EDITORIAL

National One Health Mission: An Integrated Ecosystem for Augmenting India's Pandemic Preparedness

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Abstract

Over the past two decades, outbreaks such as Nipah virus infection, Severe acute respiratory syndrome, Avian influenza, Middle East respiratory syndrome, Zika virus disease, COVID-19 and Monkeypox have highlighted the growing threat of zoonotic spillovers and the need for proactive pandemic preparedness through a One Health approach integrating human, animal, and environmental health. In India, the National One Health Mission (NOHM), launched under the aegis of the Principal Scientific Adviser to Government of India, provides an integrated framework involving 16 Ministries and Departments for coordinated pandemic preparedness and response. NOHM is anchored on six strategic pillars: intersectoral R&D, integrated surveillance & multisectoral outbreak response, 23 BSL-3 laboratories, medical countermeasure development, data integration and capacity building. Key initiatives include sentinel syndromic surveillance for acute febrile, respiratory, encephalitic, and diarrhoeal illnesses, integrated surveillance at high-risk animal–human interfaces (slaughterhouses, bird sanctuaries, wetlands, and zoos) to strengthen early zoonotic spillover detection, genomic and metagenomic surveillance, support pathogen sequencing, variant tracking, and preparedness for "Disease X". Wastewater surveillance serves a population-level early warning system for priority pathogens. The National Joint Outbreak Response Team (NJORT) and national mock drills operationalize multisectoral rapid response. The proposed integration of Integrated Disease Surveillance Program (IDSP), National Digital Livestock Mission (NDLM), Department of Animal Husbandry & Dairying (DAHD), and Ministry of Environment, Forest & Climate Change (MoEFCC) data platforms will enable real-time intelligence sharing. Together with accelerated vaccine, therapeutic, and monoclonal antibody platforms aligned to the 100 Days Mission, and strong global collaborations, NOHM is building a resilient, future-ready pandemic preparedness ecosystem for India.

