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**Review**



# Strengthening global health security: integrating One Health strategies with International Health Regulations (IHR) in a changing World

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## Abstract

The "One Health" approach is a multi-sectoral and multidisciplinary collaborative strategy, aiming to promote the health of humans, animals and the environment at local, national, regional and global levels. Effective health collaboration across sectors can be achieved through the "One Health" framework by adopting innovative health policies that shift from the concept of current healthcare services for ill people and animals to the prevention of health risks across entire communities: human, animal, plant, and environmental. This requires epidemiological surveillance, the development of risk and threat reporting systems, and the use of both descriptive and analytical epidemiological data to develop and improve overall health outcomes in humans, animals, plants, and the environment. Additionally, economic modelling can help to predict the potential impact of health threats, ensuring that new strategies are both proactive and sustainable, and are linked to health policies implemented from a One Health perspective and based on sound epidemiological studies. This would require securing the required resources, especially the human knowledge and competence necessary to implement these policies effectively. This study reviews the current concept and application of the One Health approach, its integration with the International Health Regulations (IHR) in epidemic and pandemic control, and its strengths and weaknesses. By analysing these factors, we propose a vision for future strategies that effectively incorporate the "One Health" approach into national and international health policies, with the goal of making "One Health" a practical and implementable framework, ensuring the sustainability of global health systems and fostering a healthier world for all.

## Keywords

One Health, Global Health Security, International Health Regulations (IHR), Disease Prevention, Sustainability

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## Introduction

The "One Health" approach is increasingly recognized in today's world as a key strategy for strengthening health systems through collaborative, multi-sectoral, and multidisciplinary efforts. This approach provides essential tools for promoting and protecting human and animal health in safe and sustainable environments at the local, national, regional, and global levels. While this approach has general value in stable societies, it is increasingly important in societies facing emergencies such as war, civil unrest, environmental degradation, natural disasters, rapid urbanization, gender imbalance, economic collapse, and population displacement (AVMA, OHITF. 2022).

Measuring the impact of the One Health approach on global health security is a critical issue. Importantly, the adoption of this approach has not yet demonstrated sufficient capacity to establish a sustainable model of global health resilience. Despite global commitments (such as the United Nations Sustainable Development Goals) addressing these challenges and sharing responsibility for all obstacles, the One Health approach didn't achieve global health security. This has been demonstrated by the failure of states and international organizations to protect the health of humans and animals who share a common environment, from the risks of epidemics and pandemics (such as the SARS and COVID-19 pandemics) (Baum et al, 2016; Sarah, et al. 2019).

States and international organizations were unable to implement a sustainable approach to build global health security. Other examples include the emergence of monkeypox (Mpox) or the recurring outbreaks of avian influenza. In order for the "One Health" approach to be effectively implemented, decision-makers and health professionals need comprehensive, and integrated, real-time shared information and interconnected data from all sectors (Tabbaa, 2008; Berthe et al, 2018; Agbo, et al. 2019).

This information enables them to make informed and appropriate decisions and improve risk assessment based on integrated and actionable health information. To achieve this, inter-sectoral epidemiological surveillance programs must be strengthened to maintain local, regional, and global health security and ensure the sustainability of the "One Health" approach.

This study reviews the evolution of the "One Health" approach, its impact on various health systems (local, national, regional, and global), and the challenges hindering its full implementation. It proposes a number of practical solutions that would facilitate its wider implementation in a practical and effective manner, through proposals related to the development of the International Health Regulations (IHR) based on an evaluation of previous experiences in their use.

## **Historical Perspective**

The World Health Organization (WHO) introduced the concept of "Health for All" in the 1970s. This was an ambitious goal: to ensure the health and well-being of people worldwide through universal access to health care, improved health infrastructure, and disease prevention strategies. The organization also made this goal the foundation of its primary health care strategy to promote health, human dignity, and improve quality of life. By 1981, the WHO defined "Health for All" as a state of personal well-being that enables individuals to lead socially and economically productive lives by eliminating major determinants of health, such as malnutrition, illiteracy, poor sanitation, contaminated drinking water, and inadequate housing. It highlighted the need to address issues related to limited access to medical services, such as shortages of doctors, hospital beds, medicines, and vaccines.

