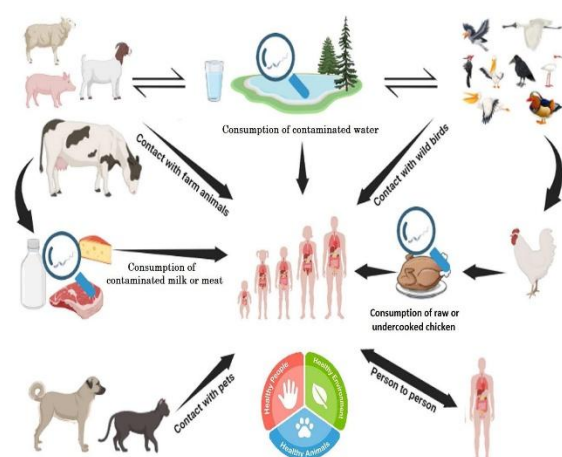
Environmental Health and Veterinary Science

Environmental conditions strongly influence animal and human health. Water quality, soil contamination, waste disposal, air pollution, climate variability, and ecosystem degradation can contribute to disease risks.

Livestock production generates manure and wastewater that can contain microorganisms, nutrients, pharmaceutical residues, and antimicrobial-resistant organisms. Poor management can contaminate soil and water resources. Veterinary professionals can support sustainable waste-management practices and disease-control measures that minimize environmental contamination.

Climate change also influences the distribution of vectors and pathogens. Changes in temperature, rainfall, humidity, and seasonal patterns may alter the geographical distribution of diseases and vectors. Veterinarians and epidemiologists can contribute to climate-sensitive disease surveillance and preparedness.

Environmental health is therefore not separate from veterinary practice. Sustainable livestock systems should balance productivity with animal health, environmental protection, resource conservation, and public health.



One Health in Livestock Production

Modern livestock production requires an integrated approach to maintain productivity while reducing disease and environmental risks. High-density animal populations can facilitate the transmission of infectious diseases if biosecurity and management systems are inadequate.

Veterinary herd-health programmes can integrate vaccination, nutrition, reproductive management, parasite control, housing, hygiene, and disease surveillance. Regular

health monitoring can identify problems early and reduce economic losses.

Biosecurity is especially important. Measures such as controlled animal movement, quarantine of newly introduced animals, cleaning and disinfection, pest control, appropriate carcass disposal, and visitor management can reduce pathogen introduction and spread.

Precision livestock technologies can strengthen One Health systems. Sensors, electronic identification, automated monitoring, artificial intelligence, and digital health records can help detect changes in body temperature, movement, feeding, milk production, behaviour, or other indicators of disease. Early detection can permit targeted intervention and reduce unnecessary medication.

Companion Animal Health and One Health

Companion animals are closely connected with human households and communities. Dogs, cats, and other companion animals can contribute positively to human well-being, but they can also participate in the transmission of certain infectious diseases and parasites.

Veterinary preventive care, including vaccination, parasite control, responsible breeding, hygiene, and routine health examinations, helps protect both animals and their owners. Veterinarians can educate owners about zoonotic risks, safe handling of animals, responsible waste disposal, and appropriate animal management.

Urban animal populations also require coordinated management. Stray animal vaccination and sterilization programmes, responsible ownership, waste management, and community education can contribute to disease prevention and animal welfare.

The human–animal bond also demonstrates that One Health includes broader aspects of well-being. Healthy companion animals can support psychological and social well-being, while responsible animal care promotes both animal welfare and community health.

One Health and Veterinary Education

Veterinary education must evolve to prepare professionals for interdisciplinary health challenges. Traditional veterinary training has often emphasized individual animal medicine, herd health, and clinical practice. One Health expands this perspective by incorporating public health, epidemiology, ecology, environmental science, food safety, antimicrobial stewardship, and communication.

Students should receive opportunities to work with medical, environmental, agricultural, and public health disciplines. Joint workshops, field exercises, simulation-based outbreak investigations, and interdisciplinary research projects can improve understanding of shared health risks.