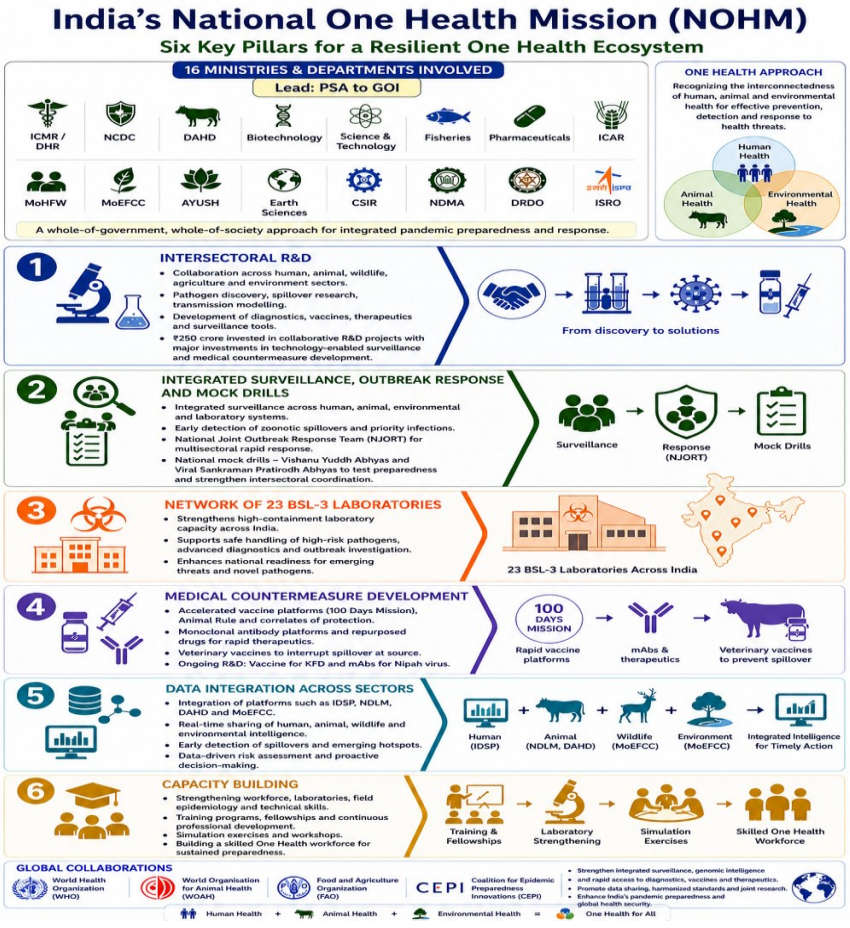
INTRODUCTION

Over the past two decades, outbreaks of Nipah, SARS, avian influenza (H5N1), H1N1, MERS, Zika, and COVID-19 have highlighted the increasing threat of zoonotic spillovers and the need for strong pandemic preparedness and vigilant health systems. The COVID-19 pandemic further emphasized the importance of a One Health approach integrating human, animal, and environmental health.

In India, the National One Health Mission (NOHM) was established in 2022 on the recommendation of the Prime Minister's Science, Technology and Innovation Advisory Council (PM-STIAC) as an integrated national framework for pandemic preparedness and response. The mission, aligned with the quadripartite One Health Joint Plan of Action (1) is steered by the Office of the Principal Scientific Adviser. It integrates 16 Ministries and Departments, including Indian Council of Medical Research (ICMR) /Department of Health Research; National Centre for Disease Control (NCDC); Departments of Animal Husbandry & Dairying (DAHD); Biotechnology; Science & Technology; Fisheries; Pharmaceuticals; Indian Council of Agricultural Research (ICAR); Ministries of Health & Family Welfare; Environment, Forest & Climate Change (MoEFCC); Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homeopathy (AYUSH); Earth Sciences; Council of Scientific & Industrial Research (CSIR); National Disaster Management Authority; Defence Research & Development Organisation (DRDO); and Indian Space Research Organization (2).

NOHM is anchored on six key pillars: intersectoral R&D, integrated surveillance & multisectoral outbreak response, a network of 23 BSL-3 laboratories, rapid medical countermeasure development, integrated data systems and capacity building (Figure 1). Together, these pillars strengthen India's preparedness for pandemics, zoonoses, antimicrobial resistance, and climate-sensitive health threats, building a resilient One Health ecosystem.

Figure 1; Source: Open AI Version 5.3



Intersectoral R&D: Intersectoral R&D is a key pillar of NOHM, fostering collaboration across human, animal, wildlife, agriculture, and environmental sectors to address emerging health threats at the human–animal–ecosystem interface. One Health approach supports surveillance, pathogen discovery, spillover research, transmission modelling, and development of diagnostics, vaccines, and therapeutics for priority pathogens and Disease X preparedness. To date, NOHM has supported collaborative R&D projects worth ₹250 crore, strengthening India's epidemic intelligence and pandemic preparedness.

Integrated surveillance & multisectoral outbreak response:

Integrated Surveillance:

Syndromic Surveillance: One of the key initiative under NOHM is the establishment of sentinel syndromic surveillance for early detection of infectious disease threats based on acute clinical syndromes of febrile illness, respiratory infection, encephalitis, and diarrhoea (3-5). This approach enables detection of pathogens which circulate across humans, animals, and the environment and may spill over unexpectedly, as seen with zoonotic infections such as Nipah virus infection, Avian influenza, Leptospirosis, and Brucellosis. By focusing on syndromic signals rather than specific pathogens, this model enables early outbreak detection, rapid public health response, and stronger situational awareness at the human–animal–environment interface. To operationalize this, ICMR has developed syndrome-wise priority pathogen lists (6), and is advancing multiplex molecular diagnostic assays for high-priority infectious syndromes (7), strengthening India's integrated surveillance, outbreak intelligence, and preparedness for emerging infections, antimicrobial resistance, and "Disease X" threats.