WHO emphasized that "Health for All" is a comprehensive concept that requires efforts across the sectors of agriculture, industry, education, housing, communications, medicine, and public health. It set plans to achieve "Health for All" by the year 2000. Two and a half decades later, WHO's plan to implement comprehensive health security has proven to be idealistic and difficult to achieve. This is due to the rapid development of global challenges occurring in our changing world (including population growth, environmental degradation caused by climate change, deforestation, urban expansion and intensive agriculture, migration, economic disparity, technological advances, wars, and the emergence of new epidemics). These changes have led to increased human contact with wildlife or domestic animals, facilitating the spread of zoonotic diseases. It has also led to the continued movement of people, animals, and animal products due to international travel and trade (WHO, 1981; World Bank, 2012; WHO, 2015).

These conditions have provided a fertile environment for the evolution of many pathogens and their mutation among wild and domestic animals and humans, followed by the spread of epidemics and pandemics that threaten the lives of humans and animals in all societies. Examples include the spread of mad cow disease, avian influenza, swine flu, severe acute respiratory syndrome (SARS), Middle East Respiratory Syndrome (MERS), and, most recently, COVID-19 (Contribution to One World, One Health. 2022; European Union. 2022).

The "One Health" approach has emerged as a modern framework that recognizes the interconnectedness of human, animal, and environmental health. WHO regional institutions and countries have developed a practical design for implementing the "One Health" approach, recognizing the need for a coordinated, multi-sectoral response to health threats, that encompasses human, animal, and environmental health. This approach has been integrated into three major international policy frameworks (FAO, WOAHA & WHO. 2010; FAO, WOAHA & WHO. 2017; FAO, WOAHA & WHO. 2018; FAO, WOAHA & WHO. 2019):

- The WHO Convention on Epidemics, which includes provisions for cross-sectoral collaboration to prevent and address global health threats.
- The European Union's Global Health Strategy, which aligns health security efforts with sustainability and international cooperation.
- The German Government's Global Health Strategy, which supports the "One Health" principles as part of its commitment to public health and environmental protection (The Federal Ministry of Health Global Health Unit, 2020).

In 2022, the One Health High-Level Expert Group (OHHLEP) was established and tasked with coordinating

collaboration among the so-called "Quadripartite" comprising WHO, the World Organization for Animal Health (WOAH), the Food and Agriculture Organization of the United Nations (FAO), and the United Nations Environment Programme (UNEP) (FAO. UNEP. WHO. WOAH 2025). The OHHLEP's theory of change identified key areas of action for the organizations, including health risk factors requiring diverse solutions to identify actionable priorities. These could relate to disease vectors, illegal wildlife trade, or animal feed. Unfortunately, however, several obstacles have hindered the global health systems' transition from policy to practice (Mettenleiter et al 2023). These include:

- The lack of political will to integrate medicine, public health, animal health, and environmental health into a single health framework;
- The fragmentation of health governance;
- The failure of global health surveillance systems to provide, integrate, and analyze real-time data across the human, veterinary, and environmental health sectors.

Today, international health organizations face challenges in implementing "One Health" due to institutional barriers, such as funding, closure in specializations, lack of coordination, and divergent priorities. These barriers make it difficult to integrate human, animal, and environmental health initiatives. Key barriers include mistrust, differing values, conflicting objectives, limited data sharing across sectors, weak political will to foster genuine collaboration, and the economic interests of pharmaceutical, vaccine, pesticide, and other companies. National and international organizations often operate in separate and isolated sectors (human health, animal health, and environment). Each of these sectors has its own mandate, budgets, and objectives, making it difficult to align and unify efforts toward "One Health". Complex issues, such as climate change and deforestation, burden local and even international "One Health" efforts. Many low- and middle-income countries also suffer from weak and inefficient healthcare systems and veterinary services, limiting their ability to effectively implement "One Health" strategies (Karesh & Cook 2009; Kumar, 2014; Haxton et al, 2015).

## **Policy Integration**

WHO established the International Health Regulations (IHR) to provide countries with a legal framework for preventing, detecting, and responding to public health threats of international concern. The concept of "One Health," as an integrated approach to addressing health risks, is closely aligned with the objectives of the Regulations. IHR and the "One Health" approach share a common goal: "Prevent and control infectious diseases before they escalate into global crises" (Rocque, et al, 2019; Mohamed, Abdifetah 2024).