Communication skills are equally important. Veterinarians often serve as intermediaries between scientific knowledge and farmers, animal owners, government agencies, and communities. Effective communication can improve vaccination acceptance, biosecurity compliance, responsible antimicrobial use, and reporting of unusual disease events.

Digital Technologies Supporting One Health

Digital technologies are increasingly important for integrating health information across sectors. Electronic veterinary records, geographic information systems, mobile reporting applications, remote sensing, laboratory databases, and artificial intelligence can support disease surveillance and decision-making.

Geographic information systems can map disease distribution and identify environmental and demographic risk factors. Mobile applications can facilitate rapid reporting from farms and field veterinarians. Cloud-based databases can enable authorized information sharing between veterinary laboratories, public health agencies, and environmental monitoring systems.

Artificial intelligence can assist with disease prediction, image-based diagnosis, outbreak modelling, and identification of unusual

patterns in large datasets. Digital technologies are particularly useful when information from multiple sectors must be integrated.

Technology alone, nevertheless, cannot replace professional judgment. Data quality, interoperability, privacy, cybersecurity, laboratory capacity, and appropriate interpretation remain important considerations.

Community Participation in One Health

One Health is most effective when communities are actively involved. Farmers, livestock keepers, animal owners, food handlers, wildlife-dependent communities, and local organizations often possess practical knowledge about local health conditions.

Veterinary extension services can help translate scientific information into practical recommendations. Training programmes can address vaccination, hygiene, disease reporting, animal handling, antimicrobial use, and biosecurity.

Participatory approaches can also improve trust. Communities are more likely to adopt health interventions when they understand the reasons behind them and participate in their development. Local veterinarians and extension professionals can act as important links between scientific institutions and rural communities.

Challenges in Implementing One Health

Despite its benefits, implementation of One Health faces several challenges. One major limitation is the separation of human, veterinary, agricultural, and environmental health systems. Different agencies may use separate databases, reporting systems, terminology, and operational procedures.

Limited resources can also restrict surveillance and laboratory capacity, particularly in rural and developing regions. Shortages of trained personnel, diagnostic facilities, equipment, and financial support may delay disease detection.

Data sharing presents another challenge. Institutions may be reluctant to exchange information because of administrative, legal,

commercial, or privacy concerns. Establishing clear data-sharing protocols and responsibilities is therefore essential.

Interdisciplinary communication can also be difficult because professionals from different fields may use different concepts and approaches. Regular joint training and collaborative programmes can help overcome these barriers.

Another challenge is converting the One Health concept into practical action. Successful implementation requires measurable objectives, defined responsibilities, adequate funding, and long-term institutional commitment rather than simply using One Health as a broad policy concept.

Future

The future of veterinary science will increasingly depend on integrated approaches to health. Emerging infectious diseases, antimicrobial resistance, climate change, biodiversity loss, food-system transformation, and expanding human–animal interactions will require collaboration across professional boundaries.

Veterinary surveillance systems can become more predictive through genomic epidemiology, artificial intelligence, digital sensors, and real-time data integration. Greater use of molecular diagnostics can help identify pathogens and track transmission pathways.

Sustainable livestock production will also become an important One Health priority. Improved animal genetics, precision nutrition, disease-resistant breeds, better housing, vaccination, biosecurity, and responsible resource use can increase productivity while reducing environmental impacts.

International cooperation will remain important because pathogens and antimicrobial resistance do not respect national borders. Standardized surveillance systems, laboratory networks, rapid information exchange, and coordinated emergency response mechanisms can strengthen global preparedness.

Conclusion

One Health provides a comprehensive framework for addressing health challenges that cross the boundaries between animals, humans, and the environment. Veterinary science is central to this approach because veterinarians contribute to zoonotic disease prevention, animal health, food safety, antimicrobial stewardship, wildlife health, environmental protection, and community education. Effective One Health implementation requires collaboration among veterinary, medical, environmental, agricultural, and public health sectors.

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