One of the key initiatives to support syndromic surveillance is the development of multiplex diagnostic tests. Multiplex diagnostics strengthen syndromic surveillance by enabling simultaneous detection of multiple priority pathogens from a single sample, particularly in syndromes with overlapping clinical presentations such as acute febrile illness, respiratory infections, encephalitis, and diarrhoeal diseases. They improve diagnostic speed and accuracy while reducing sample requirements, time, cost, and uncertainty. These platforms support integrated human–animal–environment surveillance and early detection of zoonotic spillovers, co-infections, and priority pathogens.

Integrated Animal–Human–Wildlife–Livestock Interface Surveillance: Surveillance at the animal–human–wildlife–livestock interface is a critical pillar of India's National One Health Mission (NOHM), as most emerging infectious diseases are zoonotic and originate from animal reservoirs. High-risk settings such as slaughterhouses, wetlands, bird sanctuaries, and zoos provide key opportunities for early detection of zoonotic spillovers and outbreak prevention. Under NOHM, ICMR and partner agencies have initiated targeted surveillance at these interfaces, integrating human syndromic surveillance, animal sampling, environmental monitoring, and genomic diagnostics. This ecosystem-based approach strengthens early detection of priority zoonoses such as Avian influenza, Nipah virus infection, Leptospirosis, and Brucellosis, enhancing India's epidemic intelligence and pandemic preparedness for pathogen "X".

Genomic/ Metagenomic Surveillance: Genomic surveillance and metagenomics have emerged as transformative tools within the One Health paradigm, for high-resolution tracking of pathogens across human, animal, and environmental systems. Whole-genome sequencing supports real-time monitoring of pathogen evolution, transmission chains, antimicrobial resistance determinants, and emergence of new variants, while metagenomics enables unbiased detection of known, rare, and novel pathogens directly from clinical or environmental samples, critical for "Disease X" preparedness. Under NOHM, genomic and metagenomic surveillance capacity is being strengthened by leveraging

the existing infrastructure and expertise of Indian SARS-CoV-2 Genomics Consortium (INSACOG) (8). Five such genomic/metagenomic hubs have been established under NOHM, providing a scalable capacity-building model for integrated pathogen sequencing, outbreak intelligence, antimicrobial resistance tracking, and early warning systems.

Wastewater surveillance: Wastewater surveillance is a powerful population-level tool for early detection of infectious disease transmission, often identifying pathogen circulation before clinical cases emerge and enabling early warning for outbreaks and emerging variants. Under NOHM, a national multi-pathogen wastewater surveillance initiative has been launched across 65 cities to monitor 13 priority enteric and respiratory pathogens, led by ICMR in collaboration with Tata Centre for Genomics & Society; National Institute of Virology, NCDC, CSIR, and WHO India.

National Joint Outbreak Response Team (NJORT) and Mock Drills: The establishment of the National Joint Outbreak Response Team (NJORT) under NOHM is a major step in strengthening outbreak preparedness through a rapid, multisectoral response mechanism for zoonotic and emerging infectious diseases. NJORT integrates expertise from human health, veterinary, wildlife, laboratory, environmental, water and food safety sectors to enable coordinated outbreak investigation, risk assessment, field epidemiology, and containment planning, aligned with synchronized action at the human–animal–environment interface involving multiple ministries synergistically. This is especially critical for zoonotic threats such as Avian influenza, Nipah virus infection, Crimean-Congo hemorrhagic fever, and Brucellosis. Complementing this, national mock drills, Vishanu Yuddh Abhyas and Viral Sankraman Pratirodh Abhyas (9, 10) have operationalized NJORT by simulating zoonotic outbreak scenarios and testing India's surveillance, diagnostics, genomics, and intersectoral response systems. Together, they strengthen preparedness, identify operational gaps, and build a unified One Health emergency response framework for future outbreaks and "Disease X" scenarios.