While IHR and the "One Health" approach can be synergistic, they face significant implementation challenges. These include limited resources for implementing integrated disease surveillance systems across health sectors. Political and administrative barriers to linking human, veterinary, and environmental health interventions also fragment decision-making. This leads to a lack of preparedness, delayed response, and missed opportunities for early intervention (WHO, 2008; Tabbaa, 2020).

An integrated "One Health" system can bridge this gap, allowing for faster identification of outbreaks and more effective containment measures. This approach is achieved through deliberate steps through health forecasting modelling linked to accurate and integrated data from all sectors (Serge Nzietchueng 2015; Kandel et al, 2017; Machalaba, et al, 2017; Kitua, et al. 2019).

This addresses food production, supply, storage, preparation, and safety. Takes into account changing rainfall patterns, and adapts new agricultural programs to manage rainfall to ensure resilience in crop and environmental management. However, in practice, many governments have failed to meaningfully integrate these principles into their national policies. It has become clear that it is essential to establish advanced "One Health" platforms, develop multi-sectoral coordination mechanisms, and leverage advanced technologies. These technologies include databases and various types of Artificial Intelligence (AI), and implement frameworks based on memoranda of understanding, ministerial executive orders, and government decisions. A major obstacle to implementation remains the misalignment of investment priorities. Despite growing evidence that preventative health measures are more cost-effective than reactive medical interventions, global health systems continue to prioritize disease treatment over prevention. Human and veterinary medicines, hospital infrastructure, and vaccine development dominate healthcare financing and investment. While basic preventive measures, such as biosecurity, ecosystem conservation, and sustainable agriculture, receive scant investment (Rushton, et al. 2012; Narrod, et al. 2012).

The overuse of antibiotics, pesticides, and vaccines has contributed to the rise of Antimicrobial Resistance (AMR)

(AMR is a global health threat in which germs such as bacteria, viruses, fungi, and parasites develop resistance to the drugs used to treat them, making infections more difficult to treat), environmental degradation, and the increased likelihood of new infectious disease outbreaks. COVID-19 has exposed the shortcomings of the current global health system, leading to delayed health responses and humanitarian and economic disasters that have impacted the global socioeconomic system. This comes despite the international community mandating that international organizations and the United Nations implement all the tools they have worked on since adopting the “One Health” approach in 2009. This includes implementing the approved version of IHR. The impact has also extended beyond immediate health risks, as unsustainable agricultural methods have created conditions favorable to microbial mutations, increasing the likelihood of future infectious diseases and pandemics (Machalaba, et al 2018; WOA, 2018; Pelican. et al, 2019; Garg & Banerjee 2021). Most medical education systems in human, animal, and plant health still prioritize disease treatment over disease prevention. They focus little on the broader interconnectedness of human, animal, and environmental health. Therefore, medical and veterinary education systems often fail to meaningfully support the “One Health” approach. This is largely because healthcare professionals and related sectors derive their primary revenues from treatment-based models rather than prevention. Global pharmaceutical consumption has continued its steady rise. IQVIA data indicates that growth projections for these uses have increased by two percentage points, despite lower projections for COVID-19 vaccines and treatments. Global pharmaceutical consumption has already grown by 14% over the past five years. It is expected to increase by another 12% by 2028, reaching an estimated annual consumption of 3.8 trillion defined daily doses. These indicators are in stark contrast to the implementation of the “One Health” approach, which primarily aims to improve health, alleviate suffering in people, animals, and the environment, and reduce the spread of disease (Stratton, et al. 2019; IQVIA Institute. 2025).

## **Technological Enablers**

Modeling the potential economic impact of the spread of health risks and threats helps anticipate and prevent large-scale health crises. This leads to more proactive and cost-effective interventions by establishing benchmarks for various infectious diseases and using these benchmarks to calculate the impacts of various interventions, such as mass vaccination programs, social distancing, biosecurity measures, or other measures established by IHR.

Modeling helps identify interventions to be avoided and those to be implemented. It can also predict future growth patterns. Next-generation sequencing (NGS), which is a modern method for rapidly sequencing fragments of DNA or RNA, is used in genomic surveillance to detect and track known and emerging infectious diseases caused by various pathogens. This technology provides insights into the behavior and evolution of these pathogens in communities around the world, offering exceptional scalability, speed, and accuracy in pathogen detection, providing the confidence needed to protect public health (Rüegg, et al. 2018; Zhang, et al. 2024a; Zhang, et al. 2024B; WHO, 2025).