Network of 23 BSL-3 Laboratories: The National BSL-3 Laboratory Network under NOHM is a pluripotent coordinated platform of 23 nominated BSL-3 laboratories distributed across the country and anchored by multiple parent organizations, including the ICMR (10 laboratories), DBT (5), CSIR (2), DAHD (1), ICAR (4), and DRDO (1). This national network served as a coordinated for the safe handling and testing of high-risk pathogens across human, animal and environment sectors. The network is trained, equipped, and mandated to test 39 human and 15 animal pathogens with outbreak potential.

Medical Countermeasure (MCM) Development Framework: The development of diagnostics, vaccines and therapeutics is another key pillar of NOHM, aimed at strengthening preparedness against emerging zoonotic and pandemic threats. For high-fatality pathogens where conventional Phase 3 efficacy trials are often infeasible, NOHM is promoting accelerated regulatory pathways through the Animal route and validated correlates of protection to enable rapid vaccine development and approval. Aligned with the global 100 Days Mission concept, NOHM emphasizes ready-to-deploy vaccine platforms capable of generating candidate vaccines within 100 days of pathogen identification, alongside standardized monoclonal antibody platforms and repurposed drug pipelines for rapid therapeutic deployment. Coupled with veterinary vaccine development to interrupt spillover at the source, this integrated strategy will enhance India's capacity for rapid MCM development, outbreak containment, and pandemic resilience. Vaccine for Kyasanur Forest Disease (KFD) and monoclonal antibodies for Nipah virus infection are being developed as one of the first few R&D initiatives.

Data integration across sectors: Data integration across human, animal, and environmental health systems is a key pillar of NOHM. By linking surveillance platforms such as the Integrated Disease Surveillance

Programme (IDSP), National Digital Livestock Mission (NDLM), DAHD, and MoEFCC systems, NOHM will create an integrated surveillance ecosystem for real-time sharing of human, livestock, wildlife, and environmental intelligence. This will enable early detection of zoonotic spillovers, identification of emerging hotspots, and strengthens risk assessment and timely public health action, shifting India's preparedness from reactive response to proactive epidemic prediction and prevention.

Capacity Building:
Trained workforce of laboratory scientists has been developed under NOHM. Key areas of training include biosafety for human, animal, and environmental samples; testing of viral, bacterial and parasite across domains; biorepository establishment; immunology; sequencing and bioinformatics. These efforts thereby supporting an integrated One Health approach to national biosecurity and epidemic preparedness. Further, State level trainings for establishment of State Joint Outbreak Response Teams (SJORT) are underway.

Global collaborations: Global collaborations are a key pillar of NOHM, as zoonotic threats and antimicrobial resistance transcend national borders. Partnerships with the WHO, World Organisation for Animal Health (WOAH), Food and Agriculture Organization (FAO), and the Coalition for Epidemic Preparedness Innovations (CEPI) strengthen integrated surveillance, genomic intelligence, and access to diagnostics, vaccines, and therapeutics. These collaborations facilitate data sharing, harmonization of standards, and joint research initiatives, thereby strengthening India's pandemic preparedness and contributing to global health security.

In conclusion, the National One Health Mission is a key enabler of India's *Viksit Bharat 2047* vision, shifting the country from reactive healthcare to a proactive, bio-secure and resilient system through an integrated One Health approach. By building a national bio-surveillance grid of high-containment laboratories and digital early-warning systems, strengthening indigenous R&D for diagnostics and vaccines under *Atmanirbhar Bharat*, protecting livestock and agriculture systems from zoonotic threats, and linking 16 ministries through a unified data-sharing framework, the mission aims to strengthen health security, economic stability, and India's leadership in global pandemic preparedness and sustainable development.

Declaration of Generative AI and AI Assisted Technologies in the Writing Process

During the preparation of this work, the authors used ChatGPT (OpenAI) to assist in the conceptualization and preparation of Figure 1. Following the use of this tool, the authors critically reviewed, modified, and finalized the figure and take full responsibility for the content of the publication.

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