Digital innovations, (such as Artificial Intelligence (AI), big data analytics, and blockchain technology), significantly support the core capabilities of IHR by enhancing disease outbreak detection, interoperability, and predictive risk modeling in the context of “One Health”. AI analyzes massive and disparate data streams from diverse sources across multiple sectors, (such as social media, news reports, and electronic health records), to identify early patterns of disease spread, that manual systems might miss. Blockchain technology also provides a secure and transparent framework for sharing data across multiple systems and stakeholders (human health, animal health, and environmental agencies) without the need for a single control center. This ensures data integrity and privacy for more effective disease surveillance and response (Ezenwaji et al 2024).

AI also contributes to building effective predictive models by integrating a wide range of factors, (such as travel patterns, climate data, population density, wildlife movement, and historical epidemics), to predict the location and time of the next disease outbreak. These models enable public health officials to make proactive decisions, (such as optimizing resource allocation, preparing for potential increases in cases at their source), before they reach humans or cause zoonotic epidemics, and implementing targeted interventions to mitigate the impact of disease outbreaks.

Initiatives such as the WHO Epidemic Intelligence from Open Sources (EIOS) demonstrate how integrating formal and informal data streams can enhance disease outbreak detection (WHO, 2024). The potential of these technologies lies in their ability to connect diverse, multi-sectoral information systems, creating interoperable decision support tools aligned with One Health principles (Figure 1).

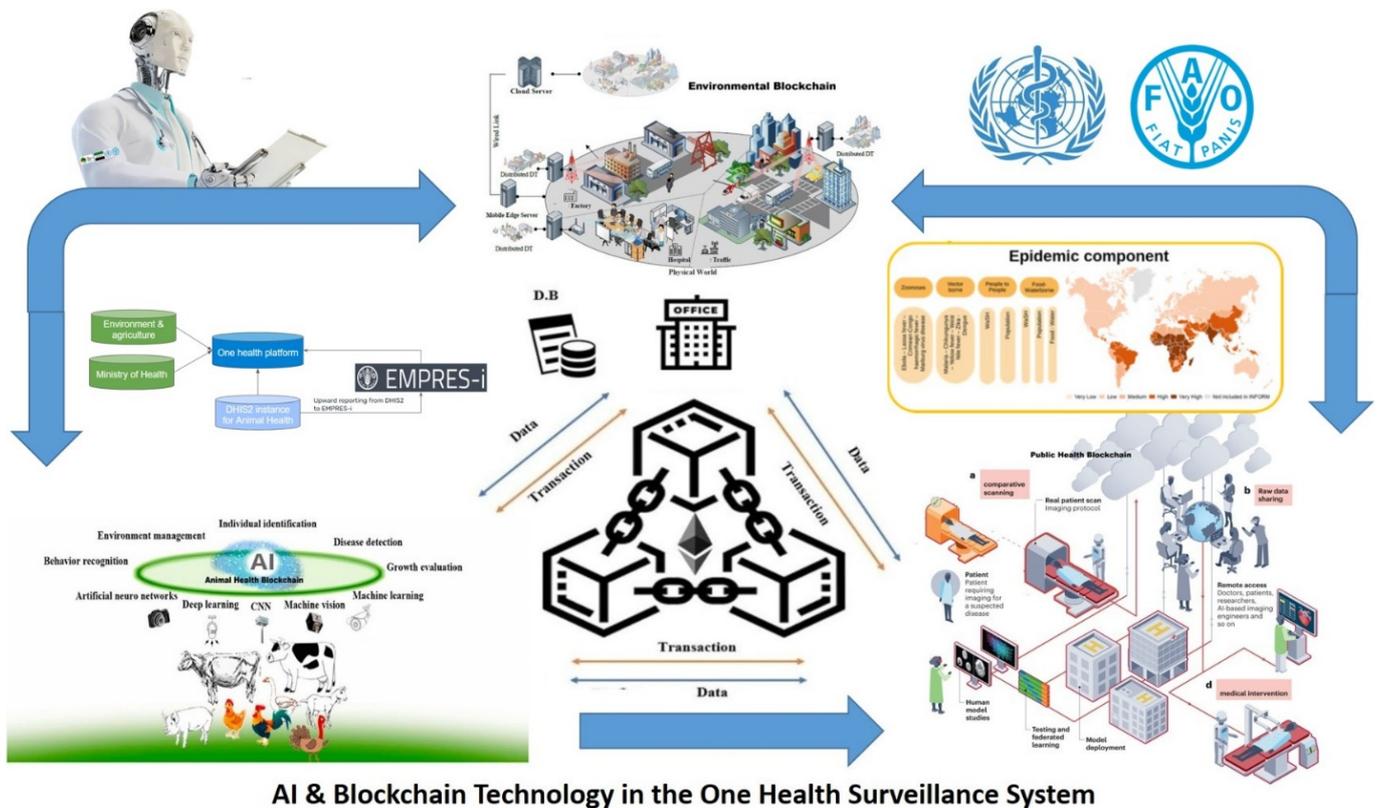


Figure 1. Artificial intelligence and blockchain technology in a One Health surveillance system.

## Ethical Governance

Local communities play a critical role in the success of "One Health" initiatives. Traditional and indigenous knowledge systems provide valuable insights for sustainable biodiversity management, zoonotic disease prevention, and ecosystem health. In many countries, developing joint health policies with local communities has improved risk management, participatory surveillance, and acceptance of public health measures. Linking scientific and traditional knowledge systems enhances cultural relevance and long-term sustainability, which also promotes community ownership of sustainable and effective health solutions. Diseases and their needs are made a status of exception, funded through taxes on health investments, and all medical interventions are provided at a high standard and free of charge to all. Attention is paid to raising community awareness so that commercial companies and international health organizations move away from investing in disease treatment and toward investing in public, animal, and environmental health, while promoting hygiene measures (personal hygiene, air hygiene, water hygiene, soil hygiene, and wildlife hygiene) and biosecurity. Reporting disease outbreaks can lead to commercial restrictions, social stigma, or political repercussions, discouraging transparency in disclosure. Therefore, ethical "One Health" governance should create safe and trustworthy reporting environments and protect whistleblowers and vulnerable people.

Therefore, a truly ethical "One Health" approach must be based on the four principles of health equity, which are:

- The equitable distribution of health resources and opportunities;
- Environmental equity, the right to a safe, healthy, and sustainable environment;
- Solidarity, shared responsibility and cooperation across countries and sectors;
- Subsidiarity, the decision-making process at the broadest possible and enabling local scale.

Ethical "One Health" governance is not merely a technical matter; it is a matter of political will, social justice, and moral responsibility. Only by integrating these principles into policy frameworks, education, and institutional design can "One Health" become a vehicle for achieving a sustainable and equitable global health transformation.

## Conclusions

Integrating IHR and the “One Health” framework is no longer just a theoretical aspiration; it has become a global necessity for shaping a more resilient, equitable, and sustainable health future. The COVID-19 pandemic and other recent epidemics have exposed shortcomings in existing health strategies. This underscores the need for a more integrated, proactive, and sustainable approach to global health security, based on shifting the traditional concept of health services to one focused on maintaining community health, using modern technologies rather than simply treating diseases.

Sustainable preventive health measures include:

- Ensuring universal access to clean and safe drinking water.
- Reorganizing cities and rural areas in a thoughtful and sustainable manner.
- Addressing personal needs to maintain public health, including biosecurity requirements, and improving healthy food production systems from animal and plant sources.
- Protecting the health of wildlife and regulating the interaction between humans and their biosphere.
- Leveraging AI and other available modern technologies to achieve effective interconnection between sectors for early and proactive management in identifying, preventing, preparing, and responding to risks.

A decisive shift toward integrated health governance, cross-sectoral collaboration, and proactive policies will spare the world preventable epidemics and easily avoidable environmental crises. It is time to bridge the gap between theory and practice and ensure that “One Health” becomes not just a guide, but a practical global health strategy that protects the future of humanity, including animals and the planet, and ensures the continuity of our lives and the lives of future generations.

## Ethical Approval

This study did not require ethical approval, as it was based solely on data from peer-reviewed literature, with no animal handling involvement.

## Conflict of Interest

The authors declare that they have no known competing financial or personal interests that could have appeared to influence the work reported in this paper.

## Author Contributions

All authors contributed equally to paper design, literature analysis, manuscript drafting and revision, and approved the final manuscript.

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